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Baby goat photo by Patrick Fore

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Department of Biology, Faculty of Mathematics and Natural Sciences, Universitas Padjadjaran. Jl. Raya Bandung-Sumedang Km 21, Jatinangor, Sumedang 45363, West Java, Indonesia. Tel. +62-22-7796412 line 104, Fax. +62-22-7794545, email: aje@smujo.id, asianjethnobiol@gmail.com

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Book:

Rai MK, Carpinella C. 2006. Naturally Occurring Bioactive Compounds. Elsevier, Amsterdam.

Chapter in book:

Webb CO, Cannon CH, Davies SJ. 2008. Ecological organization, biogeography, and the phylogenetic structure of rainforest tree communities. In: Carson W, Schnitzer S (eds) Tropical Forest Community Ecology. Wiley-Blackwell, New York.

Abstract:

Assaeed AM. 2007. Seed production and dispersal of *Rhazya stricta***.** 50th Annual Symposium of the International Association for Vegetation Science, Swansea, UK, 23-27 July 2007.

Proceeding:

Alikodra HS. 2000. Biodiversity for development of local autonomous government. In: Setyawan AD, Sutarno (eds.) Toward Mount Lawu National Park; Proceeding of National Seminary and Workshop on Biodiversity Conservation to Protect and Save Germplasm in Java Island. Universitas Sebelas Maret, Surakarta, 17-20 July 2000. [Indonesian]

Thesis, Dissertation:

Sugiyarto. 2004. Soil Macro-invertebrates Diversity and Inter-Cropping Plants Productivity in Agroforestry System based on Sengon. [Dissertation]. Universitas Brawijaya, Malang. [Indonesian]

Information from internet:

Balagadde FK, Song H, Ozaki J, Collins CH, Barnet M, Arnold FH, Quake SR, You L. 2008. A synthetic *Escherichia coli* predator-prey ecosystem. Mol Syst Biol 4: 187. www.molecularsystemsbiology.com. DOI:10.1038/msb.2008.24

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Species of forages utilized by farmers producing halal goats in Bangsamoro Autonomous Region in Muslim Mindanao (BARMM), Philippines

GERALDSON A. NAVARRA[1], FLORENCE ROY P. SALVAÑA[2,3,4,♥], ELMA G. SEPELAGIO[3], CARLITO B. SANCHEZ[5], CYRELLE M. BESANA[3], LEANNES JAY S. MANCERAS[3], SULOG G. BRA[6]

[1]Bureau of Animal Industry (BAI), Cotabato City, Philippines
[2]Graduate School, University of the Philippines Los Baños, College, Laguna, Philippines. ♥email: rdsalvana@usm.edu.ph
[3]Department of Biological Sciences, College of Arts and Sciences, University of Southern Mindanao, Kabacan, Cotabato, Philippines
[4]Philippine Council for Agriculture, Aquatics and Natural Resources Research and Development (DOST-PCAARRD), Brgy. Timugan, Los Baños, Laguna, Philippines
[5]Department of Clinical Veterinary Sciences College of Veterinary Medicine, University of Southern Mindanao, Kabacan, Cotabato, Philippines
[6]Mindanao State University-Maguindanao, Dinaig, Datu Odin Sinsuat, Maguindanao, Philippines

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Abstract. *Navarra GA, Salvaña FRP, Sepelagio EG, Sanchez CB, Besana CM, Manceras LJS, Bra SG. 2019. Species of forages utilized by farmers producing halal goats in Bangsamoro Autonomous Region in Muslim Mindanao (BARMM), Philippines. Asian J Ethnobiol 2: 1-7.* Local production of small ruminants necessitates forage assessment because animals are typically fed with locally available plant species. This study was carried out to determine the plants used as forage by raisers producing halal goats in BARMM (Bangsamoro Autonomous Region in Muslim Mindanao). A personal interview with the respondents producing halal goats was conducted, and a questionnaire was used to determine species of forages. A total of eight municipalities were included in the survey, seven of which were from Maguindanao, and one was from Lanao del Sur. Purposive sampling was used in the survey. A total of 47 respondents was interviewed based on the criteria: (i) a believer of Islam, (ii) with 5 to 24 breeders does, and (iii) willingness of the farm owner to participate in the survey. All respondents who fell to these criteria were interviewed. All respondents used forage species, including para grass (*Brachiaria mutica*), carabao grass (*Paspalum conjugatum*), ipil-ipil (*Leucaena leucocephala*), and kakawate (*Gliricidia sepium*) in all sampling sites. Other species included malunggay (*Moringa oleifera*), banana (*Musa balbisiana*), stylo (*Stylosanthes humilis*), Centrosema (*Centrosema pubescens*), langka (*Artocarpus heterophyllus*), pinto peanut (*Arachis pintoi*), Napier (*Pennisetum purpureum*), barnyard grass (*Echinochloa* sp.), Guinea grass (*Panicum maximum*), Indigofera (*Indigofera tinctoria*), calliandra (*Calliandra calothrysus*), katurai (*Sesbania grandiflora*) and rensonii (*Desmodium rensonii*). Only eleven percent (11%) of the respondents utilized improved and domesticated species of forages. Improved and domestic forage species are plants commonly cultivated forage for livestock production. According to the respondents, some plants in open vegetated areas like *Erigeron canadensis*, *Sphagneticola trilobata*, *Ageratum conyzoides*, and *Urena lobata* were also consumed by goats. The respondents also observed plant-related toxicosis caused by *C. pubescens* and *Urena lobata*. Most of the respondents in BARMM are not utilizing improved and domesticated species of forages and rely on locally available forages present in rangeland. Most of them have limited knowledge of the nutritional requirements of goats. There is a need to enhance the understanding of farmers'/breeders' importance of proper forage selection and combination.

Keywords: BARMM, forage, goats, halal

INTRODUCTION

Halal means "permissible," More often than not, it is being applied as a preferred method of animal slaughter (Ibrahim 2011). The term is also used for food and products acceptable to individuals practicing Islam. Farouk et al. (2016) added that it is not just the way animals are slaughtered but also how they are raised. Products labeled as Halal are gaining worldwide attention since it offers an alternative benchmark for food safety, hygiene, and quality assurance (Ambali and Bakar 2014). Among Halal food products, goat meat is one of the most important exported and imported commodities. Established Halal goat meat production facilities are globally located in Islamic countries like Indonesia, Malaysia, Pakistan, and Saudi Arabia. Non-Islamic countries like Singapore are also known to produce Halal goat meat in international trade (E-Halal Organization 2010). There have been issues with the authenticity of Halal meat and meat products. Nakyinsige et al. (2012) provided a complete review of these issues. Some of these issues include pork substitution, undeclared blood plasma, the use of prohibited ingredients, pork intestine casings, and non-halal methods of slaughter.

Halal goat production is becoming an economically viable enterprise in the Philippines. Some of the identified regions in the Philippines producing Halal goats include Bangsamoro Autonomous Region for Muslim Mindanao (BARMM) and Region XII (SOCCKSARGEN). Based on the number of goat heads nationwide, 4.55% of goats are from BARMM. All raisers in the region practiced backyard raising, which constitutes 4.61% of all backyard raisers in the country. There is a total annual production volume of

644 metric tons live weight. Based Although the per capita consumption is only 0.21 kg per year, Halal goats are commonly used by Muslims as a sacrifice in the observance of their faith, especially during religious occasions such as Kanduli, Aqiqah, Ramadan, Eid al-Fitr, and Eid al-Adha, which increase local demands for such commodity during these times.

The Philippine Halal products and services in 2017 were at Php 5.52 billion or 8.73% of the country's total export. Currently, the Halal goat industry in the Philippines is still in its infancy with minimal annual production, and resources, like forages, are devoted to this are undocumented. Naanep et al. (2009) also observed that goat raisers had inadequate knowledge of various Halal goat production aspects. Knowing this, there is a need to evaluate appropriate and acceptable resources in Halal goat production.

One of the primary resources needed to consider livestock production is forage. Forage assessment is an important consideration, especially in goat raising producing halal meat, since there is no available Halal certified feed concentrate. Moreover, backyard goat raisers commonly use locally available plant species as forage (Nampanzira et al., 2015). The type of forage used for livestock production has nutritional and health implications. Naturally, goats are considered active foragers and browsers. Browse refers to the leaves and twigs from shrubs and trees available to ruminants, such as goats, as feed. Free-forage individual goats can cover a wide area in search of plant materials. The morphology of the goat's mouth enables them to pick small plant parts, choosing the most nutritious available feed. Given the opportunity, goats select over 60 percent of their daily diet from bush and woody perennials and broadleaf plants over herbaceous species (Mkhize et al., 2014). As browsers, goats have been observed to stand on their hind legs and stretch up to browse the leaves. They can also throw their bodies against saplings to bring the tops within reach. Goats are also observed to climb trees or shrubs to consume preferred forage (Schlecht et al. 1999). Pasture areas tend to graze from top to bottom of plants and do not like to feed near the soil. In this type of feeding strategy, goats select grasses when the protein content and digestibility are high. However, they tend to switch to browse when these nutritive values are higher (Bojkovski et al., 2014).

Most backyard goat raisers rely on vegetated areas for forages, and the establishment of improved pasture is minimal (Cosadio et al., 2011). Also, a proper feeding ratio is not observed, and feeding is dependent on available plant species regardless of nutritional value. On the other hand, rangelands, where most farmers are dependent, may be contaminated with plants that are toxic to animals. There have been cases of poisoning, with a considerable mortality rate, due to consuming large amounts of toxic plants (Krueger and Sharp 1978). Moreover, most of the browse species preferred by goats are legumes and contain more tannins. Tannins have adverse and beneficial effects depending on their concentration and nature, animal species, physiological state of the animals, and diet composition (Makkar 2003). Silanikove et al. (1996) concluded that Goats could consume many tannin-rich plants. A tannin level below 5 percent seems to be tolerable for ruminant animals (Ebong 1995). While tannins are best known as an anti-nutritional factor, there is a long list of plant secondary products, such as cyanide, nitrate, fluoroacetate, cyanogenic glycosides, saponins, oxalates, mimosine, and various sterols, present in most browse species (Leng 1997).

As they constitute a significant portion of Halal goat production, forage assessment is necessary to address nutrition and health problems. It is one way to educate Halal goat raisers on proper forage selection and enhance their understanding of the importance of establishing their pasture planted with improved and domesticated species of forages.

MATERIALS AND METHODS

Location of the study

The study was conducted in some provinces of the Bangsamoro Autonomous Region in Muslim Mindanao (BARMM) consisting of five predominantly Muslim provinces: Basilan (except Isabela City), Lanao del Sur, Maguindanao, Sulu, and Tawi-Tawi. BARMM traverses two geological territories: Lanao del Sur and Maguindanao (recently Cotabato City included) in southwestern Mindanao and the island areas of Basilan (except Isabela City), Sulu and Tawi-Tawi in the Sulu Archipelago.

Municipalities included in the study were selected using purposive sampling with 2 criteria; (i) barangays (small areas which constitute a municipality) whose municipalities are producing sizeable heads of goats based on the reports provided by the Municipal Agriculture Office, and (ii) consideration of the peace and order condition of the area. Based on records, the two provinces have the highest concentration of goats, Maguindanao and Lanao del Sur. From Maguindanao, 7 municipalities were selected, namely Ampatuan, Datu Odin Sinsuat, North Upi, Sultan Kudarat, Sultan Mastura, Buldon, and Parang and from Lanao del Sur, only the Municipality of Balabagan. Respondents from these municipalities were purposely selected. The location of each respondent's farm was determined, and a map was generated (Figure 1).

Respondents and sampling procedures

Before sampling, meetings with the Provincial Agricultural Officer, Municipal Agricultural Officers, livestock technicians, and Barangay Chairpersons of the different barangays with the highest concentration of goats were done to discuss the study's rationale.

A total of 47 respondents were interviewed. Socio-demographic information of each respondent was determined, including age, sex, educational attainment, civil status, occupation, and herd size. The selection of respondents in each municipality was based on the following criteria: (i) a believer of Islam (ii) with 5 to 24 breeders does; and (iii) willingness of the farm owner to participate in the survey.

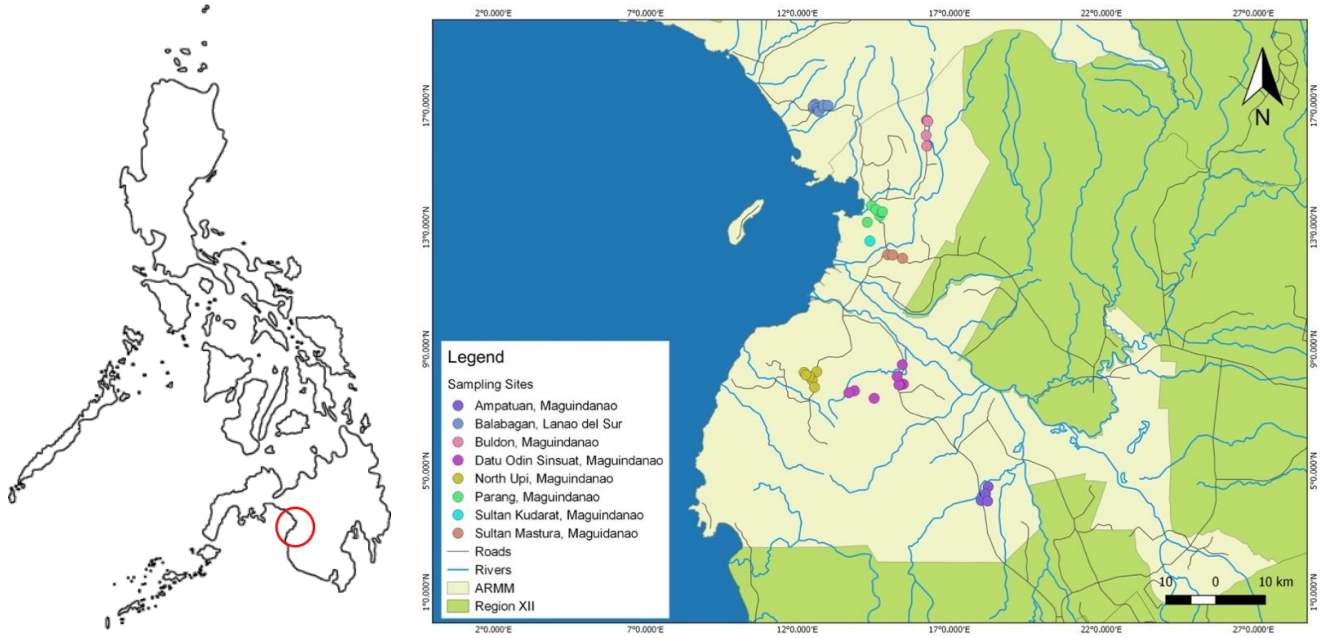

Figure 1. Map of the sampling sites in Bangsamoro Autonomous Region in Muslim Mindanao, the Philippines, showing the locations of the respondents

An on-farm assessment of resources included actual farm visitation and interviews of respondents. Each respondent was interviewed on the species of plants they used as forage.

Data analysis

Species richness represents the number of forage species provided by each respondent. Each species was ranked based on the frequency of all respondents who mentioned the species. Shannon-Weiner Index was used to determine the diversity of forage species in each site.

RESULTS AND DISCUSSION

Socio-demographic profile of the respondents

Table 1 shows the socio-demographic profile of the respondents. Among the 47 respondents, 80% were male, and 20% were female. Respondents' age ranged from 19-80 years old, with a mean of 40.7. Twenty percent (20%) of the respondents were elementary graduates, 60% were high school graduates, and 20 % were college graduates. Most of the respondents were married (98%), and 2% were single. Aside from goat raising, 22 % of the respondents have other jobs like employment in Local Government Units (LGU), University, and carpentry work. Others were engaged in crop farming (66%), and 12 % primarily depended on goat raising. Regarding herd size, 20% of the respondents have >20 breeder does while 80% have 5-20 breeder does. Most respondents stated that they sell their goats for school and emergency expenses. Only a few slaughter their goats for personal consumption during special occasions.

Table 1. Socio-demographic profile of the respondents

Indicators		n	Percentage (%)
Age	19-33 years old	15	31
	34-48 years old	24	51
	49 years old and above	8	18
Mean age	40.7 years old		
Sex	Male	37	80
	Female	10	20
Educational attainment	Elementary Graduate	9	20
	High School Graduate	29	60
	College Graduate	9	20
Civil status	Single	2	2
	Married	45	98
Occupation	Farming	32	66
	Goat	5	12
	Other	10	22
Herd size	5-20 does	37	80
	>20 does	10	20

Species of forages

Based on the interview results, a total of 17 plant species were used by the respondents as forage. Out of the 17 species, four were used by all respondents as forage, namely para grass (*Brachiaria mutica*), carabao grass (*Paspalum conjugatum*), ipil-ipil (*Leucaena leucocephala*), and kakawate (*Gliricidia sepium*) (Figure 2).

Most of the respondents also used malunggay (*Moringa oleifera*), banana (*Musa balbisiana*) leaves, stylo (*Stylosanthes humilis*), langka (*Artocarpus heterophyllus*) leaves, and centrosema (*Centrosema pubescens*) (Figure 3).

Among the respondents, less than 20% were using pinto peanut (*Arachis pintoi*), barnyard grass (*Echinochloa* sp.), Napier (*Pennisetum purpureum*), Guinea grass (*Panicum maximum*), Indigofera (*Indigofera tinctoria*), calliandra (*Calliandra calothyrsus*), katurai (*Sesbania grandiflora*) and rensonii (*Desmodium cinereum*) (Figure 4). It was also documented that only a few respondents (11%) established some of the aforementioned improved forages. Other respondents collect forages from vegetated areas or tethered goats in rangeland. Improved forages are species of plants commonly cultivated for livestock production.

Most of the respondents practiced tethering in open vegetated areas. The goat consumed other plant species tethered, including *Erigeron canadensis*, *Ageratum conyzoides*, *Sphagneticola trilobata*, and *Urena lobata* (Figure 5). Identification of these plants was based on the respondents' statement coupled with field observation and the respondents.

There were also issues stated by farmers related to forages. In Buldon (Maguindanao) and Balabagan (Lanao del Sur), *C. pubescens* (Figure 3-d) were the most common and abundant legumes. However, they seldom use this species since it has been associated with diarrhea cases in goats. In addition, respondents observed more than 60 deaths of a goat after consuming large amounts of *Urena lobata* (Figure 5-d) in Datu Odin Sinsuat, Maguindanao. According to them, it is the only available plant species, especially during the dry season.

Diversity index

Table 2 shows the computed diversity index values in each sampling site. The Highest Shannon-Weiner index was recorded in Balabagan, Lanao del Sur (2.369). This was followed by Ampatuan (2.288), Buldon (2.172) and Parang (2.043), all in Maguindanao. Sultan Kudarat, Maguindanao had the lowest Shannon-Weiner diversity index (1.609).

Table 1. Species richness and Shannon-Weiner Index of each sampling site

Sampling site	Species richness (n)	Shannon-Weiner Index (H)
Ampatuan, Maguindanao	10	2.288
Buldon, Maguindanao	9	2.172
Datu Odin Sinsuat, Maguindanao	7	1.661
Upi, Maguindanao	7	1.898
Parang, Maguindanao	9	2.043
Sultan Kudarat, Maguindanao	5	1.609
Sultan Amstura, Maguindanao	7	1.872
Balabagan, Lanao del Sur	15	2.369

Figure 2. Habit of (A) paragrass (*Brachiaria mutica*), (B) carabao grass (*Paspalum conjugatum*), (C) ipil-ipil (*Leucaena leucocephala*) and (D) kakawate (*Gliricidia sepium*).

Figure 3. Habit of (A) malunggay (*Moringa oleifera*), (B) banana (*Musa balbisiana*), (C) langka (*Artocarpus heterophyllus*) and (D) centrosema (*Centrosema pubescens*)

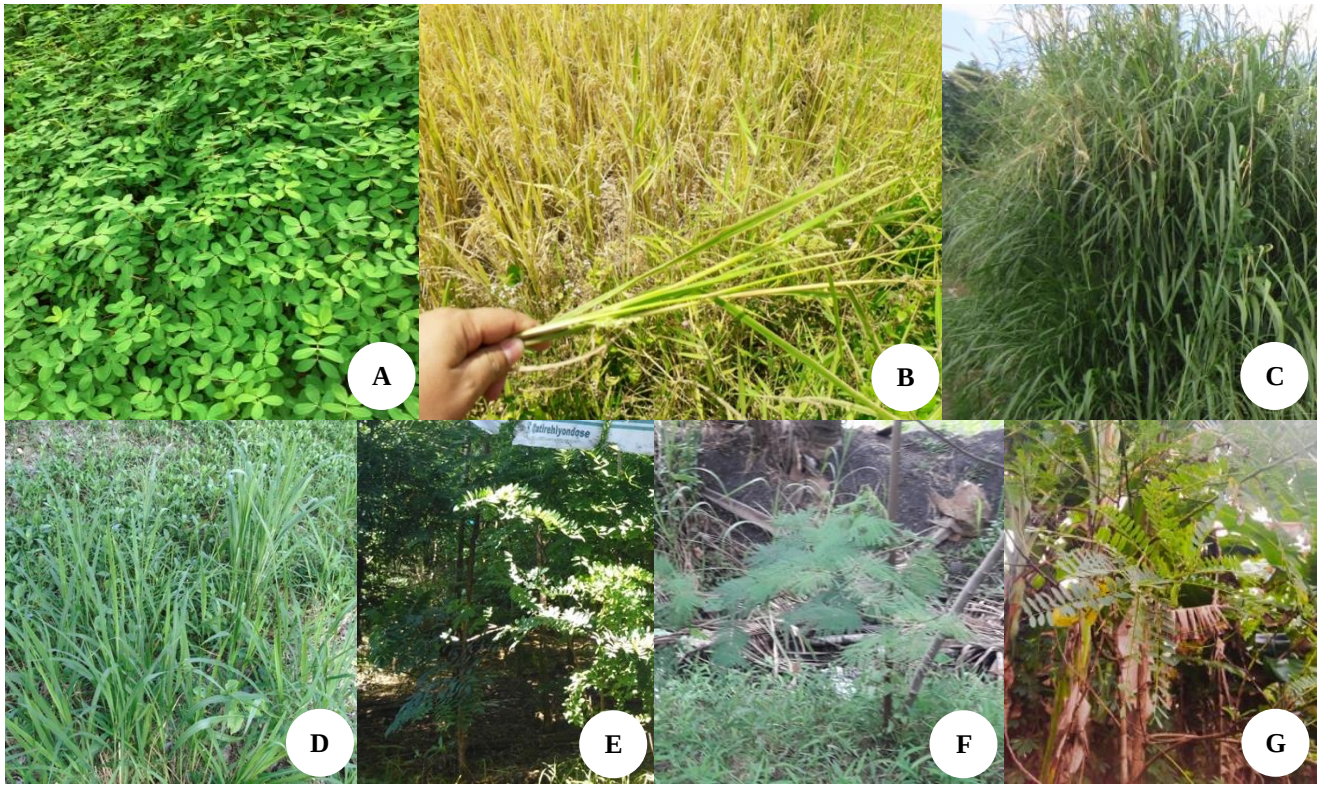

Figure 4. Habit of (A) pinto peanut (*Arachis pintoi*), (B) barnyard grass (*Echinochloa* sp.), (C) Napier (*Pennisetum purpureum*), (D) Guinea grass (*Panicum maximum*), (E) Indigofera (*Indigofera tinctoria*), (F) calliandra (*Calliandra calothyrsus*) and (G) katurai (*Sesbania grandiflora*)

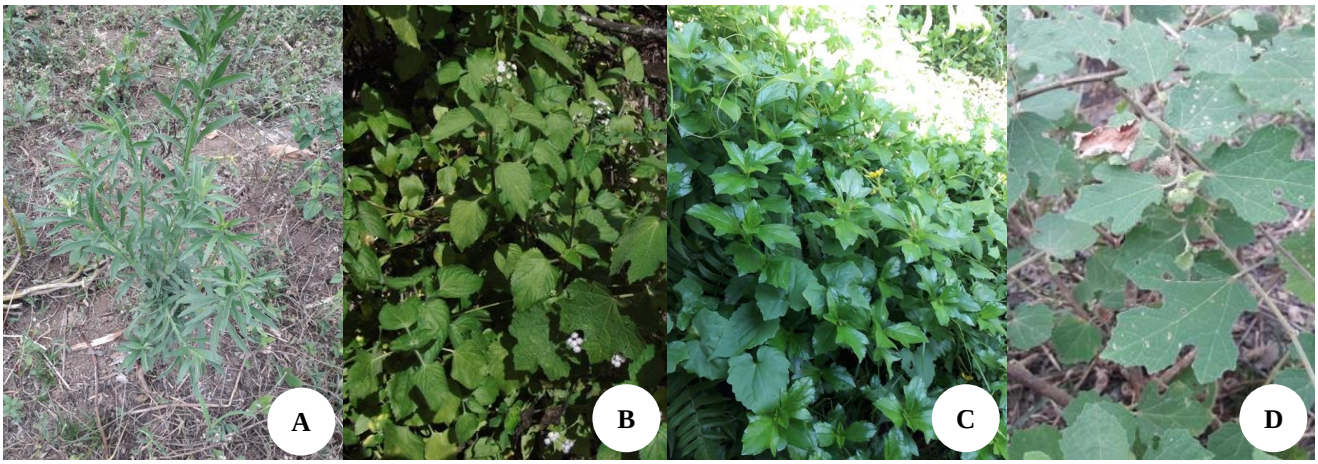

Figure 5. Habit of (A) *Erigeron canadensis*, (B) *Ageratum conyzoides*, (C) *Sphagneticola trilobata* and (D) *Urena lobata*

Discussion

It can be noted that forages used by the respondents differ from region to region. However, similarities may be observed, especially species that are well-known as forages. All of the respondents utilized para grass (*Brachiaria mutica*), carabao grass (*Paspalum conjugatum*), ipil-ipil (*Leucaena leucocephala*), and kakawate (*Gliricidia sepium*). In Fuentes et al.'s (2006) study, these species were also commonly used by conventional goat raisers in the nearby region of Davao (Philippines). In most cases, *B. mutica*, *L. leucocephala*, and *G. sepium* are used for cut-and-carry feeding systems, while *P. conjugatum* is grazed by goats in an open field. In the Philippines, Gerpacio and Castillo (1979) established a list of feedstuffs for goat production with their respective nutrient composition. The list includes some forage species like Napier grass (*Pennisetum purpureum*), para grass (*Urochloa mutica*), star grass (*Cynodon plectostachyus*),

Guinea grass (*Panicum maximum*), flemingia (*Flemingia macrophylla*), ipil-ipil (*Leucaena leucocephala*), Centrosema (*Centrosema pubescens*), siratro (*Phaseolus atropurpureus*), calliandra (*Calliandra callothyrsus*), kakawate (*Gliricidia sepium*), pigeon pea (*Cajanus cajan*), mulberry (*Morus alba*) and rensonii (*Desmodium rensonii*). Goats are known to relish paragraphs, stargrass, Napier grass, Guinea grass, and Centrosema over-improved tropical grasses and legumes among these forages.

Moreover, Fujihara et al. (2006) evaluated the mineral nutrition of grazing goats and have enumerated some forage species in pasture areas for goats in Luzon. Several species of forages identified include *Axonopus compressus, Brachiaria mutica, Cynodon plectostachyus, Eleusine indica, Imperata cylindrical, Pennisetum purpureum, Rottboellia exaltata, Gliciridia sepium, Aeschynomene indica, Calopogonium mucunoides, Centrosema pubescens, Desmodium tortousum, Leucaena leucocephala,* and *Sesbania sesban.*

Among the *Brachiaria* species, only *B. mutica* can thrive well in waterlogged areas (Cardoso et al., 2013). The location of sampling areas can explain the availability of this species to all respondents interviewed. Based on the map (Figure 1), most of the sampling areas are located near bodies of water which favors the growth of *B. mutica.*

Both *L. leucocephala* and *G. sepium* are multipurpose forages. Farmers need to select species that can be used in different ways on the farm. These two species are not only protein-rich forage that can be used for ruminants but has other significant uses in the farm, such as fuelwood, fence, live post, shade, and windbreak. In addition, these species are easy to propagate using only stem cuttings (Mangesho et al., 2017). They are also common in open, shaded, and unutilized areas. *Leucaena leucocephala* is also known to be well-adapted in different environmental conditions in the tropics. It can also maintain green leaf and remain productive throughout a long dry season (Dubeux et al., 2017). On the other hand, Bestil et al. (2014) stated that *Paspalum conjugatum* has more significant potential as ruminant feed. However, the quantity of forage obtained from the species and its versatility to grow in marginal areas are its limitations when utilized as forage.

Most respondents also used *Moringa oleifera, Musa balbisiana* leaves, *Stylosanthes humilis, Centrosema pubescens,* and *Artocarpus heterophyllus* leaves. In Manh et al.'s (2005) study, *M. oleifera* can be used as sole feed for goats compared to *L. leucocephala*. Makkar and Becker (1996) added that *Moringa* foliage is an excellent and inexpensive protein source with low anti-nutritional factors. Banana leaves can be used as supplemental forage but not as sole forage. It is not enough to supply the nutritional requirements of goats. Although, banana leaves can be an alternative to reduce the weight loss of goats in case of reduction of forage availability, especially during the dry season (Pathoummalangsy and Preston 2008). This agrees with the interview results, wherein most of the respondents stated that banana leaves are utilized as supplemental feed. *Stylosanthes humilis* and *Centrosema pubescens* are also used as a protein for goats. Stylo is suited for forage in subhumid tropical and subtropical areas with a marked dry season and is applicable for cut and carry systems (Cook et al., 2005 source). *Centrosema pubescens* trailing-climbing forage crop with crude protein content ranges from 20 to 26%, usually intercropped with grasses, small tree legumes, and shrubs. In the upland areas of Leyte (Philippines), *Artocarpus heterophyllus* leaves are commonly fed in goats and have the potential to be supplemental foliage based on in-situ degradation since it may provide more excellent by-pass nutrients for utilization at the intestinal level (Bestil et al. 2014).

It is interesting to note that less than 20% of the respondents utilize improved species of forages. This result is commonly attributed to two factors: limited land area, expenses for improved pasture establishment, and unavailable planting materials for improved species of forages. Due to limited land area, many respondents practiced a cut and carry system of feeding their animals. Forage establishment bears additional costs for farmers. Prices may include planting materials, maintenance, and even fencing. In the study of Cosadio et al. (2011), although improved pasture establishment should be prioritized, most farmers only utilized open vegetated areas due to these constraints. Some farmers establish improved pastures but use native species. Unable to develop improved pastures with domesticated forage species can also be attributed to the existing knowledge of the respondents. Farmers are generally not aware of whether or not their goats have satisfied the daily nutritional requirements. They have nutritional needs of goats and feeding technology that can boost goat performance (Alcedo et al., 2015).

More than 60 deaths were recorded in Datu Odin Sinsuat, Maguindanao due to consumption of *Urena lobata*. Rangeland is composed of different species of plants that can be of poor nutritional value and contain toxic compounds. These plants are expected to be abundant, especially during extreme conditions like drought, while other plants cannot survive. In these manners, animals dependent on these plants like goats have no alternatives but to consume what is available in the field. It can be noted that plant poisoning is due to either accidental ingestion of material consumed along with forages or willful consumption of poisonous plants (Mugera 1970). This event is common to livestock, particularly goats, due to their dietary plasticity. Moreover, their capacity to access preferred and desirable plant species is also associated with poisoning events and limited pasture areas, and rangeland results in an increased incidence of animal poisoning (Damiran and Darambazar 2003). Non-conventional forage as a supplement to the poor quality and inadequate grasses during the dry season can also be attributed to plant-related poisoning, common in the topics (Olafadehan 2011). Poisoning events also depend on grazing behavior and animal susceptibility to plant toxins. In most cases, fewer production losses are observed when animals grazed on several species of forages than single species consumption. Moreover, variations in the palatability of plants to animals also affect cases of poisoning (Ralphs and Provenza 1990). Cardiac glycoside, a toxic compound in most animals, is

present in *Urena lobata*, which can cause death cases of goats (Fagbohun et al., 2012).

Based on the Shannon-Weinner index, Balabagan had the highest value corresponding to increased diversity. This result can be attributed to the respondents' more increased number of forage species identified and used in the area. This index measures the species abundance and richness, so high diversity in Balabagan, Lanao del Sur (Gaines et al. 1999). In addition, the Shannon diversity index ranges from 1.5 to 3.5, wherein the computed values in all sampling sites belong to this range which supports the accuracy of the results.

In conclusion, most respondents utilized feed resources available in open vegetated areas. Only a few of them use improved and domesticated species of forages due to limited land area, additional expenses in establishing improved forages, and unavailable planting materials.

REFERENCES

Alcedo MJ, Ito K, Maeda K. 2015. Stockmanship competence and its relation to productivity and economic profitability: The context of backyard goat production in the Philippines. Asian Australas J Anim Sci 28 (3): 428-434. DOI: 10.5713/ajas.14.0693.

Ambali AR, Bakar AN. 2014. People's awareness on halal foods and products: Potential issues for policy-makers. Procedia- Soc Behav Sci 121: 3-25. DOI: 10.1016/j.sbspro.2014.01.1104.

Bestil LC, Atole AF, Rama J. 2014. Chemical composition and digestibility of in situ common feed resources for ruminants in marginal uplands. Ann Trop Res 3: 179-190. DOI: 10.32945/atr36s12.2014.

Bojkovski D, Stuhec I, Kompan D, Zupan M. 2014. The behavior of sheep and goats co-grazing on pasture with different vegetation types in the karst region. J Anim Sci 92 (60): 2752-2758. DOI: 10.2527/jas.2013-7199.

Cardoso JA, Rincon J, Jimenez JC, Noguera D, Rao I. 2003. Morpho-anatomical adaptations to waterlogging by germplasm accessions in a tropical forage grass. AoB Plants 5: 1-14. DOI: 10.1093/aobpla/plt047.

Cook BG, Pengelly BC, Brown SD, Donnelly JL, Eagles DA, Franco MA, Hanson J, Mullen BF, Partridge IJ, Peters M, Schultze-Kraft R. 2005. Tropical Forages. CSIRO, DPI & F (Qld), CIAT and ILRI, Brisbane, Australia.

Cosadio AL, Hebron IU, Ellacer R. 2011. Assessment of Backyard Goat Raising in Claveria, Misamis Oriental, Philippines. Mindanao J Sci Technol 9: 73-86.

Damiran D, Darambazar E. 2003. Toxic Plants of Mongolian Rangelands. Eastern Oregon Agricultural Research Station Union, Oregon State University, Oregon, U.S.A.

Dubeux Jr, JCB, Muir J, Apolinarion VXO, Nair PKR, Lira MA, Sollenberger LE. 2017. Tree legumes: an underexploited resource in warm-climate silvopasture. Braz J Anim Sci 46 (8): 689-703. DOI: 10.1590/s1806-92902017000800010.

Ebong C. 1995. *Acacia nilotica*, *Acacia seyal*, and *Sesbania sesban* as supplements to tef (*Eragrostis tef*) straw fed to sheep and goats. Small Ruminant Res 18: 233-238. DOI: 10.1016/0921-4488(95)00676-6.

E-Halal Organization. 2010. Your ultimate guide to the world of Halal food. www.islamicpopulation.com

Fagbohun ED, Asare RR, Egbebi AO. 2012. Chemical composition and antimicrobial activities of *Urena lobata* L. (Malvaceae). J Med Plant Res 6 (12): 2256-2260. DOI: 10.5897/JMPR09.233.

Farouk MM, Pufpaff KM, AMIR M. 2016. Industrial halal meat production and animal welfare: A review. Meat Sci 120: 60-70. DOI: 10.1016/j.meatsci.2016.04.023.

Fuentes A, Revilla NN, Tanduyan R, Subaldo M, Natad V, Tantano R. 2006. Goat production and marketing practices in Davao del Sur. PCARRD [Philippine Council for Agriculture, Forestry and Natural Resources Research and Development] Highlights 2005. [Philippines]

Fujihara T, Serra AB, Serra SD, Orden EA. 2006. Mineral nutrition of grazing goats in Luzon Island, Philippines. Bull Fac Life Env Sci Shimane Univ 11: 19-34.

Gaines WL, Harrod JR, Lehkuhl JF. 1999. Monitoring Biodiversity: Quantification and Interpretation. General Technical Report PNW-GTR-443, USDA Forest Service, Pacific North-West Research Station. DOI: 10.2737/PNW-GTR-443.

Gerpacio AL, Castillo LS. 1979. Nutrient composition of some Philippine feedstuffs. Extension Division, Department of Animal Science, College of Agriculture, University of the Philippines Los Baños.

Ibrahim M. 2011. Consumer willingness to pay a premium for Halal goat meat: A case from Atlanta, Georgia. J Food Distrib Res 42 (1): 72-76.

Krueger WM, Sharp LA. 1978. Management approaches to reduce livestock losses from poisonous plants on rangeland. J Range Manag 31 (5): 347-350. DOI: 10.2307/3897357.

Leng RA. 1997. Tree legumes in ruminant nutrition. FAO Animal Production and Health Paper. 139, FAO, Rome.

Makkar HPS, Becker K. 1996**.** Nutritional value and anti-nutritional components of whole and extracted *Moringa oleifera* leaves. Anim Feed Sci Technol 63: 211-228. DOI: 10.1016/S0377-8401(96)01023-1.

Makkar HPS. 2003. Effects and fate of tannins in ruminant animals, adaptation to tannins, and strategies to overcome detrimental effects of feeding tannin-rich feeds. Small Ruminant Res 49: 241-256. DOI: 10.1016/S0921-4488(03)00142-1.

Mangesho WE, Kurwijila LR, Shirima DD. 2017. Leguminous fodder trees as protein source and carbon sink in smallholder dairy production systems in Muheza District, Tanga Region, Tanzania. Livest Res Rural Dev Volume 29, Article #186. http: //www.lrrd.org/lrrd29/10/wman29186.html

Manh LH, Nhut N, Dung X, Phung Ngoi T. 2005. Introduction and evaluation of *Moringa oleifera* for biomass production and as feed for goats in the Mekong Delta. Livest Res Rural Dev Volume 17, Article #104. http: //www.lrrd.org/lrrd17/9/manh17104.htm

Mkhize N, Scogings P, Nsahlai I, Dziba L. 2014. Diet selection of goats depends on season: roles of plant physical and chemical traits. Afr J Range For Sci 31 (3): 209- 214. DOI: 10.2989/10220119.2014.901417.

Mugera GM. 1970. *Phytolacca dodecandra* L'Herit toxicity in livestock in Kenya. Bull Epizoot Dis Afr 18: 41-43.

Naanep N, Velasco N, Tayab C, Jordan R, Alo A.M. 2009. Benchmarking of Halal goat production and processing practices in Region XII. Philippine J Vet Anim Sci 28 (2): 177-186.

Nakyinsige K, Che Man, YB, Sazili AQ. 2012. Halal authenticity issues in meat and meat products. Meat Sci 91: 207-214. DOI: 10.1016/j.meatsci.2012.02.015.

Nampanzira DK, Kabasa JD, Nalule SA, Nakalembe I, Tabuti JR. 2015. Characterization of the goat feeding system among rural smallholder farmers in the semi-arid regions of Uganda. Springer Plus 4: 188. DOI: 10.1186/s40064-015-0961-3.

Olafadehan OA. 2011. Changes in haematological and biochemical diagnostic parameters of Red Sokoto goats fed tannin-rich *Pterocarpus erinaceus* forage diets. Vet Archiv 81: 471-483.

PathoummalangsyK, Preston TR. 2008. Effects of supplementation with rumen fermentable carbohydrate and sources of 'bypass' protein on feed intake, digestibility, and N retention in growing goats fed a basal diet of foliage of *Tithonia diversifolia*. Livest Res Rural Dev Volume 20, supplement. http://www.lrrd.org/lrrd20/supplement/kham20076.htm

Ralphs MH, Provenza FD. 1990. Minimizing toxic plant losses through behavior modification. Proceedings, West Texas Toxic Plant Symposium. Ft. Stockton, Texas.

Schlecht E, Sangaré M, Becker K. 1999. Supplementation of Zebu cattle grazing Sahelian pasture. I. Diet selection and intake. J Agric Sci 133: 69-81. DOI: 10.1017/S002185969900667X.

Silanikove N, Gilboa N, Perevolotsky A, Nitsan Z. 1996. Goats fed tannin-containing leaves do not exhibit toxic syndromes. Small Ruminant Res 21: 195-201. DOI: 10.1016/0921-4488(95)00833-0.

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Functional food plants in Debre Markos district, East Gojjam, Ethiopia

HIRUT BELAY, TIGIST WONDIMU♥
Department of Biology, Addis Ababa University. Addis Ababa, Ethiopia. ♥Email: twtigistw@gmail.com.

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Abstract. *Belay H, Wondimu T. 2019. functional food plants in Debre Markos district, East Gojjam, Ethiopia. Asian J Ethnobiol 2: 8-21.* An ethnobotanical analysis of functional food plants was conducted in Debre Markos District, East Gojjam, Ethiopia, to record indigenous knowledge. Ethnobotanical methods were used to collect data from October 2015 to July 2016. Ten of 21 villages in this district were chosen randomly to perform the analysis. A total of 80 informants (61 men and 19 women) ranging in age from 20 to 79 were selected to participate in the study and provide information on functional food plants grown and used in the District. Twenty of the 80 informants were chosen (as key informants) based on recommendations from elders and kebele administrators, while the rest were selected at random. Semi-structured interviews and group discussions were used to gather ethnobotanical data. As functional food plants grown in the District, 29 species from 27 genera and 19 families were identified. The Poaceae and Fabaceae families proved to be the most diverse, with 5 and 4 species, respectively. Herbs (23), shrubs (3), and trees (3) are the species' habits (growth forms). Grains (23.4%) and leaves (23.4%) were the most commonly used plant components (13.8%). Cooking/boiling seeds was the most common form of preparation (23.4%), followed by raw/unprocessed seeds (12.9%). According to informant consensus, *Lupinus albus* L. (Gibto) was the most commonly recorded species (90%), followed by *Eragrostis tef* L. (Dabbo teff) (78.8%). *Linum usitatissimum* L. (Telba) was the most favored species for preventing multiple diseases in a preference rating. Based on the general use-value of functional food plants, a direct matrix analysis showed that *Eragrostis tef* L. (Dabbo teff) was the most important species. *Cinnamomum verum* L. was identified by the fidelity level index. *Lupinus albus* L. (Kerefa) (Gibto) has a high practical benefit in preventing diabetes mellitus and hypertension. The loss of agricultural lands due to new building construction was a critical threat to a few functional food plants such as Lupinus albus (Gibto) in the study area. The Woreda is in the central city of East Gojjam Zone. As a result, stalk owners must focus on resolving the problem.

Keywords: Debre Markos, ethnobotany, functional food plants, indigenous knowledge, phytochemicals

INTRODUCTION

Ethiopia is a country with a diverse range of climatic and ecological conditions and a large variety of flora and fauna. Furthermore, the country's high geographic heterogeneity and the various cultural diversity of the different ethnic groups resulted in a wide range of traditional expertise and practice (Asfaw 2001). Maintaining sustainable food production while delivering high-quality products with added versatility to prevent lifestyle-related diseases is challenging in food productivity and development research. (Wang and Bohn 2012).

Over and beyond standard diet, functional foods have health benefits. Functional foods differ from medicinal foods and dietary supplements in that they can be consumed freely as part of daily life. Medicinal foods and drugs are typically used to treat disease in specific cases. On the other hand, dietary supplements overlap with foods developed for specific dietary purposes and fortified foods (Ross 2000).

Most Functional Foods that have been shown to reduce lipid and cholesterol levels, increase bone mineral density and antioxidant status, and possess anticancer properties, are derived from plants (legumes, cereals, grains, fruits, and vegetables) with a few exceptions (Eskin and Tamir 2006). However, only a handful of the hundreds of plant-based functional foods that have been documented have been integrated into everyday foods (Wang and Bohn 2012).

According to Kassaye et al. (2006), healing in Ethiopian traditional medicine is about curing diseases and preserving human physical, spiritual, social, emotional, and material well-being. This means that Ethiopians have a long history of traditional knowledge about the role of food plants. Functional food plants are still widely used in Ethiopia, and their acceptability, availability, and popularity are undeniable, given that the majority of the population consumes them. People in Debre Markos District, like people in Ethiopia, have cultural activities passed down from generation to avoid such human diseases. However, according to FAO (1995), indigenous knowledge is rapidly disappearing in many parts of the world, including Ethiopia, due to changes in lifestyle, occupational habits of household members, and the death of knowledgeable people.

According to information obtained from Debre Markos University's Botanical Department and the researcher's opinion, no ethnobotanical research on "*functional food plants*" has been conducted in the Debre Markos District. By researching and recording historically used functional food plants in Debre Markos District, this study aimed to fill a gap in the country's limited functional food plant use inventory. The research will provide helpful information on the status of functional food plants and their application in

the study field. This will serve as a baseline for future studies.

The goals of the study were (i) to identify and record the people's indigenous knowledge of functional food plants in the study area, (ii) to classify and record the most significant functional food plants used by Debre Markos District residents, (iii) to show the way local people in the study area use plant parts as functional foods and the way they prepare them.

MATERIALS AND METHODS

Study area

The geographical location of the study area

Debre Markos is one of 18 Districts of East Gojjam Zone and 151 districts in Amhara National Regional State (DMDARDO 2015). It is the largest town in the East Gojjam Region, its located about 295 kilometers from Addis Ababa and 265 kilometers from Bahir Dar, the ANRS's capital. It is made up of 7 kebeles. Its elevation is between 2,420 and 2,509 meters above sea level, and its geographical coordinates are 10^0 20¨ N. 37^0 43‟ E.\ 10^0 333¨ N. 37^0 717¨ E. (Figure 1). The district is bordered on the east, north, and the west by the Gozamin district and the south by the Aneded district. The Woreda's topography is mostly 98% plane and 2% plateau (DMDFEDO 2015).

Soil and drainage

Clay and black soil are the two most common soil types in Debre Markos District, accounting for roughly 73% and 27% of the total area. The district's topography, vegetation, and rainfall pattern promote the existence of a few perennial rivers, such as Wetrin, Weseta, and Chemoga, which have been used for irrigation in the past (DMDARDO 2015).

Climate and ecology

The agro-climatic region is traditionally known as "weina-dega," with average annual temperatures varying between 15 and 20 ° C (Figure 2). The district is known for its unimodal raindrops, with the total yearly rainfall falling between the end of April and the end of October, with an average annual range of 1200mm and 1380mm (Figure 3) (DMDARDO 2015).

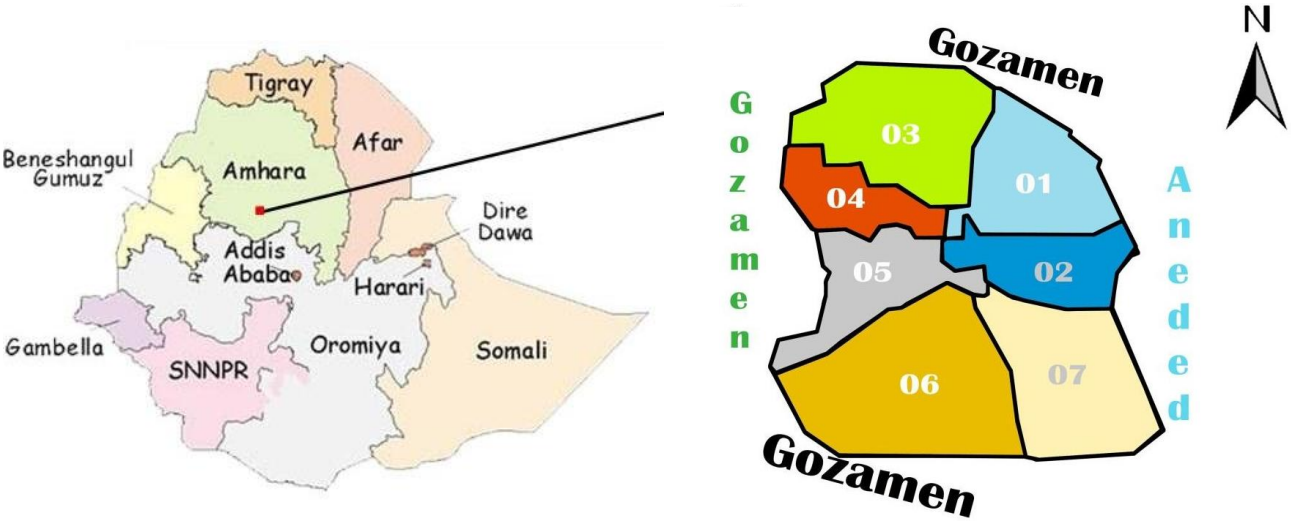

Figure 1. -Map of Debre Markos District (source: DMDFEDO 2015)

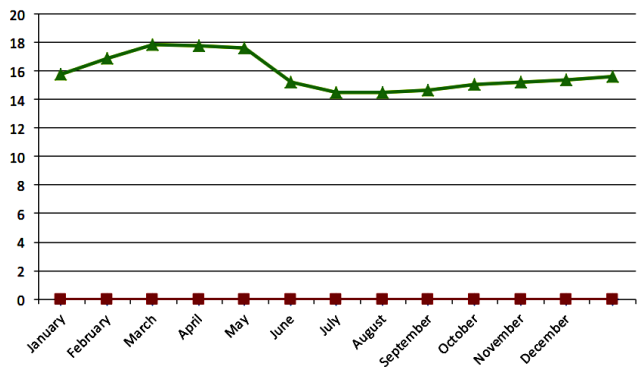

Figure 2. The monthly temperature of Debre Markos District 2015 (Source of data: -Versat international LLC)

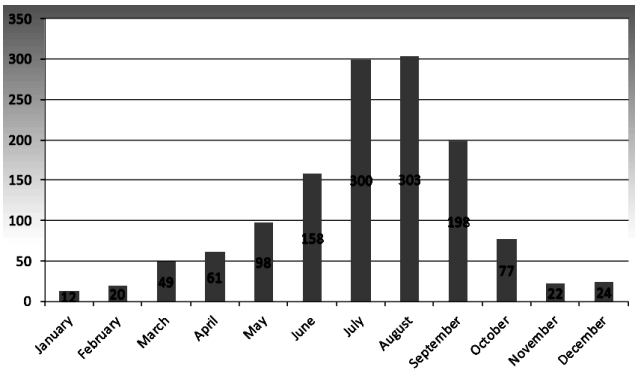

Figure 3. Monthly precipitation of Debre Markos District 2015 (Source of data:-Versat international LLC)

Crop production is mainly dependent on rain and small-scale irrigation. Only one rainy season (known locally as "kiremt") is critical for cultivating long- and short-cycle crops.

The area's agricultural system is a mixed farming system, in which crop production is multiple cropping with a small amount of land used intensively. Crop rotation, which alternates cereal production with legume crop production to preserve soil fertility, has traditionally been used to practice continuous cropping. The food crops grown in the district include cereal (wheat, teff, maize, barley, engedo, oat), fruits (papaya, pom, cocks, limes, oranges, mangoes, bananas, gibberries), vegetables (garlic, chocolate, tomatoes, pumpkins, salad, Kosta), root crops (sweet potatoes, potatoes, reddish, carrots) and cash crops, including the cereal crop, (cereals, pumpkins, gibberries, etc.), and (DMDARDO 2015). Land use and agricultural system

The district covers a total area of 6,160 hectares. The majority of the land is for farming purposes (2,363 ha, and 38,36%), followed by residential, road, and water areas of 1,995 ha, according to information obtained from DMDARDO (2015). (32.4%). Other land characteristics share significant areas, as listed in Table 1.

Population structure and medical service

The district has a total population of 107,433 people, with 50,036 males and 57,397 females. Rural dwellers account for 1,268 (1,053 males and 215 females) of the total population, while urban dwellers account for 106,165 (48,983 males and 57,182 females). The Amhara (98%), Oromo (0.8%), and other ethnic groups are the most numerous in the district (1.2%). 1Amharic is the first language of 99.3% of the population, and Orthodox Christianity is practiced by the majority (96%) of the people, whereas Protestantism and Islam are practiced by the remainder (DMDFEDO 2015).

According to DMDHHIV/AIDSPCO (2015), the first top ten human diseases in the area are acute upper respiratory infection with 3,431 (20.53%) of infected people, followed by Dyspepsia (gastritis) with 1,984 (11.87%) of infected people and the others are mentioned on Table 2.

However, according to DMDHHIV/AIDSPCO (2015), few people of Debre Markos are affected by chronic diseases such as diabetes, hypertension, heart disease, and cancer, with numbers 104, 432, 5, 12, respectively.

Table 1. Land use patterns of Debre Markos District, Ethiopia

Land use	Area (ha)	Percentage
Agricultural land	2363	38.36
Residence, road, and water bodies	1995	32.40
Grazing land	815	13.23
Forest areas	624	10.12
Irrigation areas	363	5.89
Total	6160	100

Source: DMDARDO (2015)

Table 2. Top ten human diseases in Debre Markos District, Ethiopia

Type of disease	No. of people affected	Percentage
Acute upper respiratory infection	3431	20.53
Dyspepsia (gastritis)	1984	11.87
Acute febrile illness	1891	11.31
Parasitic disease	1600	9.57
The disease of the musculoskeletal system and connective tissue	1506	9.01
Urinary tract infection	1407	8.42
Diarrhea	1338	8.01
Un specified digestive system disease	1305	7.81
Eye disease	1159	6.93
Pneumonia	1093	6.54
Total	16714	100

Source: DMDHHIV/AIDSPCO (2015)

MATERIALS AND METHODS

Design of the research

This cross-sectional study aimed to investigate and document the functional food plants in the Debre Markos District. From September 30, 2015, to November 12, 2015, the collection of journals and other literature was employed. A reconnaissance survey was carried out from October 5 to November 5, 2015. The deadline for developing and submitting proposals was November 27, 2015. Data collection took place from December 22, 2015, to the first two weeks of March 2016, and thesis development took place from the middle of April to the end of June 2016.

Reconnaissance survey and selection of starting

Before starting the actual study, a reconnaissance survey was conducted from October 5 to November 5, 2015, to gather information about functional food plants and identify sampling sites. Ten representative villages were chosen from seven kebeles (Table 3). To determine the number of representative villages, the population size and number of villages in each kebele were considered, and random selection was used to assess sample sites from each kebele. As a result, the study sites were chosen using a systematic simple random sampling method.

Selection of informants

A total of 80 informants (61 males and 19 females) aged 20 to 79 years were chosen, with the number of informants from each kebele determined systematically based on the proportion of the population size. In addition, twenty elders and knowledgeable people were identified as critical informants through purposive sampling (Martin, 1995), and other informants were chosen at random from the sampled villages. The key informants were selected based on the recommendations and comments of community elders, farmers, students, religious leaders, and the researcher's observations. Age group, educational and marital status of informants shows in Table 4

Table 3. Study kebeles with their corresponding sampling site and no. of informants participated

Study kebeles	Sample villages	Population size	Number of informants	Total
1	Endegem	12762	9	9
2	Engecha	13505	10	10
3	Shola amba	27163	13	21
	Yebragie		8	
4	Yemeka	14000	10	10
5	Kebi achira	18016	7	13
	Muakuat		6	
6	Yenora	10921	7	7
7	Abedeg	11066	6	10
	Chemoga		4	
Total	10	107433	80	80

Note: Source of population data: DMDFEDO, (2015)

Table 4. Demographics

	Age group (in yrs.)	Sex and no of informants		Total
		Male	Female	
Age group	20-30	13	5	18
	35-49	21	10	31
	50-64	20	3	23
	65-79	7	1	8
Education level	Illiterate	12	3	15
	Only read and write	22	9	31
	Modern education	20	7	27
	Church education	7	-	7
Marital status	Single	6	2	8
	Married	53	15	68
	Divorce	2	2	4

In the study area, eighty informants were divided into four age groups. They were young (20-34), middle-aged (35-49), elder (50-64), and elderly (65-79). The middle-aged groups had the highest number of informants. Males outnumbered females (61 to 19). The majority of the informants (31) could read and write. Approximately 68 of the total informants were married (Table 4).

Ethnobotanical data collection

Ethnobotanical data were collected from December 22, 2015, to March 21, 2016. Ethnobotanical information covers different types of functional food plants, cured diseases, parts used, and preparation methods, following the data collection tools recommended by Martin (1995).

Semi-structured interview-Ethnobotanical data was collected through semi-structured interviews using checklist item questions written in English (Appendix 2) and later translated into Amharic. The items include information on the informant's identity, a local health problem, the names of functional food plants, the part(s) used, preparation methods, and disease management. The entire informant interview was conducted directly between the researcher and the informants (Figure 4). Before starting data collection, informants' willingness was confirmed. This was accomplished by raising informant awareness by describing the future significance of the research for the study area and the country.

Group discussion-Short and detailed group discussions were held with informants about the functional food plants in the study sites. Local names of functional food plants, their uses, preparation methods, indigenous knowledge about them, and other data were collected.

Functional food plant specimen collection and identification

During a guided field walk, the voucher specimens were collected, numbered, pressed, and dried for the title. Flora of Ethiopia and Eritrea was used for identification with assistance from the Biology Department of Debre Markos University, Ethiopia.

Figure 4. Photographs showing group discussion to key informants during ethnobotanical data collection

Data analysis

Descriptive statistics

The ethnobotanical data was analyzed using survey and analytical techniques that Martin (1995) and Alexiades (1996) recommended for ethnobotanical methods. The data on functional food plants and associated information obtained from informants in the study area were analyzed and summarized using descriptive statistical methods. The most helpful information gathered on functional food plants identified by local people, including functional importance and preparation, was analyzed using appropriate software and descriptive research methods.

Informant consensus

Informants were consulted to assess the reliability of the information provided during the interview. It was dismissed as irrelevant if the informant's idea differed from the original report. Only the most important ones were considered and statistically analyzed; Alexiades' approach was used (1996). Similarly, the informant consensus factor was quantitatively analyzed for six plant uses identified by informants.

ICF=nur-nt /nur-1

Where,
ICF: Informants Consensus Factor
Nur: Number of citations in each category
Nt: Number of species used

Preference ranking

For most functional food plants used to prevent the most prevalent disease in the study field, preference (priority) ranking was performed using seven primary informants. As a result, key informants selected five functional food plants to be rated preferentially on a numerical scale for preventing Gastritis (0 for no value, 1 for lowest value, and 5 the highest value, and the rest with intermediate values). The values provided by the primary informants were combined to determine the community's preference for functional food plants in the study area. The highest score was placed first, while the lowest was placed last, and the rest were assigned different ranks based on the study results. A similar study on six functional food plants was conducted to see how effectively they prevented various diseases.

Direct matrix ranking

Direct matrix ranking compares the multiple purposes of plants commonly identified by informants (Cotton, 1996). Thus, a direct matrix ranking exercise was conducted on eight functional food plants based on the relative benefits obtained from each plant during the general group discussion and semi-structured interviews with key informants. Use values to each attribute assigned as (5-best, 4-very good, 3-good, 2-less used, 1-least used, and 0-no used) based on their perceived degree of usefulness; later, the value assigned for each plant were added together to decide its rank.

Fidelity level index

The fidelity level index (FL) is utilized to prove that certain plant species are used for the same main reason (Alexiaden, 1996). As a result, the fidelity level for functional food plants used to Prevent Diabetes and Hypertension was determined. The degree of fidelity is measured as follows:

FL (%) = (NP/N) X 100

Where
NP: Number of informants that claim the use of a plant species to prevent a particular disease
N: Number of informants who use the plant as a functional food, as Alexiades (1996) described.

RESULTS AND DISCUSSION

Status of indigenous knowledge related to functional food plants in the study area

The study area residents use a variety of functional food plants to prevent and treat various diseases. Except for a few (such as tuberculosis, pneumonia, and acute diarrhea), several health problems are thought to have plant or spiritual remedies in the region. These people use a variety of functional food plants to prevent and treat various diseases and improve their immunity. According to informants, information regarding functional food plants as a health feature was collected informally from friends or elders of neighbors, often mainly in conversation and mainly during the outbreak of a health-related issue. The second most common source of information acquisition was from family members who learned from their parents, accounting for 20% of all responses.

The majority of indigenous knowledge is acquired orally from elders, parents, or relatives, as it is done elsewhere (Abbasi et al., 2013). As a result, the information-transfer mechanism can challenge indigenous knowledge. Indigenous information is rapidly disappearing in many parts of the world, including Ethiopia, due to changes in lifestyle, changing occupational habits of household members, and the death of village elders (FAO, 1995). Many people interviewed for this study believe that modernization is endangering the information system.

Functional food plants in the study area

Distribution of functional food plants among taxa

During the research, 29 species from 27 genera and 19 families were described and reported. The Poaceae family proved to be the most numerous, with six species divided into five genera, followed by the Fabaceae family, which had four species divided into four genera. This could be because these are the most abundant, widely used, and cultivated food plants in the area. Solanaceae had two species and two genera, Rutaceae had two species under one genus, and the remaining (15) had one species (Table 5). This shows a high diversity of functional food plants in the study field and their use.

Diversity of habits (growth forms) of functional food plants

Herbs are the most common group of functional food plants in the study field, accounting for 23 species (79.3%), followed by shrubs and trees, each with 3 species (10.34%) (Figure 5).

Human diseases and the corresponding number of Functional Food Plant species used in the study area

A total of 29 food plant species have been shown to have anti-disease and immunity-boosting properties. The majority of them are local species widely used in the study area's culture. Apart from that, most of them are traditional foods, and their preparation methods are close to those used in our daily diet (Table 6).

As a result, about 19 human diseases have been avoided or healed by 29 plant species. In the study region, 13 diseases are prevented by using two or more Functional Food Plant species, and six are controlled by using only one plant species (Table 7). Chronic diseases were sporadic among the top ten illnesses identified by DMDHIV/AIDSPCO in 2015, indicating that the population's lifestyle is more closely linked to the use of Functional Foods; Functional Foods have a beneficial impact on improving health, preventing and reducing chronic disease risk factor (Roberfroid 2003).

The documentation demonstrates the use of significant numbers of functional food plants by Gastrontia with 8 species followed by Hypertension using 7 species; Cancer 6; Microbial and Diabetes with 5 species each and then Constipation with 4 species each (Table 8). This shows that various functional food plants in the field of study can prevent a particular disease.

Plant parts used as a functional food

Different sections of the plant were stated to be used for functional purposes in this research. According to the results of the interviews, grains were the most widely used plant components, accounting for (14; 48.3%), followed by leaves (4; 13.8%), tuber (3; 10.3%), fruits and grains (3; 10.3%), fruits (2; 6.9%), roots, barks, and bulb (1; 3.4%) (Figure 6). Functional food plants are regularly part of a diverse diet at an appropriate stage. As a result, grain is the most common standard edible component of plant species that is expected to have functional value in the study field.

Methods of preparation of functional food plants

Diverse processing of functional food plants is practiced in the local communities of the Debre Markos district; most of them are cook/boil (37.9%) followed by raw (20.7%), powder/baking (17.2%), and Fluid/juice account (17.2%). Other forms of preparations are also shown (Table 9).

Table 5. Number of Functional Food Plant species in each family in the studying area

Family	Scientific name	Vernacular name	Habit	No. of genera	No. of species	Percentage of plant species	Abundance
Alliaceae	*Allium sativum*	Nech shinkurt	Herb	1	1	3.44	Common
Apiaceae	*Daucus carota*	Carrot	Herb	1	1	3.44	Common
Asteraceae	*Guizotia abyssinica*	Nug	Herb	1	1	3.44	Common
Brassicaceae	*Brassica carinata*	Yabeshagomen	Herb	1	1	3.44	Common
Caricaceae	*Carica papaya*	Papaya	Tree	1	1	3.44	Common
Chenopodiaceae	*Beta vulgaris*	Key sir	Herb	1	1	3.44	Common
Cucurbitaceae	*Cucurbita pepo*	Duba	Herb	1	1	3.44	Common
Fabaceae	*Cicer arietinum*	Shimbra	Herb	4	4	13.79	Common
	Lupinus albus	Gibto	Herb				Common
	Trigonella foenum graecum	Abish	Herb				Common
	Vicia faba	Bakela	Herb				Common
Lamiaceae	*Thymus schimperi*	Tosign	Herb	1	1	3.44	Rare
Lauraceae	*Cinnamomum verum*	Kerefa	Tree	1	1	3.44	Rare
Lineaceae	*Linum usitatissimum*	Telba	Herb	1	1	3.44	Common
Pedaliaceae	*Sesamum orientale*	Selit	Herb	1	1	3.44	Rare
Poaceae	*Avena sativa*	Engedo	Herb	5	6	20.68	Common
	Eragrostis tef	Dabbo teff	Herb				Common
	Hordeum vulgare	Gebis	Herb				Common
	Sorghum bicolor	Zengada	Herb				Common
	Triticum dicoccon	Ajja	Herb				Common
	Triticum aestivum	Sendie	Herb				Common
Ranunculaceae	*Nigella sativa*	Tikurazemud	Shrub	1	1	3.44	Rare
Rutaceae	*Citrus aurantifolia*	Lomi	Shrub	1	2	6.89	Common
	Citrus sinensis	Birtukan	Shrub				
Solanaceae	*Lycopersicon esculentum*	Timatim	Herb	2	2	6.89	Common
	Solanum tuberosum	Dinich					Common
Theaceae	*Camellia sinensis*	Shay kitel	Tree	1	1	3.44	Rare
Urticaceae	*Urtica simensis*	Sama	Herb	1	1	3.44	Common
Zingiberaceae	*Zingiber officinale*	Zingiber	Herb	1	1	3.44	Common

Table 6. List of functional food plants

Scientific name of functional food plants	Family	Local name in Amharic	HbH	Pp	Disease type	Method of preparation
Allium sativum L.	Alliaceae	Nech shinkurt	H Hg	Bulb	Cancer, hypertension. Microbial disease	Crush the bulb of Allium sativum and daily prepare it as in "watt." Crush the bulb and add with tea or honey.
Avena sativa L.	Poaceae	Engedo	H CU	Grain	Diabetes, general weakness, osteoporosis.	Grind and bake the grain of *Avena sativa* to form "injera" or mix the grain powder with *Hordeum vulgare* and *Triticum dicoccon* and boil it to make "atmit*"* (gruel).
Beta vulgaris L.	Chenopodiaceae	Keysir	H Hg	taproot	Hypertension	Roast or cook the taproot of *Beta* vulgaris.
Brassica carinata A.Braun	Brassicaceae	Yabeshagomen	H Hg	Leaf	Constipation and cancer	Chop the leaf of *Allium cepa* and cook it with oil for a few minutes.
Camellia sinensis L.	Theaceae	Shay kitel	T Cu	Leaf	Heart disease	In water, boil the leaf of *Camellia sinensis*.
Cicer arietinum L.	Fabaceae	Shimbra	H Cu	Grain	Diabetes and general weakness	Roast the grain of *Cicer arietinum* as "Kolo" or cook it as "Nifro" or utilize the roasted powder as "Shiro."
Carica papaya L	Caricaceae	Papaya	T Hg	Fruit and Grain	Gastritis Helminthiasis	Without processing or in raw condition, eat the fruit of *Carica papaya* Dry and crush the grain of *Carica papaya* and drink it with tea.
Cinnamomum verum L.	Lauraceae	Kerefa	T Cu	bark	Diabetes	Boil the bark of *Cinnamomum verum* in water and mix it with tea or honey.
Citrus aurantifolia Christm.	Rutaceae	Lomi	Sh Hg	Fruit	Microbial disease	Pour the juice of the fruit of *Citrus aurantifolia* on uncooked vegetables as a salad or mix it with tea.
					Cancer	Eat the fruit as it is.
Citrus sinensis L.	Rutaceae	Birtukan	Sh Hg	Fruit	Microbial disease	The fruit or juice of the plant.
Cucurbita pepo L.	Cucurbitaceae	Duba	H Hg	Fruit	Gastritis Helminthiasis	Eat the fruit of *Cucurbita pepo* after being boiled. Roast the dried seed of the plant.
Daucus carota L.	Apiaceae	Carrot	H Hg	root	Cancer	Eat the fresh, unprocessed, or roasted and cooked, juice of *Daucus carota* root.
Eragrostis tef L.	Poaceae	Dabbo teff	H Cu	Grain	Anemia	Consume the grain powder of *Eragrostis tef* as "injera" or "atmit" gruel.
Guizotia abyssinica L.f.	Asteraceae	Nug	H Cu	Grain	Bronchitis	Eat the grain of *Guizotia abyssinica* after being roasted, well ground. Prepare the "Kolo" from *Hordeum vulgare* and *Cicer arietinum* by boiling them with water and drunk after being filtered.
Hordeum vulgare L.	Poaceae	Gebis	H Cu	Grain	Gastritis	Dehulled, roast, and then ground the grain of *Hordeum vulgare* and mix the powder with water and honey or sugar as "beso" or the roasted hulled grain of the plant as" Kolo."
					Osteoporosis or general weakness	Hull the seed of *Hordeum vulgare*, roast and grind it and cook it like porridge.
Linum usitatissimum L.	Linaceae	Telba	H Cu	Grain	Gastritis constipation, Breast cancer, attention deficit	Soak the seed of *Linum usitatissimum* with water, boil it, cool it, and drink it. Place the seed of *Linum usitatissimum* in any form, but usually the roasted and ground one, in the glass and mix it with warm water.

Lupinus albus L.	Fabaceae	Gibto	H	Cu	Grain	Hypertension	Consume the seed of *Lupinus albus* after being soaked for 2-3 days to remove its bitter taste. Then, it is roasted, boiled, and spiced with onion and pepper or processed in the local way "areki" synthesized to prepare "Gibto areki."
Lycopersicon esculentum Mill.	Solanaceae	Timatim	H	Hg	Fruit	Anemia, heart disease and cancer	Consume the juice, fresh or canned, of *Lycopersicon esculentum*; whole fresh or canned or crushed diced fruit or as tomato paste or soup.
Nigella sativa L.	Ranunculaceae	Tikur azmud	Sh	Hg	Grain	Constipation, liver disease and general weakness	Eat the powdered seed of *Nigella sativa*, mixed with honey or bread, or chew the seed directly.
Sesamum orientale L.	Pedaliaceae	Selit	H	Cu	Grain	Diarrhea	Consume the seed of *Sesamum orientale* or the roasted seed mixed on a loaf of bread as a spice.
Solanum tuberosum L.	Solanaceae	Dinich	H	Hg, and Cu	Tuber	Gastritis	The tuber of *Solanum tuberosum* in the form of juice.
Sorghum bicolor L.	Poaceae	Zengada	H	Cu	Grain	Hypertension and diabetes	The grain powder of *Sorghum bicolor* is a form of "atmit" or "injera."
Triticum dicoccon Schrank	Poaceae	Ajja	H	Cu	Grain	Diabetes, blood pressure, Rheumatism and osteoporosis	The flour from the grain of *Triticum dicoccon* as bread or "atmit" or the crushed seed as "Kinchie" or soup.
Triticum aestivum L.	Poaceae	Sendie	H	Cu	Grain	Constipation	The whole grain flour of *Triticum aestivum is* "injera" or bread. Also, the seed is roasted as "Kolo."
Thymus schimperi R.	Lamiaceae	Tosign	H	Wd	leaf	Hypertension and microbial disease	The leaf of *Thymus schimperi boiled with* water.
Trigonella foenum-graecum L.	Fabaceae	Abish	H	Cu	Grain	Gastritis hypertension and	Grind the germinated and dried seed of *Trigonella foenum-graecum* and Soak it with water for one night, withdraw the filtrate to minimize its bitterness, and mix it with water and drink it or boil and drink it with honey or sugar.
						Poliomyelitis	Grind the grain, mix it with water, put it at the child's back under the sun, and stroke it slowly.
Urtica simensis Steudel.	Urticaceae	Sama	H	Wd	leaf	Gastritis	Pick the leaves of Urtica simensis carefully with a protected hand, cut the leaves, spread them out b/n two hides on the ground, and rub them to avoid the burning sensation of the leaves; after that, boil and grind, then put salt on and prepare them.
Vicia faba L.	Fabaceae	Bakela	H	Cu	Grain	Bronchitis	Boil the Vicia faba grain and get water to drink.
						Gastritis	Drink roasted and powdered Vicia faba grains soaked in water overnight.
Zingiber officinale Mill.	Zingiberaceae	Zingiber	H	Hg	rhizome	Microbial disease	Place a few pieces of Zingiber officinale in a cup of boiling water, strain, and drink.
						Badmouth odor	Chewing the rhizome as it is and rinsing the mouth with water

Note: Hb: habit, H: herb, T: tree, Sh: shrub; H: habitat, Hg: home garden, Cu: cultivated; Pp: plant parts used

Table 7. List of human diseases in the study area with several functional food plants (NFFP) used to prevent them.

Disease prevented	Local name of the disease	NFFP	Percentage
Gastritis	Yechegoara beshita	8	27.5
Hypertension	Yedem gfit	7	24.1
Cancer	Cancer	5	17.2
Diabetes mellitus	Yeskuar beshita	5	17.2
Microbial disease	Worershign	5	17.2
Constipation	Yehod dirket	4	13.8
General weakness	Yeakim medakem	4	13.8
Osteoporosis	Yeatint melashek/Sibrat	3	10.3
Rheumatism	Kurtimat	2	6.9
Bronchitis	Yesal beshita	2	6.9
Heart disease	yelib himem	2	6.9
Anemia	Deme manes	2	6.9
Helminthiasis	Yehod telatil	2	6.9
Attention deficit	Yeamro zigemet	1	3.4
Badmouth odor	Motifo yeaf teren	1	3.4
Breast cancer	Yetuit cancer	1	3.4
Diarrhea	Tekimat	1	3.4
Liver disease	Yegubet beshita	1	3.4
Poliomyelitis	Yelejinet lemisha	1	3.4

Table 9. Methods of preparation of functional food plants

Methods of preparation	No. of FFP species	Percentage
Cooking/boiling	11	37.9
Raw/unprocessed	6	20.7
Powdering and baking	5	17.2
Fluid juice	5	17.2
Powdering and boiling	4	13.8
Crushing	3	10.3
Roasting	3	10.3
Roasting and crushing	3	10.3
Crushing and cooking	2	6.8
Boiling and grinding	1	3.4
Roasting, powdering, and soaking	1	3.4
Soaking and roasting	1	3.4
Dehulling and roasting	1	3.4
Powdering soaking	1	3.4

Table 8. List of human diseases that are prevented by more than three functional food plants in the study area

Family name	Scientific name of the plant	Vernacular name	Disease prevented	Local name of the disease	No. of plant	Percentage
Caricaceae	*Carica papaya*	Papaya	Gastritis	Yecheguara beshita	8	27.6
Cucurbitaceae	*Cucurbita pepo*	Duba				
Poaceae	*Horedeum vulgare*	Gebs				
Lineaceae	*Linum usitatissimum*	Telba				
Solanaceae	*Solanum tuberosum*	Dinich				
Fabaceae	*Trigonella foenum graecum*	Abish				
Urticaceae	*Urtica simensis*	Sama				
Fabaceae	*Vicia faba*	Bakela				
Alliaceae	*Allium sativum*	Nech shinkurt	Hypertension	Yedem gfit	7	24.1
Chenopodiaceae	*Beta vulgaris*	Key sir				
Fabaceae	*Lupinus albus*	Gibto				
Poaceae	*Sorghum bicolor*	Zengada				
Poaceae	*Triticum dicoccon*	Ajja				
Lamiaceae	*Thymus schimperi*	Tosign				
Fabaceae	*Trigonella foenum graecum*	Abish				
Alliaceae	*Allium sativum*	Nech shinkurt	Cancer	Nekersa	6	20.7
Brassicaceae	*Brassica carinata*	Yabeshagomen				
Rutaceae	*Citrus aurantifolia*	Lomi				
Rutaceae	*Citrus sinensis*	Birtukan				
Linaceae	*Linum usitatissimum*	Telba				
Pedaliaceae	*Sesamum orientale*	Selit				
Alliaceae	*Allium sativum*	Nech shinkurt	Microbial disease	Worershign	5	17.2
Rutaceae	*Citrus aurantifolia*	Lomi				
Rutaceae	*Citrus sinensis*	Birtukan				
Lamiaceae	*Thymus schimperi*	Tosign				
Zingiberaceae	*Zingiber officinale*	Zinjibil				
Poaceae	*Avena sativa*	Engedo	Diabetes	Yeskuar beshita	5	17.2
Fabaceae	*Cicer arietinum*	Shimbra				
Lauraceae	*Cinnamomum verum*	Kerefa				
Poaceae	*Sorghum bicolor*	Zengada				
Poaceae	*Triticum dicoccon*	Ajja				
Brassicaceae	*Brassica carinata*	Yabeshagomen	Constipation	Yehod dirket	4	13.8
Ranunculaceae	*Nigella sativa*	Tikur azmud				
Linaceae	*Linum usitatissimum*	Telba				
Poaceae	*Triticum aestivum*	Sendie				
Poaceae	*Avena sativa*	Engedo	General weakness	Yeakim medakem	4	13,8
Fabaceae	*Cicer arietinum*	Shimbra				
Poaceae	*Hordeum vulgare*	Gebs				
	Nigella sativa	Tikur azmud				

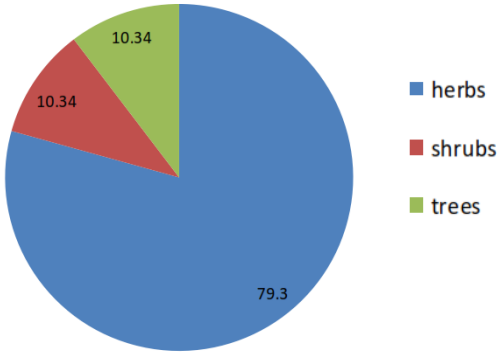

Figure 5. Habits (growth forms) of functional food plants in the study area

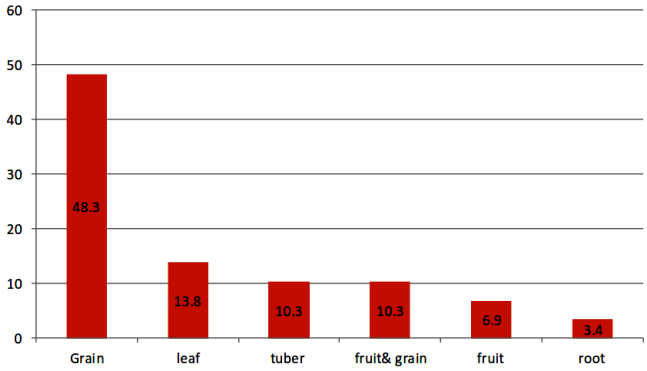

Figure 6. Plant part used as a functional food

Major plant use categories of functional food plants used by the people in the study area

The research area yielded 29 plants with high Functional Food values. The community uses plants for a variety of purposes in addition to their functionalities. Informants in the study area identified six different types of use (Table 10). As a result, 2,257 use reports (ur) are recorded from 94 frequency of occurrences for the total use category, with each informant reporting on 29 Functional Foods Plants. Plants used in construction have the highest ICF value (0.98), followed by functional food plants and forage use-category, with ICF values of (0.97). This research revealed that ethnobotanical knowledge is homogeneous, and plant use reports from informants on various plant use categories are highly consistent.

Informant consensus (FFP use report) of popular functional food plants

The use of informant consensus is one method of verifying the efficacy of a given plant species. Common functional food plants cited by most local people in an area were recorded and analyzed in these cases. As a result, 72 (90%) informants cited *Lupinus albus* (Gibto), while 63 (79.8%) informants cited *Eragrostis tef* (Dabbo teff) for their functionality as health care, and others are shown in Table 11. The popularity of these functional food plants may be due to their effectiveness or the ease with which they can be obtained.

Preference ranking of functional food plants used to prevent gastritis

Several plant species can protect against a single disease. In such situations, the locals prioritize plant species is based on their ability to avoid a specific disease. Cucurbita pepo (Duba) is the most favored species, followed by *Linum usitatissimum* (Telba), in this study's preference rating for five plants based on preventing Gastritis (Table 12). The score was determined by seven primary informants and was focused on the ability of each species to avoid Gastritis. The highest value (5) was assigned to species with the highest preventing potential. In contrast, the lowest value (1) was set to species with the lowest preventing potential than the species identified.

On the other hand, specific plant species treat various diseases. Similarly, people prefer plant species that can resist different diseases. Based on disease prevention, a preference ranking conducted by seven primary informants (respondents) for six selected plant species (Table 13) revealed that the most common is *Linum usitatissimum* L. (Telba), followed by *Triticum dicoccon* Schrank (Ajja).

Table 10. ICF by use categories of plants for the local people in the study area

Use-category	Species(#) (nt)	Percentage of species	Use reports (nur)	Percentage of use reports	ICF (nur-nt/nur-1)
Functional food	29	100	809	35.8	0.97
Food/drink	21	72.4	557	24.7	0.96
Spice	10	34.5	171	7.6	0.95
Medicinal plants	22	75.9	317	14	0.93
Forage	9	31.0	306	13.6	0.97
Construction	3	10.3	97	4.3	0.98
Mean ICF					0.96

Direct matrix ranking for multiple uses of functional food plants

Direct matrix ranking is used to compare multipurpose plants commonly identified by informants. As a result, most people in the study area depend on plants for various reasons, including functionality, food/drink, spice, medicinal, forage, construction, etc. According to the results, *Eragrostis tef* (Dabbo teff) was ranked first, followed by Hordeum vulgar (Gebis) and Avena sativa (Engedo) (Table 14). According to the informants' reports and the researcher's perspective, local people prefer these plants for different uses and are the most readily available plant species. Thymus schimperi is the lowest in the direct data matrix (Tosign). This is most likely due to its scarcity in the study field. As a result, the utility of resources is determined by their availability.

Table 11. List of functional food plant species reported by thirty and more number of informants

Scientific name	Vernacular name in Amharic	Number of informants	Percentage of informants
Lupinus albus	Gibto	72	90.0s
Eragrostis tef	Dabbo teff	63	78.8
Avena sativa	Engedo	54	67.5
Cucurbita pepo	Duba	51	63.8
Linum usitatissimums	Telba	49	61.3
Citrus aurantifolia	Lomi	49	61.3
Hordeum vulgare	Gebis	48	60.0
Allium sativum	Nech shinkurt	43	53.8
Triticum dicoccon	Ajja	39	48.8
Lycopersicon esculentum	Timatim	37	46.3
Trigonella foenum graecum	Abish	36	45.0

Table12. Preference ranking of functional food plants used to prevent gastritis by key informants (respondents)

Functional food plant	R.4	R.5	R.16	R.20	R.39	R.42	R.53	Total	Rank
Cucurbita pepo	4	5	5	4	4	5	5	31	1
Hordeum vulgare	5	3	4	4	5	1	4	26	3
Linum usitatissimum	3	5	5	4	4	5	4	30	2
Trigonella foenum graecum	4	5	1	3	4	3	2	22	5
Urtica simensis	3	4	3	1	5	3	4	23	4

Table 13. Preference ranking of six selected functional food plants on the degree of preventing several diseases by key informants (respondent)

Functional Food plant	R.11	R.28	R.43	R.62	R.67	R.73	R.80	Total	Rank
Cicer arietinum	3	2	3	4	4	3	3	22	3
Linum usitatissimum	5	5	4	4	5	5	4	32	1
Lycopersicon esculentum	1	1	5	2	1	2	1	13	6
Nigella sativa	2	2	1	3	4	2	1	15	5
Trigonella foenum graecum	2	3	2	2	3	2	5	19	4
Triticum dicoccon	4	5	4	5	5	3	4	30	2

Table14. Direct matrix analyses of selected functional food plants

Species	Use category						Total	Rank
	Functionality	Food/drink	Spice	Medicinal plants	Forage	Construction		
Avena sativa	5	4	0	5	5	1	20	3
Cicer arietinum	3	5	0	2	4	0	14	7
Eragrostis tef	5	5	0	2	5	5	22	1
Guizotia abyssinica	4	4	2	4	5	0	19	4
Hordeum vulgare	4	5	0	4	4	4	21	2
Lycopersicon esculentum	3	4	4	4	0	0	15	6
Thymus schimper	3	0	5	3	2	0	13	8
Vicia faba	3	5	0	4	4	0	16	5

Note Use values are given from 0 to 5; 5: Best, 4: very good, 3: good, 2: less, 1: least, and 0: no value.

Table 15. Fidelity level indexes for plant species used to treat Diabetes mellitus and hypertension in the study area

Disease	Percentage of informants	Species	NP	N	Fidelity level index (NP/N)
Diabetes mellitus	67.5	*Avena sativa*	35	54	0.65
	21.3	*Cicer arietinum*	10	17	0.58
	11.3	*Cinnamomum verum*	7	9	0.78
	78.8	*Eragrostis tef*	26	63	0.41
	10	*Sorghum bicolor*	6	8	0.75
	48.8	*Triticum dicoccon*	28	39	0.72
Hypertension	13.8	*Thymus schimperi*	5	11	0.45
	53.8	*Allium sativum*	38	43	0.88
	22.5	*Beta vulgaris*	10	18	0.56
	10	*Sorghum bicolor*	6	8	0.75
	90	*Lupinus albus*	64	72	0.89
	48.8	*Triticum dicoccon*	26	39	0.67

Fidelity level index of functional food plants used to prevent diabetes and hypertension

The percentage of informants who claim to use certain plant species for the same main reason or to confirm the effectiveness of plant species in assessing its value is known as the fidelity level (FL) (Amenu 2007). Fidelity level index was measured for functional food plants used to Prevent Diabetes and Hypertension, and the results showed that *Cinnamomum Verum* (Kerefa) and *Lupinus albus* (Gibto) have the highest Functional value to avoid diabetes and hypertension, with (FL=0.78) and (FL=0.89), respectively (Table 15).

Description of most cited (ten top) functional food plants in the study area with their functionality

All functional food plants (10 species) cited by informants above 45% (Table 11) are described below.

Lupinus albus L. (Fabaceae) GIBTO (Amh.)

Lupinus albus L. is an herbaceous plant with a shortly hairy, bushy steam; lower leaves have obovate leaflets, and upper leaves obovate-cuneate. It has a white to the blue corolla. The pod is villous and glabrescent, and the seeds are smooth. The plant is prevalent to be planted in Gojjam. In the study region, the seed is primarily used to prevent hypertension. According to Nigussie (2012), people in northwestern Ethiopia used "Gibto Areki" as a locally-made antihypertensive medicine. In Ethiopia, the fruit and seed of this plant are both used for the same functional reason, according to Ragunathan and Solomon (2009).

Eragrostis tef L. (Poaceae) TEFF (Amh.)

Eragrostis tef L. is a cultivated herb that grows in tufts and can reach a height of 120cm in cultivated plants. The leaf blades are narrow, and the panicle is folded and depressed at the base; the spikes are grey or golden, with up to ten florets, and the seedlings are tiny and delicate. Ethiopia is home to this species. Two types of teff are grown in Ethiopia: white grain (Nech teff) and brown grain (Dabbo teff). The seeds of this plant, especially Dabbo teff, are used to prevent anemia and diabetes mellitus in some parts of the world (lower blood glucose). Teff contains omega-3 fatty acids, which have been linked to a reduced risk of heart attacks and prostate tumor development, as well as omega-6 fatty acids, which have been linked to a reduced risk of cardiovascular disease, and docosahexaenoic acids, which have been linked to a reduced risk of breast cancer, according to different authors cited on SUDASR23 (2010).

Avena sativa L. (Poaceae) ENGEDO (Amh.)

The herb Avena sativa L. is cultivated. It may appear as a wheat contaminant or escape near cultivations on rare occasions. Culms are simple, erect, and 40-180cm tall. The uppermost florets are reduced to 1.7-3cm long and non-shuttering, and the florets lack a basal bearded callus. The glumes are narrowly elliptic, oblong, and acute. Lemmas are robust and glabrous hairy around the awn insertion, measuring 1.2-2.5cm in length. Ethiopia is typically grown at 2,700-3,000m, particularly in areas where soil fertility is declining, preferred over barley. Forage is made out of crop residue. The plant's seed was traditionally used to lower blood sugar, prevent osteoporosis, and improve overall health. According to Lance and Garren (2002), beta-glucan in the seed can lower blood cholesterol and help prevent heart disease, and the seed of this plant can also control gastrointestinal function.

Cucurbita pepo L. (Cucurbitaceae) DUBA (Amh)

Cucurbita pepo L. is an annual herb with ascending, creeping, or bushy, 5-angled stems up to 15 meters long in some varieties. The branched shallow root stem grows from a well-developed taproot. Scabrous and setose stems branch and sometimes root at the noods. It has unisexual yellow flowers on the same plant as the male. The fruit was cooked simply with water and eaten when cool to prevent Gastritis, and the seeds were roasted and eaten to avoid helminthiasis. In various studies, pumpkin (Duba) and other vegetables are functional plant-based foods. For example, Braun and Cohen (2007) looked at how beta-carotene in pumpkin affects the immune and hormonal systems and its ability to protect against lung cancer.

Linum usitatissimum L. (Linaceae) TELBA (Amh)

Flax is a slender annual herb that grows to a height of 0.3 to 0.9 meters. It has thin, pale green alternating leaves and branches at the end. One or two delicate blue flowers are tipped on each unit. The locals used the seed of this plant to prevent Gastritis, Constipation, and Breast Cancer and boost attention deficiency. Still, some informants advised that a child taking "absho" for this purpose should avoid flaxseed as a side effect. According to the following, the alpha-linolenic acid, lignans, and fiber in flaxseed have possible health benefits such as reducing cancer, diabetes, osteoporosis, atherosclerosis, autoimmune, arthritis, cardiovascular disease, and neurological disorder Martinchik et al. (2012). Aside from that, it helps with menopausal symptoms and attention deficit disorder. Furthermore, according to Roizen and Oz (2005), eating flax seeds regularly will improve real age by 3.4 years due to monounsaturated fats.

Citrus aurantifolia L. (Rutaceae) LOMI (Amh)

It's an evergreen shrub that grows up to 5 meters tall and has a lot of short sharp spines on the stems and beside the leaves. The leaves are oval and delicate, with a gleaming green color. Flowers are white, and the fruit is round or oval, up to 6cm in diameter but typically more petite, with a thin green or yellow peel. The pulp is green, acidic, and juicy. The locals used these plant fruits to protect themselves from microbial diseases and "nekersa". According to Wondimu et al. (2000), the community of "Dheerra city" used the fruit of this plant as a nutraceutical to treat flu, wounds, stomach ache, and skin rash. On the other hand, Hasegawa and Miyake (1996) discovered that the phytochemical limonoids in citrus fruits were responsible for anticancer activity.

Hordeum vulgare L. (Poaceae) GEBIS (Amh)

Hordeum vulgare L. is an upright, stout, and tufted annual grass. The leaf is truncate and 1-2 mm long. The leaf blades measure 10-15 mm in width. The flower anthers are three, and the ovary is pubescent at the apex. It has a caryopsis fruit with an adherent pericarp. The local community used the plant to prevent Gastritis as a type of "Beso" or underlying "Kolo," and it was also thought to provide extra strength during illness and for mothers during childbirth as a form of "Gonfo." According to Robles-Escajeda et al. (2013), bioactive compounds found in barley (Beta-glucans, tocotrienols, and poly-phendlunasin) have anti-cancer properties.

Allium sativum L (Alliaceae) NECH SHINKURT (Amh)

It's a cultivated herb found in home gardens and farmland. Bulb ovoid with a white coat that encloses the bulb leaf. The bulbs used to prevent hypertension and microbial and "nekersa" were found in the research field. To name a few, the supposed health benefits include cancer chemoprevention, antibiotic, anti-hypertensive, and cholesterol-lowering properties (Srivastava et al. 1995). The bulb of this plant had a nutraceutical benefit to treat flue and lung abscess in the population of "Dheerra city," according to Wondimu et al. (2000). Ernst (1997), on the other hand, discovered that alliums could protect against cancer of the gastrointestinal tract. *Triticum dicoccon* Schrank (Poaceae) AJJA (Amh)

It's solid or thick-wailed annual cultivated grass culms. Rhachis is glabrous or shortly ciliated at the nodes, fragile, disarticulating above the spikelet insertion, spikelet falling attached to the internode below; spikelets 3-10 cm long, laterally compressed; rhachis glabrous or shortly ciliated at the nodes, fragile, disarticulating above the spikelet insertion, spikelet falling attached to the internode below. Glumes 7-10 mm long, coriaceous with a single prominent keel; lemma with an awn up to 15 cm long; spikelet 3(4) flowered. The locals in the study area used this food plant to treat diabetes Miletus, hypertension, and cholesterol in the blood and maintain general health and bone strength, often as a form of "Atmit." Phytochemical saponins and functional component B-glucan in oat help lower LDL cholesterol, reduce blood pressure, and lower heart disease risk.

Lycopersicon esculentum Mill. (Solanaceae) TIMATIM (Amh)

It's an annual or perennial herb with petiolate leaves that alternate. Flowers have two sexes. Above the base, pedicels articulate. The calyx is strongly 5-lobed, and the yellow corolla is stellate. It has 5 stamens of similar length and a bilocular or plurilocular ovary with false septae. The fruit is a berry that is red or orange and has elliptical seeds. The locals claimed that eating fresh tomatoes or tomato paste could help them avoid anemia and heart disease. On the other hand, Krinsky and Johnson (2005) say that the phytochemical lycopene found in tomatoes helps prevent prostate cancer. This phytochemical in tomatoes has also been shown to inhibit the growth of breast, lung, cervical, ovarian, and pancreatic tumors, according to Rao and Rao (2007).

In conclusion, the study's findings showed that indigenous people in the study region have traditional knowledge and practices on functional food plants that they have learned over centuries. The majority of the area's usable food plants are grown at home and in the field. Only one species, Urtica simensis steudel, is purchased from the market for consumption, and it is a rare wild species in the area. Herbs were the most commonly used functional food plants, followed by shrubs and trees. Seeds have also been the most frequently used plant parts in Functional Food. Although the residents' favorite method of preparing functional food plants is cooking/boiling, most are prepared this way. Almost all functional food plants in the study area were expected because they are everyday demands of their daily life activities. Still, one of the most commonly cultivated functional food plants in Gojjam, *Lupinus albus*, is under threat due to the loss of agricultural lands in the case of construction as the Woreda is developed into an administrative town, responsible stakeholders should make such strong effects. It was also stated that when suffering from the disease, information transfer among the population about the functionality of foods was presupposed. As a result, it is critical to continue building a safe citizen documentation of functional food plants by

passing on information to current and future generations to raise our awareness and avoid chronic diseases triggered by a drastic change in our lifestyle and environmental effects.

REFERENCES

Abbasi AM, Khan MA, Shah MM, Prevez A, Ahmed M. 2013. Ethnobotanical appraisal and cultural values of medicinally important wild edible vegetables of Lesser Himalayas-Pakistan. J Ethnobiol Ethnomed 9: 66. DOI: 10.1186/1746-4269-9-66.

Alexiades M. 1996. Collecting Ethnobotanical Data. In: Alexiades H, Sheldon JW (eds). An introduction to basic concepts and techniques selected guidelines for ethnobotanical research: A manual. New York Botanical Garden. Bronk, NY, USA.

Amenu E. 2007. Use and management of medicinal plants by indigenous people of Ejaji area (Chelya woreda) west Showa, Ethiopia: An Ethnobotanical Approach. [Thesis]. Addis Ababa University, Ethiopia.

Asfaw Z. 2001. The role of home gardens in production and sustainable use of Medicinal Plants in Ethiopia. IBCR, Addis Ababa, Ethiopia.

Braun L, Cohn M. 2007. Herbs and Natural Supplements. Elsevier, Australia.

Cotton CM. 1996. Ethnobotany: Principle and application. John Wiley and Sons Ltd., West Sussex, UK.

DMDHHIV/AIDSPCO. 2015. Debre Markos District health and HIV/AIDS prevention and control office annual report (unpublished).

DMDFEDO. 2015. Debre Markos District finance and economic development office annual report (unpublished).

DMDARDO. 2015. Debre Markos District rural and agricultural development office annual report (unpublished).

Ernst E. 1997. Can Allium vegetables prevent cancer? Phytomedicine 4: 79-83. DOI: 10.1016/S0944-7113(97)80032-3

Eskin NAM, Tamir S. 2006. Dictionary of nutraceuticals and functional foods. CRC Press, USA.

FAO. 1995. Non-woody forest product and nutrition. In: Report of the International Experts Conclusion On Non-Woody Forest Product. FAO, Rome, Italy.

Hasegawa S, Miyake M. 1996. Biochemistry and biological functions of citrus limonoids. Food Rev Intellectuals 12: 413-435. DOI: 10.1080/87559129609541089

Kassaye KD, Amberbir A, Getachew B, Mussema Y. 2006. A historical overview of traditional medicine practice and policy in Ethiopia. Ethiopian J Health Dev 20 (2): 128-134. DOI: 10.4314/ejhd.v20i2.10023.

Krinsky NI, Johnson, EJ. (2005). Carotenoid actions and their relation to health and disease. Mol Aspects Med 26 (6): 459-516. DOI: 10.1016/j.mam.2005.10.001

Wang L, Bohn T. 2012. Health Promoting Food Ingredients and Functional Food. In: Bouayed J (ed). Nutrition, Well-Being, and Health. IntecOpen, London, UK.

Martin GJ. 1995. Ethnobotany: A Method Manual. Springer, NY.

Martinchik AN, Baturin AK, Zubtsov VV, Molofeev VIU. 2012. Nutritional value and functional food properties of flaxseed. Voprosy Pitaniia 8 (3): 4-10.

Nigussie Z. 2012. Contribution of white Lupin (*Lupinus albus* L.) for food security in North-Western Ethiopia: A Review. Asian J Plant Sci 11: 200-205.

Ragunathan M, Solomon M. 2009. The study of spiritual remedies in Orthodox rural churches and traditional medicinal practice in Gondar Zuria District, North-Western Ethiopia. J Pharmacogn 1: 178-183.

Rao AV, Rao LG. 2007. Carotenoids and human health. Pharmacol Res 55 (3): 207-216.

Roberfroid M. 2003. Functional food concept and its application to prebiotics. Dig Liver Dis 2: S105-110. DOI: 10.1016/s1590-8658(02)80176-1

Robles-Escajeda E, Lerma D, Nyakeriga MA, Ross JA, Kirken RA, Aguilera RJ, Varela-Ramirez A. 2013. Searching in mother nature for anti-cancer activity: anti-proliferative and pro-apoptotic effect elicited by green barley on leukemia/lymphoma cells. PLoS One 8 (9): e73508. DOI: 10.1371/journal.pone.0073508.

Roizen ME. Oz MC. 2005. You, The Owner‟s Manual: An Insider‟s Guide to the Body That Will make you Healthier and Younger. Harper Collins Publisher, Inc., New York.

Ross S. 2000. Functional Food: The Food and Drug Administration Perspective. Am J Clin Nutr 71 (6): 1735s-1738s.

Srivastava KC, Bordia A, Verma SK. 1995. Garlic Allium sativum for disease prevention. South Afr J Sci 91: 68-77.

SUDASR23. 2010. Nutritional Data on SkipThepie.org. “Teff uncooked” https://skipthepie.org/cereal-grains-and-pasta/millet-flour/compared-to/teff-uncooked. [July 2016]

Wondimu T, Asfaw Z, Kelbesa E. 2000. Ethnobotanical study of food plants around “Dheerra” Town, Arsi, SINET: Ethiopia. J Sci 29 (1): 71-80.

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Assessment of biodiversity conservation in Entoto Natural Park, Ethiopia for ecotourism development

ASFAW DEMEKE TESEMA, GETACHEW BERHAN♥
School of Earth Science, Addis Ababa University. Addis Ababa, Ethiopia. ♥email: getachew@aau.edu.et

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Abstract. *Tesema AD, Berhan G. 2019. Assessment of biodiversity conservation in Entoto Natural Park, Ethiopia for ecotourism development. Asian J Ethnobiol 2: 22-37.* The study's main goal was to use Geographic Information Systems (GISs) and remote sensing to generate biodiversity and land use/cover changes to develop ecotourism in Ethiopia's Entoto natural park. During field verification, the primary data was collected. Questionnaires and interviews were conducted to assess the status of biodiversity, prospects, and opinions for creating ecotourism in Entoto Park to collect the required primary data for this research. Different and suitable software was used to process remotely sensed data depending on the data type. Since the field verification provided a priori information, the imageries were classified using the supervised classification technique. The field verification results revealed that 25 different tree and shrub plant species were discovered in the Entoto natural park. The responses to questionnaires and details gathered from personal interviews were nearly identical to the data collected in the field. Almost 88% of the overall species abundance in the study region was accounted for by *Eucalyptus globulous* and *Juniperus procera*. In an ArcGIS and ERDAS Imagine the setting, outputs such as change detection maps and topography maps were developed. The analyses revealed that the region's forest cover has increased when comparing successive decadal results. The land in these park areas could be used for new campgrounds, various developed structures and amenities such as lodging and venues, and nature-based activities such as canopy walks. This study will contribute to the literature on the importance of biodiversity in the growth of ecotourism and the benefits of ecotourism to environmental conservation and their close coexistence. Entoto Natural Park can be considered a suitable site for ecotourism promotion based on the existing resources of the studied region and the assessment results.

Keywords: Afromontain, biodiversity, criteria, ecotourism, GISs, sustainable

INTRODUCTION

Forest habitats, for example, cover most of the Earth's surface. The earth sciences provide new information about the natural environment and its resources (Fedorov 1980). The rise and advancement of geospatial technology have made it possible to capture, store, process, analyze, and view spatial data for various environmental applications. The data collected by Remote Sensing is related to the Earth's electromagnetic properties. The data can be linked to real-world parameters or features in various ways. Remote sensing is the instrumentation, techniques, and process of observing the Earth's surface from afar, acquiring data, and interpreting the images or numerical values to gain accurate information about specific Earth objects.

Ethiopia has a wide range of geographical features and macro-and microclimatic variations. There are ten ecosystems in the region, 18 major and 49 minor agro-ecological zones. Ethiopia is home to over 6,000 species of higher plants, with 10% of them being endemic to the country. The Ethiopian Biological Diversity Institute/EBI reports that the country has 284 species of wild mammals and 861 species of birds (Ethiopian Biological Diversity Institute/EBI, 2014). The country has a rich diversity of plant and animal genetic capital. Ethiopia is one of the world's most biologically diverse nations. The country is implementing two area closures to reconstruct and restore damaged areas. The first is to isolate an area from livestock and people to regen natural vegetation. The second is to separate degraded lands while introducing additional steps such as seedling planting, mulching, and building water harvesting systems to improve and speed up the regeneration process (et.chm-cbd.net/biodiversity/biodiversity-ethiopia).

Entertainment and recreation are essential to humans, considering conservation and long-term utilization goals. As a result, establishing and constructing forest parks and resource conservation are necessary to draw visitors, generate revenue, and provide leisure and relaxation. The recognition that the Protected Landscape approach offers both a functional and economic position for farmers and an essential structure around which environmental protection can be connected to improving local people's quality of life is critical (Okello 2003). The perceived potential of ecotourism as an important tool for sustainable development is the primary reason that developing countries are now incorporating it into their economic development and conservation strategies. In the 1990s, ecotourism arose as an alternative type of tourism to address the shortcomings of traditional (mass) tourism in meeting the needs of sustainable growth. Ecotourism is often described as any type of tourism that involves nature. The above activities often include the placement of a hotel in a beautiful landscape, to the detriment of the environment. Above all, ecotourism must educate people about the beauty and fragility of nature. Bunruamkaewa and Murayama (2011)

oppose the actions of some operators who disseminate their activities by using the terms "green" and "eco-friendly" while acting in environmentally insensitive ways. Ecotourism has long been common in developing countries worldwide, and it is likely to continue to expand. The majority of ecotourism tourists are mature and wealthy. They are a decent source of revenue for tour companies, but they can also be challenging. They are usually interested in a variety of tours, including safari-style luxury tours to explore wildlife, birds, and landscapes, as well as more modest adventure tours that emphasize remote areas, colorful people, or unusual geologic features.

Ethiopia is rich in such assets that can provide a diverse range of experiences and opportunities to observe local life and natural attractions, such as those that already exist at Bishangari on Lake Langano and the site in the Afar region, and others that are in the planning stages (Henze 2007). As Ethiopian tourism expands, more of the country's attractions will become available to visitors, including international tourists, diaspora visitors, foreign residents, and Ethiopian people. Ecotourism is a good fit for students and young adults who are less wealthy and comfortable with simple housing and fewer amenities. Trekking, discovering remote landscapes, wild animals, birds, river and lake encounters, and studying exotic ethnic groups are all things they're interested in. Person and community tours funded by organizations are available for scholars with a professional interest in ethnography, archaeology, various aspects of biology, and geology (Malede and Girma 2015). Ecotourism is a low-impact, mostly small-scale alternative to traditional commercial (mass) tourism that involves visiting delicate, untouched, and relatively undisturbed natural areas. Ecotourism has always been a part of Ethiopian tourism. Visitors to the historical sites are mainly interested in Ethiopia's past and the extraordinary achievements of Ethiopians over millennia. But they're also curious about the physical characteristics of these areas and how well they're covered. Some travel companies specialize in animal and bird-watching tours and tours to see native forests and rare geologic features (http://www.e-unwto.org/doi/book/ 10.18111/9789284416899).

After the World Ecotourism Summit held in 2002, the ecological tourism sector has been increasingly concerned since it is supposed to act as an instrument to ensure that destination areas are safe, support the tourist population, and contribute to poverty reduction. According to recent WTO market surveys, the growth of ecotourism demand would particularly benefit Africa (Theodros 2004). The area is more likely to draw visitors in the region (http://www.e-unwto.org/doi/book/10.1811/9789284416899) both from ecotourism tours and those looking for newly-developed destinations which are abundant in the region. In Ethiopia, conservation and sustainable use activities are being actively undertaken. Consequently, significant changes have been made to the status of such biodiversity resources. For example, rehabilitation and restoration of degraded areas, forestation, and sustainable management practices of natural resources led to increased forest cover and improved associated biodiversity (EBI, 2014).

The current study aims: (i) to generate changes in biodiversity and land and coverage by using indices derived from geospatial data, (ii) to evaluate the status of the study area for biodiversity conservation. (iii) to calculate the land use and cover and produce maps, (iv) to identify multi-faceted ecotourism growth threats and opportunities.

MATERIALS AND METHODS

Materials

The study used a purposive sampling approach to collect data from various stakeholders. Ethiopian Heritage Trust, Addis Ababa Culture and Tourism Development Bureau, Ministry of Culture and Tourism, Institute of Biodiversity, Addis Ababa City Administration's Environmental Protection Bureau, and other relevant institutions were contacted for primary data collection. The second task was to collect data on biodiversity conservation and ecotourism production in the Entoto Natural Park from key stakeholders and other relevant sources.

During field verification, the primary data was collected. Moreover, during the transect walk, there were both difficulties and opportunities. Various datasets variety from multiple sources, such as satellite data, maps, and plant measure data, were processed to support this research. Literature, the Internet, electronic source materials, and other secondary data were also used in this analysis. Three-decade time-series datasets were analyzed to identify shifts in the land use/cover of the Entoto natural park. For remote sensing of vegetation resources, satellites such as ASTER, IKONOS, Landsat 5 TM (Thematic Mapper), Landsat 7 ETM+ (Enhanced Thematic Mapper), Quickbird 2, RapidEye, SPOT 5 (Satellite Pour l'Observation de la Terre), and Worldview-2 are frequently used.

One of the significant input datasets for this analysis was remotely sensed data. For the studies, imageries from the Landsat system acquired in 1986, 1995, and 2015 and a SPOT image from 2006 were used. The Ethiopian Mapping Agency provided maps at scales of 1:50,000 and 1:250,000. EMA provided the vector data (road, river, and contour) digitized from two 1:50,000 topographical paper maps. Other data types were used for terrain analysis, elevation data collection, and displaying the study area's general topographic characteristics. These data forms include TIN, DEM, and SRTM, which are used to display the slope and feature of an area and were downloaded from the internet (www.earthexplorer.com and www.glcf.com). Additional sources of information include legal, regulation, assessment studies, and media sources.

The Institute of Biodiversity and Conservation provided formats for collecting vegetation data, including floral richness, tree/shrub species, seedling and sapling data, and Land Cover Relieve Data Sheet. A Global Positioning System (GPS), a Compass, and a Map of 1: 50,000 scales were used for field verification. A GPS was used to record each sample map's positions (coordinates) (Table 2). The information needed for this study came from several places. Various references, studies, and blogs helped me

learn about existing policies, programs, projects, best practices, and so on.

Methodology

The first step in the methodology was to conduct a thorough analysis of the current literature to gather both theoretical and secondary data. Both quantitative and qualitative approaches were used in this thesis. Questionnaires and interviews were used to collect primary data to assess the status of biodiversity. Questionnaires were used to collect opinions from interested experts to identify prospects for the advancement of ecotourism in Entoto Park. Qualitative data were collected using semi-structured questionnaires, a transect walk, and field observations transcribed and analyzed. When the questionnaires were returned, a personal interview was conducted with a select group of respondents to delve deeper into their perspectives on conservation and ecotourism promotion. Key members from the Ethiopian Ministry of Tourism and EHT received questionnaires. Most of the interviews were conducted in person, with a few conducted over the internet. Respondents were asked about the park's viewpoint, the most significant environmental effects, and the factors they believed led to its existence. Digital recordings were made of the interviews, and notes were taken. One of the techniques used in this study's field data collection was systematic sampling. The systematically formed quadrats along each transect recorded all trees and shrubs. During field verification, the primary data was collected.

Moreover, during the transect walk, there were both difficulties and opportunities. The study used a purposive sampling approach to collect data from various stakeholders. Ethiopian Heritage Trust, Addis Ababa Culture and Tourism Development Bureau, Ministry of Culture and Tourism, Institute of Biodiversity, Environmental Protection Bureau of the Addis Ababa City Administration and other relevant institutions were contacted for primary data collection. The second task was to collect data on biodiversity conservation and ecotourism production in the Entoto Natural Park from key stakeholders and other relevant sources.

The data was then analyzed using geospatial, remote sensing, and GIS techniques. Integration of all datasets (raster, vector attribute, and statistical) is one of the most important procedures for assessing the spatial changes in land use/cover and biodiversity in the study areas. Remotely sensed data needs some pre-processing before being used directly, in which the atmospheric effect and geometric error are corrected, among other things. The spectral profile is a graphical representation of the reflectance spectrum of a single pixel. Improving the image was one of the techniques used. Any sensor system, as stated, has a variety of sources of noise, resulting in a few erratic pixels. Thus, satellite data were pre-processed and improved to eliminate noise and radiometric error, and they were made ready for further interpretation and study before being used. Enhancement techniques can be used in Multispectral Scanner (MSS) data to reduce atmospheric and sensor variability with minimal pre-and post-processing. The process of making an image more interpretable for a specific application is known as image enhancement. The resolution merge function has been implemented to resample data with a low spatial resolution (30 m) to a higher spatial resolution (15 m) while retaining spectral information. A sensor's resolution can be described in radiometric, spatial, spectral, or temporal resolution. Enhancement improves the human eye's ability to perceive essential features of raw, remotely sensed data. Enhancement techniques are also used to analyze and locate areas and items on the ground and extract the best information from the raster data instead of classification techniques (Faust 1989). Data integration was one of the methods used to make the data consistent.

Ethiopia is home to over 6000 species of higher plants, with 10% of them being endemic to the country. There are 284 species of wild mammals and 861 species of birds in the world. There are little data on other wild animals, with only 201 reptiles, 200 fish, 63 amphibians, and 1,225 arthropod species reported. Ethiopia is home to 29 wild mammals, 18 bird species, ten reptiles, 40 birds, 25 amphibians, and seven arthropod species. Ecosystems and various wild plants and animals, including endangered species, farmer varieties, and indigenous animal breeds, are all decreasing due to direct and indirect pressures. As a result, 103 tree and shrub species, 31 bird species, one reptile, nine amphibian species, two fish species, and 14 other invertebrate species are threatened (EBI 2014).

The study area

Study area description

The Entoto Natural Park was created with the love of a few people. It's between 38°48'00" and 38°47'01" East, and 09°04'05" and 09°07'33" North. The park is 2,300 hectares in size and is located on the south-eastern slopes of Mt. Entoto between the northern limit of Addis Ababa (at 2,600 m) and the track along the mountain ridge (at over 3,100 m) (figure 2). The Entoto escarpment, including the Entoto natural park, has 1,300 ha Ethiopian Heritage Trust (EHT). Several researchers have looked into the geology of Addis Ababa and its environs. At the crest of the Entoto hills and across the Sululta plains, the Alaji basalts can be seen. They are the oldest rocks in the Alaji cycle, forming high topography (ridges). The texture of these basalts ranges from porphyritic to aphanitic. The Entoto mountain chains in the north are rhyolite and trachyte with a small amount of obsidian-rich tuffs known as the Entoto silicic. They are part of the Alaji formation and sit atop older basalt. Rhyolites are porphyritic, with quartz, sandstone, andesine-oligoclase phenocrysts and a devitrified glass, iron oxide, plagioclase, and quartz groundmass. The trachytes are composed of phenocrysts of anorthoclase sanidine, oligoclase, magnetite, and a groundmass of plagioclase (Haileselassie and Getaneh 1989).

The study area has a diverse range of vertic cambisol soil types. The Entoto Hill Chain, on which the Entoto Natural Park is located in the northern part of Addis Ababa, is made up of basalts that are covered in one to two meters thick volcanic topsoil materials. Entoto's predominant soil type is clay, and topsoil materials in the western areas are

thick and soft in comparison to those in the northern and eastern parts. The mountain is made up of a tilted block of bedrock with very steep, soil-free slopes and cliffs on the northern side and much longer, shallower slopes on the south-eastern side. Sharp changes in the inclination of the slope, as well as some flat land areas, are common in different parts of the region. The tops of the hills and ridges, which include Entoto streams, are densely forested. The park is a great place to see vultures (i.e. five species), as well as eagles, buzzards, hawks, larks, and ravens. *Gypaetus barbatus* (a significant population exists in the Entoto and Gorfu hills), *Buteo oreophilus*, *Bubo capensis* (historical records only), *Aquila wahlbergi*, and *Accipiter rufiventris* are all of particular interest. The park is home to a variety of Palearctic and intra-African migrant animals (EWNHS, 2015).

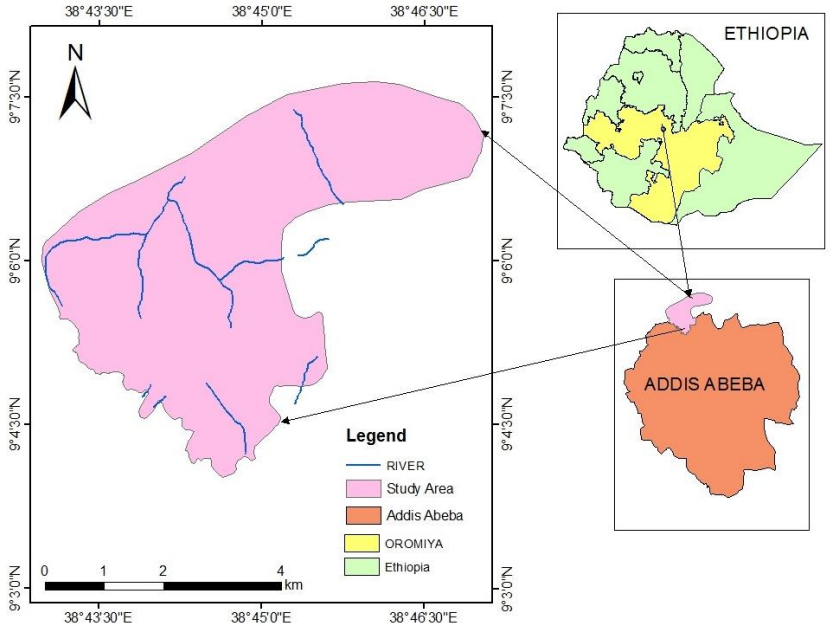

Figure 2. Location map of the study area

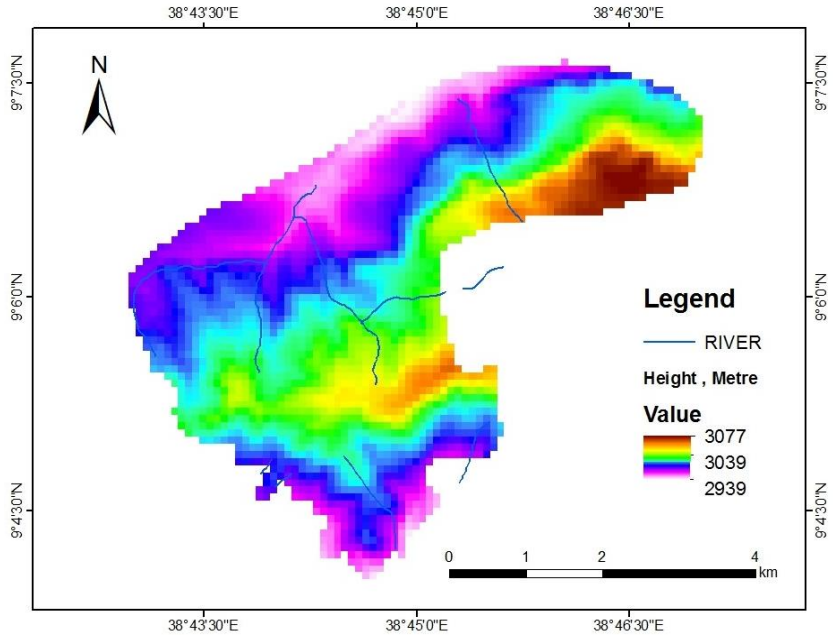

Figure 3. Topographical map of the study area

Topography

The Entoto Natural Park is located on the south-eastern slopes of Mt.Entoto, between (2300 m-3,100 m) the northern limit of Addis Ababa (at 2,600 m), and the track along the mountain ridge is (at over 3,100 m) the highest point in Ethiopia (Figure 3). Low pressure, also known as the Inter-Tropical Convergence Zone, moves across the equator seasonally northward and southward on the African continent, affecting the climate in Entoto Natural Park. The average maximum temperature is 24.3°C in May and 20.3°C in August, while the average minimum temperature is 11.8°C in May and 7.7°C in December. The primary rainy season lasts from June to September and accounts for roughly 70% of annual rainfall, with August being the wettest month. In April, there is a minor increase in rainfall. According to the Ethiopian National Meteorological Agency (NMAE, 2014), Addis Ababa and its surrounding areas receive 270 mm of rainfall during the summer months (June, July, and August) and 12 to 32 mm of rainfall during the winter months (December, January, and February). The study region and the city of Addis Ababa receive an average annual rainfall of (1165 to 1170 mm). There is a track in the Entoto Park that separates two major watersheds, the Abbay (Blue Nile) to the north and the Awash to the south, and forms the boundary between Addis Ababa and Oromiya Regions (Figure 2).

Sample site selection

The data were collected in the field in February of 2016. The field data were collected using a measuring tape meter to lay down sample quadrats along transects at a distance of 50 m apart. A total of 29 quadrats (with a total area of 2.6 hectares) were sampled (Figure 7). Individuals were classified in a series of girth classes at specific height intervals (Diameter at Breast Height (DBH)) ≥3.5m high (considered as trees) 1.0 m to 2.5 m saplings) and less than ≤ 1.0 m high (seedlings). With each quadrat/plot positioned along a linear transect at 500 m intervals, the control transects used in this study reflect the recommended standardized protocol for recording plant distributions and abundances. Each control transect is 1 km apart and has a quadrat-width of 30 x 30 m. (Figure 7). The sample plots were placed at a fixed interval (500m) on parallel linear transects that were 1km apart. For species composition assessment, open space estimation, and bare land cover estimation, one to seven 30m x 30m subplots were formed in each major plot. To collect samples, a mixture of systematic sampling methods was used to set up sampling plots. This method uses a grid superimposed over the survey area to identify stands and subsamples inside stands. At one scale, intersections of north-south and east-west lines identify sampling points within stands, while intersections at a finer scale define stands to be sampled. Eight line transects were laid down starting from the lower limit of the study area to the top of the ridge to investigate the plant community structure, species composition, and regeneration status of Entoto Natural Park Forest. Trees, Seedlings, Saplings, and Shrubs were measured in 30m x 30m quadrants. The main (900m square size) plot was sampled for species richness, density, and saplings. Both trees and shrubs rooted in the plot were considered, and Tree Caliper was used to calculate diameter at breast height (dbh) for trees and diameter at stamp height (dsh) for shrubs. Trees and shrubs with a dbh/dsh greater than 2.5 cm had their height estimated visually. For trees and shrubs with dbh/dsh greater than 2.5cm, the number of stems above ground was also counted and registered. Garmin Mapsource software was used to download the GPS data, which was then processed according to the appropriate method for each data type. Then, using the Forest Genetic Resources Conservation Project (FGRCP) database Access for Windows version7.0 software, percentage cover, frequency, and woody species richness were measured and analyzed.

Data analysis

All of the data processing was done using different and suitable software depending on the data type. ERDAS Imagine 2014, ArcGIS 10.3, and FGCP were the software packages used. ERDAS Imagine, ArcGIS, MSExcel, and other tools were used to process and analyze geospatial data. A systematic suitability study for biodiversity conservation and ecotourism creation in the Entoto natural park is one of the methodological phases, which is determined using ArcGIS and other software and proper techniques. When used in conjunction with suitable models, GIS may offer a more systematic approach to problem-solving in which both qualitative and quantitative data must be processed (Beedasy and Whyatt 1999). The suitability map analysis was then used to construct GIS vector layers, which were then used as input parameters. The Forest Park's final suitability map was then created in a GIS environment. Since an a priori information was acquired during the field verification of the study area, the imageries were classified using the supervised classification technique. With the aid of ground truth data, pixels that reflect patterns and each land cover feature were identified and selected.

The word "accuracy assessment" refers to comparing the classification to geographical data that is believed to be correct in order to determine the classification process's accuracy. Accuracy assessment should be a critical component of any classification, but it is often overlooked. The reason for this is that it usually involves a lot of work in the field, which can be very expensive and time-consuming (Congalton 1991).

RESULTS AND DISCUSSION

The results of field verification revealed that 25 different tree and shrub plant species were discovered in the Entoto natural park, and that the responses to questionnaires and details gathered from personal interviews were nearly identical to the data collected in the field. The plants have already been planted on 500 hectares of the EHT project's 1300 hectares. Furthermore, the Entoto natural park's floristic species compositions are notable, with 20 of them being registered. However, compared to other small Ethiopian forests, the Entoto forest

had a species diversity of less than 30 tree and shrub plant species. The deforestation of natural vegetation due to population growth and expansion of Addis Ababa city, which began at the end of the 19th century, resulted in a major reduction in plant species in Entoto (Figure 5 and 6).

As shown in two-dimensional plots, the Spectral Profile algorithm revealed that the reflectance values of most vegetation, such as forest, woodland, grass, and shrub, were more separated/de-correlated by Band 5 of Landsat TM (Figure 4). On band 2, however, most feature groups were poorly differentiated, and the reflectance of forest and woodland, as well as shrub and soil, showed subtle differences. As a result, Bands 3, 4, and 5 were identified as insightful and chosen as candidate bands for further investigation. The bands have been plotted in two dimensions (Figure 4).

Then, using a supervised classification system, Landsat data with a resolution of 30 meters for the years 1986, 1995, 2007, and 2015 were graded (Figure 5 and 6). Both GIS and Remote Sensing techniques helped to speed up the testing process, improve accuracy, and cut costs. In addition, an ArcGIS and ERDAS Imagine setting was used to create the study area chart, land use/cover maps, and topographical maps.

The accuracy of classification is usually assessed by comparing the classification with some reference data that is believed to accurately reflect the true land cover (Congalton 1991). The disparity between our classification and the reference data is reflected in the accuracy rating. This table can be used to calculate the overall classification accuracy by calculating how many pixels in the satellite image and on the ground were labeled the same and dividing that amount by the total number of pixels. Land truthing, higher resolution satellite images, and topographical and thematic maps were used as sources of reference data for this research. The classification accuracy of each imagery i.e., 1986, 1995, 2007 and 2015 is 97%, 90%, 82% and 81.3% respectively.

Land use land cover change

The analysis of time-series images from 1986, 1995, 2007, and 2015 showed that the forest cover of the region increased more in relation to one decadal data by another time data. The other three land cover characteristics do not change spatially. All other characteristics, with the exception of forest cover, are on the decline (Figure 5 and 6). According to the results of image analysis, the study's forest area coverage has been steadily increasing in comparison to another vegetal cover from the 1980s to the 1990s, and from the 1990s onwards, forest cover has been gradually declining while shrub area coverage has increased by more than 1%. (Table 1).

The Ethiopian Heritage Trust's environmental protection initiative, which planted 40,000 indigenous seedlings on 500 hectares in the Entoto Natural Park, is also thought to have led to the enhancement of the Entoto forest region. Eucalyptus plantations dominated the entire Entoto mountain range (and much of its surroundings). Forest, bushland, cultivated fields, grassy meadows, rocky slopes and cliffs, lakes, and marshes are among the park's diverse ecosystems. Afro-montane forest and, where drainage is obstructed, woodland with open meadows make up the natural vegetation. *Juniperus procera, Olea europaeacuspidata* groves, *Hagenia abyssinica, Hypericumrevolutum, H.quartinianum, Podocarpus falcatus*, and *Acacia abyssinica*, with *A. negrii* in some of the more disturbing valleys, would have dominated the area. *Erica arborea* can be found at elevations of over 3,000 meters.

Fruit-eating birds are drawn to shrubby areas by species like *Rosa abyssinica* and *Carissa edulis*, which have fleshy fruits. The number of herbs, both in the forest undergrowth and in the meadows, is enormous, and includes many endemics, including clovers Ethiopian Wildlife and Natural History Society (EWNHS, 2015). Agriculture is one of the mainstays of local residents, who have taken up residence on neighboring lands, including a portion of the Entoto natural park project area, which is being undertaken by EHT. Despite its proximity to Addis Ababa, the surrounding community's farming system has been relatively unaffected by modern inputs (Figure 5 & 6). Farmers on Entoto grow barley, wheat, and raise cattle and sheep, with some farmers even dabbling in horticulture.

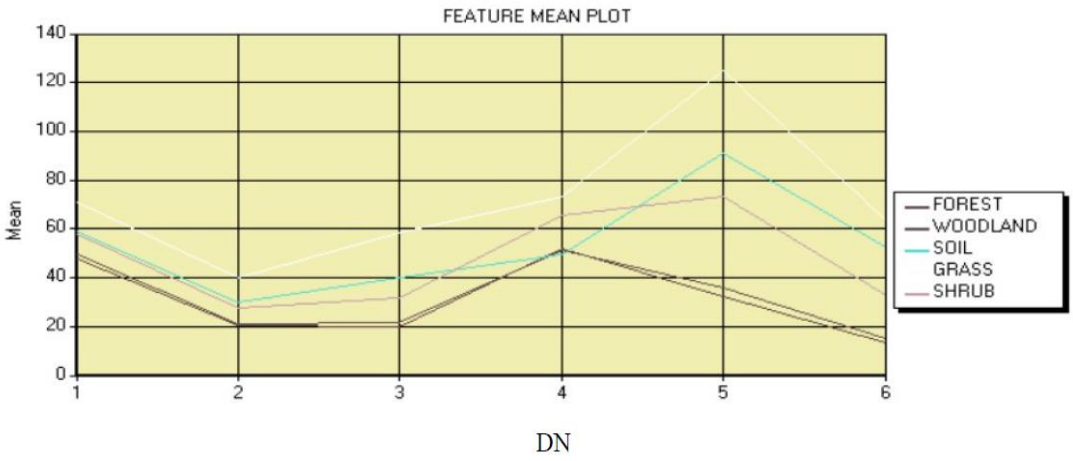

Figure 4. Feature spectrum plot

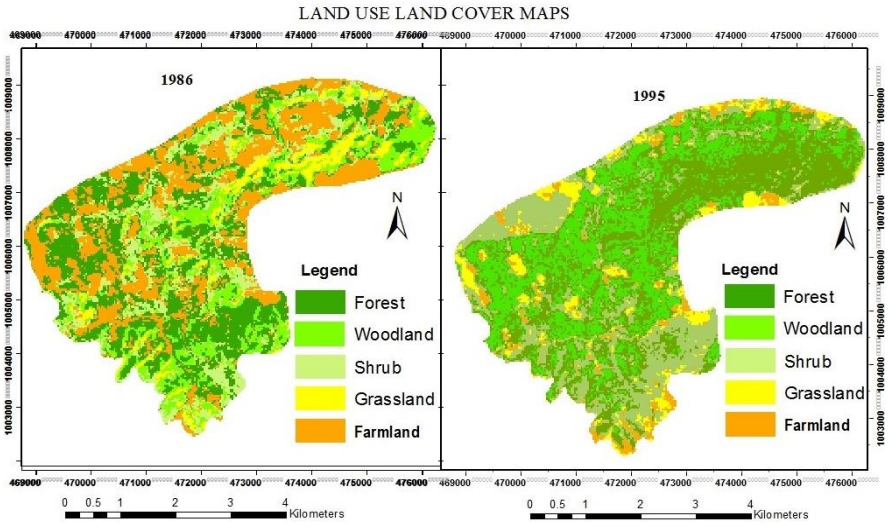

Figure 5. Land use and land cover map of year 1986, (*left*) and 1995 (*right*) (Source: Landsat images acquired in 1986 and 1995)

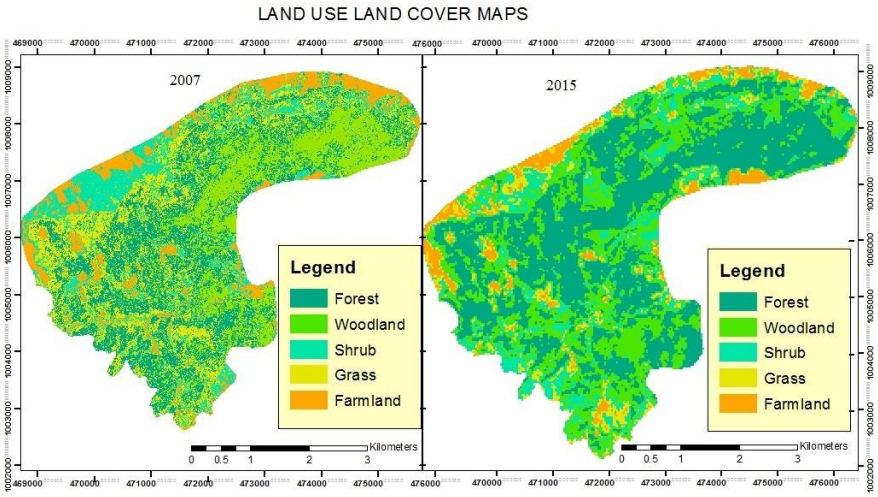

Figure 6. Land use and land cover map of year 2007 (*left*) and 2015 (*right*) (Source: SPOT image of 2007 and Landsat image of 2015)

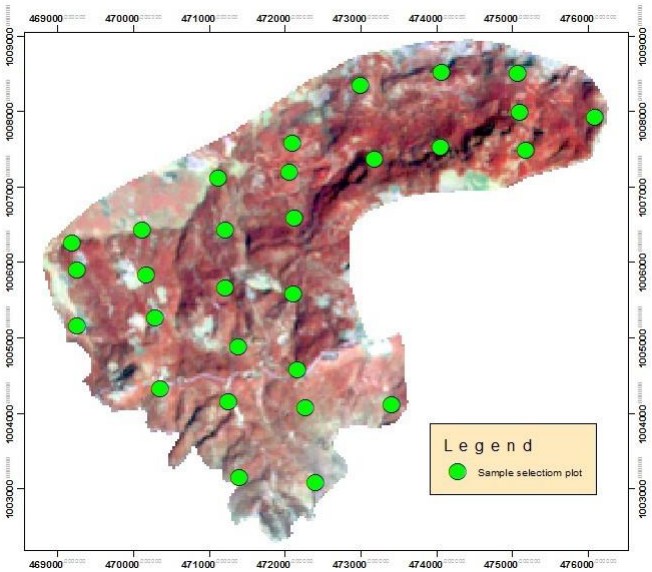

Figure 7. Plots of sample quadrats

Table 1. LU/cover change in percent

Year category	1986	1995	B/n 1986 & 1995		B/n 1995 & 2006			B/n 2006 & 2015		
			Change			Change			Change	
	(ha)	(ha)	(ha)	%	(ha)	(ha)	%	(ha)	(ha)	%
Forest	256.33	834.18	577.9	225.44	861.72	27.5	3.20	1085.20	223.5	25.9
Woodland	562.6	634.41	71.8	12.77	593.20	-41.2	-6.95	263.12	-330.1	-55.6
Shrub	838.61	565.24	-273.4	-32.60	280.18	-285.1	-101.8	682.65	402.5	143.6
Grassland	111.47	156.6	45.1	40.49	235.65	79.1	33.55	95.04	-140.6	-59.7
Soil	531.03	109.57	-421.5	-79.37	329.25	219.7	66.72	174.54	-154.7	-47.0
Total	2300.00	2300.00			2300.00	Shrub		2300.55		

Table 2. Coordinate points for plots of sample quadrants

Plot number	Easting (X-Co-ordinate)	Northing (Y-Co-ordinate)
3	468549	1005401
4	472115	1005582
5	472116	1006596
6	472058	1007189
7	472098	1007592
4	470125	1006862
3	470175	1005830
2	470297	1005260
2	474076	1008513
1	474063	1007522
6	471115	1007124
4	471201	1005675
3	471383	1004874
1	470053	1004317
1	471399	1003162
2	472997	1008345
1	473182	1007371
1	473414	1004113
3	475072	1008501
2	475106	1007981
1	475187	1007479
1	476095	1007923
2	471261	1004152
1	472403	1003085
5	471115	1007124
2	472268	1004072
3	472167	1004581
2	469289	1005701
1	469260	1005164

Table 3. Floristic richness of the Entoto Forest, Ethiopia

No.	Forest name	Genus name	Species name	Family name
1.	Entoto	*Acacia*	*abyssinica*	Fabaceae
2.	Natural	*Acacia*	*negrii*	Fabaceae
3.	Park	*Burollesa*	*polystachya*	Dioscoreaceae
4.		*Domboya*	*torrida*	Sterculiaceae
5.		*Ekebegia*	*capensis*	Meliaceae
6.		*Erica*	*arborea*	Ericaceae
7.		*Erythrina*	*brucei*	Fabaceae
8.		*Eucalyptus*	*globulous*	Myrtaceae
9.		*Ficus*	*sycomorus*	Moraceae
10.		*Hagenia*	*abyssinica*	Rosaceae
11.		*Hygenia*	*abyssinica*	Rosaceae
12.		*Hypericum*	*revolutum*	Hypericaceae
13.		*Juniperus*	*procera*	Cupressaceae
14.		*Maytenus*	*arbutiolia*	Celastraceae
15.		*Millettia*	*ferruginea*	Fabaceae
16.		*Myrica*	*salicifolia*	Myricaceae
17.		*Olea*	*europaea*	Oleaceae
18.		*Phoenix*	*reclinata*	Arecaceae
19.		*Pittosporum*	*viridiflorum*	Pittosporaceae
20.		*Podocarpus*	*falcatus*	Podocarpaceae
21.		*Prunus*	*africanus*	Rosaceae
22.		*Rosa*	*abyssinica*	Rosaceae
23.		*Salix*	*subserata*	Salicaceae
24.		*Schefflera*	*abyssinica*	Araliaceae
25.		*Syzygium*	*guineense*	Poaceae

Source: data recorded by Author

Assessment of biodiversity

There were 25 plant species in the study area, including *Acacia* (2), *Junipers* (1), *Eucalyptus* (1), *Hagenia* (2), *Erica* (1), *Olea* (1), *Hypericum* (1), *Podocarpus falcatus* (1), *Burllesa* (1), *Domboya* (1), *Ekebegia* (1), *Erythrina* (1), *Ficus* (1), Maytenus (1), *Millettia* (1), *Myrica* (1), *Phoenix* (1), *Pittosporum* (1), *Rosa* (1), There were 22 trees and three shrubs among them. As a result, only 25 plant species from 20 families were included in the research plots. The quantitative study was focused on 22 of these 25 species, which were woody plants (trees and saplings). Trees are the most common growth type among woody plants, accounting for more than 80% of the total. The field data, including plant measurement data, plot points, and their location/coordinates, were analyzed, and the outputs were produced. The plot points that resulted were combined and overlaid on the image map of the sample selection region (Figure 7).

Understanding the variation in plant diversity patterns of different scales is an important topic and crucial for both ecological explanations and for effective conservation design (Devries et al. 1997, as cited in Lema 2011). The description of plant communities involves the analysis of plant diversity, evenness and similarity (Whittaker 1960). A GPS was used to record the positions (coordinates) of each sample map. The information needed for this study came from a number of places. Various references, studies, and blogs were helpful in learning about existing policies, programs, projects, best practices, and so on. The plot point coordinates were also arranged in a tabular format (Table 2).

The diversity and equitability (evenness) of species in a given plant population are used to interpret relative differences between and within the community, and to help understand the key explanation for such differences. According to the United Nations, species diversity has been described as one of the main indices of sustainable land-use

practices, and significant resources are being spent to identify and enforce strategies that will reverse the current decline in biodiversity at local, regional, and global scales (Shackleton 2000). Other forests were chosen for comparison and then addressed. Floristic Composition

Entoto Natural Park

During field data collection in the Entoto evergreen forest, a total of 25 plant species were registered and used for study (Table 1). This demonstrates that Entoto Park lacks species diversity in comparison to many other Ethiopian forests, where over 80 tree plant species have been described in each area. Previously, *Juniperus procera* has dominated the forest, with groves of *Olea europaea cuspidata, Hagenia abyssinica, Hypericum revolutum, H. quartinianum, Podocarpus falcatus*, and *Acacia abyssinica* scattering through, and with *A.negrii* in some of the more disturbing valleys. *Erica arborea* can be found at elevations of over 3,000 meters. Fruit-eating birds are drawn to shrubby areas by species like *Rosa abyssinica* and *Carissa edulis*, which have fleshy fruits. The number of herbs, both in the forest undergrowth and in the meadows, is enormous, and includes many endemics, especially clovers. However, during fieldwork, it was discovered that the majority of the Entoto mountain range (and many others nearby) is covered in Eucalyptus plantations, followed by *Juniperus procera* trees. The data analysis revealed that the majority of the plant species found in the study plots are native to the region (Table2). Based on the data of the plant species, the FGRCP database Access for Windows version software was used to classify the vegetation into plant population types. The FGRCP database Access for Windows version7.0 software was then used to analyze field data, calculating and determining floristic richness, plant density, frequency, density per forest, and total stem per forest.

The number of stems reported in each quadrant was measured, and *Eucalyptus globulus* is the most abundant, accounting for 4560 stems in all quadrants, while Podocarpus falcatus is the least abundant, accounting for just 15 stems and 0.17 % of the total stems (Table 5). In all quadrants of the forest vegetation, a few tree species dominated the number of stems, with *Eucalyptus globulus* species accounting for nearly half of the overall abundance. *Eucalyptus globulus* and *Juniperus procera*, two tree species, accounted for nearly 88 % of the total species abundance in the region (Table 4).

Just two species were found in more than 88% of the plots, indicating that the forest was dominated by a limited number of species. With one species each, the Myrtaceae and Cupressaceae families are the most diverse, followed by the Oleaceae family. Myrtaceae is the most abundant plant in terms of stand density (Table 5).

Table 4. Quantity of stems in all quadrants

Forest name	Genus name	Species name	Sum of quantity	%
1	*Acacia*	*Negrii*	168	1.907
2	*Acacia*	*Abyssinica*	118	1.339
3	*Burollesa*	*polystachya*	75	0.76
4	*Domboya*	*Torrida*	52	0.53
5	*Ekubeergia*	*Capensis*	9	0.09
6	*Erica*	*Arborea*	870	9.875
7	*Erythrina*	*Brucei*	84	0.853
8	*Eucalyptus*	*Globulous*	4560	51.759
9	*Ficus*	*sycomorus*	96	0.98
10	*Hagenia*	*Abyssinica*	160	1.816
11	*Hypericum*	*Revolutum*	150	1.703
12	*Hypericum*	*Revolutum*	65	0.66
13	*Juniperus*	*Procera*	2432	27.605
14	*Maytenus*	*Arbutiolia*	51	0.52
15	*Millettia*	*Ferruginea*	93	0.94
16	*Myrica*	*Salicifolia*	85	0.86
17	*Olea*	*Europaea*	337	3.825
18	*Phoenix*	*Reclinata*	37	0.38
19	*Pittosporum*	*viridiflorum*	49	0.50
20	*Podocarpus*	*Falcatus*	15	0.17
21	*Prunus*	*Africanus*	57	0.58
22	*Rosa*	*Abyssinica*	91	0.92
23	*Salix*	*Subserrata*	55	0.56
24	*Schefflera*	*Abyssinica*	63	0.64
25	*Syzygium*	*Guineense*	72	0.73
			9844	

Table 6. Quantity of plant species of different forests

Forest name	Total number of species per forest
Entoto Natural Park	25
Menagesha suba Forest	128
Boginda Forest	73
Belete Forest	157

Table 5. Relative density of the plant

Forest name	Genus name	Species name	Total stems	Total stem per forest	Relative density %
Entoto Natural Park	*Acacia*	*abyssinica*	17		0.08
	Erica	*arborea*	279		1.3
	Eucalyptus	*globulous*	15359		70.21
	Hagenia	*abyssinica*	88		0.41
	Juniperus	*procera*	6106		28.00
				21570	100

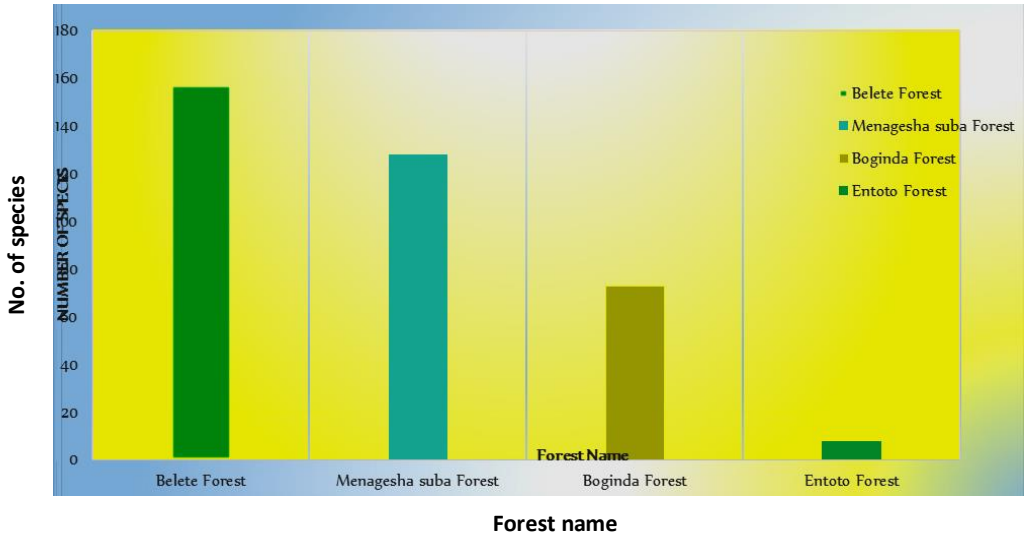

Figure 8. Comparison of forest floristic richness

Menagesha suba state forest

The Menagesha Suba State Forest is 30 km southwest of Oromia National Regional State in central Ethiopia. The mountainsides are generally steep with ravines cut by streams and rivers. The Menagesha Suba State Forest has a total area of 9,248 hectares. The Ethiopian plateau was once thought to be covered in a vegetation mosaic of dry evergreen Afromontane forest, grassland, and Acacia woodland. Forests and woodlands grow on the well-drained soils of the mountains and valley sides, while grassland grows on the thick clay soils of the bottoms of valley. The Natural Forest of Menagesha Suba State Forest is dominated by *Juniperus procera*, which grows to c. 30 m and has a relatively open canopy, according to (Lema 2011). The understory is made up of *Olea europaea* subsp *cuspidata*, *Allophyllus abyssinicus*, *Maytenus arbutifolia*, and *Euphorbia ampliphylla*, with a few *Podocarpus falcatus* trees strewn around. *Juniperus procera*, *Erica arborea*, *Rosa abyssinica*, and the endemic *Jasminum stans* coexist at higher elevations. *Lobelia giberroa* and *Solanecio gigas*, two giant herbs, dominate the valley sides, while *Scadoxus multiflorus* carpets the forest floor. The floristic data analysis was based on 106 species included in the sampled plots. Menagesha Suba State Natural Forest has a total of 128 species of herbaceous flowering plants, divided into 102 genera and 44 families (Lema 2011).

Boginda forest

Boginda forest spans 7500 hectares of natural high forest and is administratively located in Gimbo Woreda, Kafa-Shaka Zone, Southern Nations, Nationalities and Peoples Region. Boginda forest yielded a total of 73 woody specimens, 70 of which were inside the sample plots and three of which were outside the sample plots. Rubiaceae was the forest's most diverse genus, followed by Euphorbiaceae, Celastraceae, and Fabaceae.

Belete moist evergreen montane forest

Belete forest is located 375 kilometers southwest of Addis Ababa in the Shabe-Sombo District, Jimma Province, Oromia National Regional State. A total of 157 species of vascular plants belonging to 135 genera and 69 families were described in the Belete moist evergreen montane forest (Gebrehiwot and Hundera 2014). Pteridophytes and gymnosperms were described by two species each, while Angiosperms accounted for the remaining 153 species. The gymnosperms *Podocarpus falcatus* and *Juniperus procera* were found in the study field. With ten and nine species, respectively, the Fabaceae and Lamiaceae families had the most species. One species was assigned to each of the thirty-three families. Herbs dominated the growth forms of the species reported from the Belete moist evergreen montane forest, followed by trees. The Belete moist evergreen montane forest contains 17 (10.82%) Ethiopian endemic species, some of which are included in the Ethiopian endemic species list (Kflay and Kitessa 2014). The total number of plant species found in Entoto Natural Park, Menagesha Suba State Forest, Belete Moist Evergreen Montane Forest, and Boginda Forest were used as a comparison (Table 5) and the data were presented graphically (Figure 8).

Suitability analysis for ecotourism development

Since the Entoto natural park is not yet a fully-fledged national park, it is not under the control of the Addis Ababa City Administration's Culture and Tourism Bureau or the Ministry of Culture and Tourism, but rather of the Addis Ababa City Administration's Environmental Protection Bureau (EPB). The Entoto Natural Park is currently in the process of becoming a wildlife-filled, visitor-ready tourist attraction, and it is only a conservation project now. The Entoto natural park's flora and fauna are not what attract visitors. According to Tesfaye (2009), this is because it is dominated by (originally Australian) *Eucalyptus globulous* trees, which kill other vegetation. The Ethiopian Heritage Trust project is starting to yield results. The attractive,

rugged hillside above Entoto Natural Park's nursery, complete with a diverse range of indigenous plants, stands in stark contrast to the lifeless, uniform eucalyptus swaths. It gives visitors a sense of what the landscape was like before Addis; and the restoration has resulted in the return of dik diks, duikers, and jackals, as well as a number of birds and shrubs like *Rosa abyssinica*. Students and visitors flock to the park because of its scenic beauty, which includes waterfalls, hills, and a variety of birds. The Trust intends to develop restaurants, playgrounds, and a training center for students interested in natural history in the future. The local population can acquire new skills, allowing them to become less reliant on limited natural resources.

The suitability of Entoto Natural Park for ecotourism creation was assessed using selected parameters and geographic information systems (GISs) methods in this report. A simple self-assessment method for determining the suitability of a proposed ecotourism operation is the site suitability assessment. When determining suitability, environmental degradation is taken into account. For example, there may be land uses that appear to be highly productive in the short term but are more likely to result in soil erosion, progressive pasture depletion, or downstream river regime changes. Such consequences would outweigh the short-term gains, and the property would be classified as unfit for such uses. This theory does not imply that the ecosystem should be maintained in its original state. What is expected is that the likely environmental impacts of any planned land use be evaluated as accurately as possible, and the assessments be taken into account when assessing suitability (Pareta 2013).

Distance from roads, land use/cover, reservation/ protection, species diversity, elevation and slope, proximity to settlement centers, and population size were all factors considered during the assessment process for the ecotourism site. In terms of settlement sites, the park is close to Addis Ababa region, Sululta town, Chancho in the north, Burayu, Menageha, Sebeta towns in the west, and Lagatafo-lagadadi in the east, as well as all other Addis Ababa satellite towns. Those factors were chosen based on the technical expert's recommendations. An effort was made to look at the specifics of the causes. The proposed methodology was useful in identifying ecotourism sites by linking important parameters to the actual resources of the studied region. The site should be: (i) At least 1000 meters from densely populated areas. (ii) Within 1500 meters of an existing all-weather, dry-weather, and motorway route. (iii) Definitely not on farm ground. (iv) Certainly not on community-owned land. (v) Traditional owners and local communities should be involved and benefited.

The analyses were primarily focused on the parameters mentioned above. The results of the analysis revealed that the Entoto natural park met the criteria for being recommended as a suitable site for ecotourism production. In general, the following factors were established and used as indicators of suitability within land ecosystems in this study:

Accessibility and distance from roads: Access characteristics were displayed in terms of road access, with road categories (all-weather road, dry weather road, and motorways) taken into account.

Dense residential area: it was determined that the study area is located beyond a radius of 1000 meters from densely populated areas.

Landscape: The park is located on elevated ground above Addis Abeba, with attractive, wider visibility and the rugged hillside of the Entoto ridge.

Biodiversity: The Ethiopian Heritage Trust's environmental conservation project activity planted 40,000 indigenous seedlings in the Entoto Natural Park, covering 500 hectares of parkland. The Ethiopian Heritage Trust project planned to plant 44,000 indigenous seedlings in the near future and to completely cover its project area with indigenous plant species.

Topography: it is located on the top of Entoto Mountain, with excellent visibility (Figure 3).

Telecommunications: It was revealed that the study area is surrounded by a well-developed telecommunication infrastructure.

Power supply: within a 1000 m radius of the study area, there is a well-developed and adequate sub-station infrastructure.

Population size: the park is situated on the outskirts of Addis Ababa's city limits in terms of settlement centers. Other nearby towns include Addis Alem, Sululta, and Chancho in the north, Burayu, Menageha, and Sebeta in the west, and Lagatafo-lagadadi in the east, as well as Bushoftu, Dukem, and Akaki in the south. A buffer zone was established around the proposed site in terms of dense residential areas and industrial zones, meaning that it will not be too close to already heavily populated areas or existing tourist zones. It was determined that no location could be built on agricultural land or community-owned property.

The suitability of a piece of land is determined and graded based on the type of usage it may receive. This theory expresses the understanding that different types of land use have different requirements. The characteristics of each type of land are compared to the requirements of each usage, such as moisture availability or flooding risk. As a result, both the property and the land use are equally important in determining land suitability (Queensland State (2015). A collection of requirements is needed for almost all development issues. Similarly, the development of ecotourism necessitates the development of a set of parameters that can be used to select ecotourism sites in order to validate the current opportunities and challenges. In order to assess tourism alternatives, certain environmental impacts such as air quality, surface water quality, groundwater quality, road traffic, noise level, solid waste disposal system, archaeological and historical sites, natural vegetation, and wild animal life were recommended in the literature (McIntyre et al. 2006).

Discussion

Opportunities

Some interventions, involving ecotourism activities, have been attempted in Adaba-Dodola forest priority area in Bale zone in Oromia regional state. WAJIB, which is

said to be "Waldaa Jirattoota Bosonaa" in Afan Oromo meaning "forest Dwellers associations" is an example of such effort. Safe areas are now used to preserve wildlife and natural habitats on a wide scale. However, these protected areas are constantly confronted with a variety of issues. There could be both a threat to and an opportunity for natural resource protection in these protected areas (Wearing and Neil 1999). Ecotourism has been implemented in some countries' protected areas to address these issues, as ecotourism has the potential to play a major role in natural resource management and overall growth in developing countries (Strasdas 2002). To improve the quality of human life, there is a growing need and opportunity to build bridges between these two systems. Only by linking our formal knowledge system, which is based on a hypothetical-deductive approach and inductive reasoning to understand ecosystems, with the conventional knowledge system, which is derived from societal interactions and beliefs, can we understand the dynamic relationships that occur between ecological and cultural systems. Traditional ecological awareness, such as medicinal plants and local food organisms, has a reasonably well-developed understanding of tangible benefits. However, we need to improve our understanding of the connections between ecological and social processes, as well as their tangible and intangible benefits (such as spiritual and religious values), and their effect on sustainable natural resource management at the landscape level (Rudolf et al. 2003). A concurrent trend in development is the discovery of land uses that are both environmentally and economically viable. The World Commission on Environment and Development (WCED, 1987) established and promoted "sustainable development" as the umbrella under which these efforts take place (Langholz 1996).

Traditional and formal information structures must be connected to achieve ecosystem protection and sustainable use. There is a growing need and potential to create bridges between these two structures in order to enhance human life quality (Rudolf et al. 2003). People are becoming more overweight as a result of more sedentary lifestyles, putting them at risk for chronic diseases like diabetes earlier in life. There is a growing recognition that health systems will be unable to cope unless a corresponding shift to more healthy lifestyles occurs. Parks are excellent locations for getting some good exercise (Barber 2008). Urban green spaces, according to Arvaniditis (2008), offer opportunities for exercise and leisure, contributing to people's physical and mental health. Green spaces have also been shown to be beneficial to human physical and mental health, according to Kazmierczak and James (2008) as cited in (Mesfin 2011). Visiting a national park or a protected area contributes to the park's upkeep by paying fees to the staff who look after it.

Ecotourism is a form of tourism that places a strong emphasis on environmental and cultural preservation. Forests provide social benefits such as wellness, employment, education, leisure, community building, and land (Kuchelmeister 2000). These advantages are often ignored. For a developing country like Ethiopia, job benefits are especially important, while other social benefits will become more important as living standards rise. Ecotourism development entails expenses, most notably a budget for environmental protection, treatment, and management. Although the budget required is substantial, the long-term benefits will usually outweigh the costs. Other costs could include risks to human safety, structural harm, vandalism, unorganized waste disposal, and solar energy reduction. These costs, however, can be reduced by taking the right steps. Ecotourism benefits the local community by creating jobs, providing services, and stimulating the economy. It conserves resources and protects plants and animals from the negative effects of conventional tourism (Carter 1995).

The followings are some of the importance of ecotourism: (i) The expansion of the ecotourism industry would provide jobs for local residents and ensure that fewer people migrate to towns. (ii) You will appreciate the handiwork of local artisans, and purchasing from them would support their economy while also preserving the local heritage. (iii) It is low-impact tourism, in which visitors make a deliberate effort to respect the environment, conserve natural resources, and re-invest a sufficient portion of their earnings in environmental protection. (iv) Ecotourism will bring you closer to nature, open your mind to fresh ideas, take you to less-traveled areas, and provide you with a memorable new experience while minimizing environmental impact. (v) You can watch birds or take a walk through forests to explore the various natural wonders and stop by the villages to enjoy their cuisine and lifestyle.

Ethiopia received a five-year USAID (United States Agency for International Development) grant to support the country's ecotourism development after many homegrown Ethiopian ecotourism associations sprang up in the early 20s (Logan 2012). One important factor behind this trend is that there is substantially more tourism-related work being done around the organization and in different regions; evidence indicates that demand for lending and advice is growing in tandem with the political economy and tourism growth in developing countries (Mann and Hawkins 2006). Experts founded the Ethiopia Sustainable Tourism Alliance (ESTA) with grant funding to communicate with local communities and collaborate on the development of local ecotourism enterprises (Logan 2012). ESTA is a member of the USAID Global Sustainable Tourism Alliance, which uses tourism production to alleviate poverty, promote economic growth, promote environmental stewardship, and protect biodiversity in a variety of countries around the world. In Ethiopia, the Alliance is already collaborating with local stakeholders to develop a program that will build employment, protect the environment, and respect social-cultural values and heritage. Biodiversity protection, ecotourism and other niche business creation, workforce development, and handicraft production and marketing will all be part of the program. ESTA is focusing on the Central and Southern Rift Valley Lakeland in order to protect and improve both biodiversity and cultural patrimony. The Rift Valley Lakeland, home to the popular ESTA development in Lepis and the earlier German Agency for International Cooperation (GIZ) development in Adaba Dodola, is rich in nature preserves and historic lakes. ESTA brought

community members from Lepis to see what they could do with their region after GIZ built rustic accommodations in Adaba Dodola, and worked with them to pick possible campsites within the forest and identify exotic bird species that would appeal to the lucrative bird-watching tour market. Locals took the initiative to upgrade forest trails and build a river bridge to expand hiking opportunities. A 15-unit lodge with rustic reed-and-grass huts is operated by Village Ethiopia, an Ethiopian-owned tour company in the area. Despite the fact that Africa was the only place in the world to see a rise in international arrivals in 2009, at the height of the global recession, Ethiopia has been slow to reap the benefits of this international interest, attracting only 0.7% of the continent's tourists, according to the United Nations. (http://www.irrob.org/ecotourism _in_ethiopia.html_.Ecotourism in Ethiopia. EhiopianJournal).

The Ethiopian Heritage Trust (EHT) was established in 1992 by a group of patriots including Architect Yosef Bereded, Dr. Agidew Rede, Prof. Richard Pankhurst, Dr. Alula Pankhurst, Michael Sergeant (British nationality), and a few others with the aim of preserving and developing Ethiopia's historical, cultural, and natural heritage. Aside from tourism income, there has always been a trade-off between economic development and environmental conservation in the past. Green growth, or investing in renewable energy sources, has only recently become a mainstream concept. This trade-off has been and continues to be, even more, pronounced for a developing country like Ethiopia, where economic growth is the primary goal of policy. A long-term conservation project is underway on the outskirts of Addis Ababa to restore indigenous vegetation in place of the introduced eucalyptus that has dominated for over a century (William 2009). However, with the current focus on climate change issues and the broader concept of sustainability, environmental considerations have become commonplace. As these philosophies are coupled with romantic, aesthetic ideas about the protection of original ecosystems and organisms, a powerful concept emerges: not only is it good to conserve rare, natural objects, but we also need to be far more vigilant about how we use the earth's resources (William 2009). Resource evaluation, creation of management plans for forest management and land use, and organizing local communities around parks and consumers of non-timber forest products are among the successful actions that have been carried out in most of Ethiopia's national regional states since 2010. The annual economic benefit of certain protected areas is projected to be 1.5 billion dollars in direct and indirect terms. “Both the land and the communities in the destination must be safe and prosperous for tourism to be profitable and sustainable.” (http://ethiopia.usembassy.gov/pr_5.html)

The following are a few examples of ecotourism development opportunities: (i) The Ethiopian Heritage Trust's long-term conservation project to preserve indigenous plants and protect the ecosystem, as well as their ongoing monitoring. (ii) The park's position on the outskirts of Ethiopia's capital, Addis Ababa, as well as its geographical location in the heart of the country. (iii) Proximity to several urban centers that are potential stakeholders/visitors in the future, especially Addis Ababa, Ethiopia's capital and largest city. (iv) The park is along the main road from the central part of Addis to the city and can also be reached from other directions by the all-weather route. (v) The site may be accessed through existing roads and tracks without incurring maximum road construction costs. (vi) The forest has been constantly being protected from human, domestic and wildlife destruction.

Challenges

Furthermore, as demand for ecotourism grows, the availability of suitable ecotourism sites around the world is dwindling, jeopardizing their ecological viability. Incompatible economic uses of land area for other economic activities such as agriculture, industry, mining, and urban development, inappropriate tourist development and infrastructures necessary to support that development, willful destruction of ecotourism by tourists, numbers of tourists in excess of carrying capacities, and adverse environmental conditions are the main reasons for the deterioration of ecotourism sites (Tisdell and Wilson 2005). While the ecotourism industry has experienced significant growth in the last several years in terms of arrivals and offers, visitors still see the parts of the country being developed for ecotourism. It's difficult to reach Ethiopia's total glut of unspoiled natural areas independently with infrastructural concerns remaining one of the main unaddressed barriers to rural tourism (Logan 2012). In developing countries, natural resources are under considerable threat, partly due to lack of alternatives and partly because of people's livelihoods. By diversifying people's livelihoods (mainly to an environmentally friendly nature), pressure on natural resources can be minimized. Ecotourism enables the diversification of livelihoods and the sustainable management of natural resources as an economic activity In this context (Amogne 2014). The link between protected areas and the local communities is a key element in the sustainable preservation of natural resources within and around these protected areas, Okello (2003) noted. In many cases, however, there are conflicts between relations. Public participation can encourage the transfer of knowledge between park management and local communities, which can stimulate mutual understanding between concerned stakeholders.

Land scarcity as a result of population pressure, inequitable land allocation by non-local communities, and a lack of accountability in dealing with land issues can all lead to conflict. Some land disputes are caused by global factors such as trade liberalization, structural reform programs, commercialization, imperialism, and the privatization of collective lands, forests, and water services (AUC-ECA-AfDB 2010). Inequitable income sharing arises from inadequate involvement of locals in the ecotourism growth process. The simple provision of incentives as a means to exploit resources and marginalize a certain segment of a population may increase resource exploitation, loss of trust in ownership, and marginalized community frustration with ecotourism production (Teressa 2015).

The study's findings revealed/ confirmed that the Entoto Natural Park offers both crucial opportunities and challenges for ecotourism growth. Some of the recent challenges are: (i) One of the recurring disagreements between the EHT project and the surrounding community (farmers) in the Entoto park area, as described by EHT experts, revolved around access to and control over property, primarily timber, farmland, and land for house settlement. (ii) The orthodox church's repeated demand for possession of the eucalyptus trees. (iii) Deforestation, clearing of all-natural trees, and the dominance of only a few exotic plant species diversity, which is not favorable for many animal species as a habitat and has less biological diversity than many other forests. (iv) Anthropogenic practices include removing vegetation from cities, soil degradation, and population pressure. (v) Wildlife and domestic animals destroy the saplings planted by the EHT project. (vi) Unreliable budget source for indigenous plant protection and restoration, as well as trouble obtaining tourism funds. (vii) Invasive Alien Species (IAS) is the second most important cause of ecosystem change after climate change. *Eucalyptus globulous* is one of the Invasive Alien Species, according to Mack et al. (2007). (IAS). Unfortunately, the (originally Australian) *E. globulous* trees dominate Entoto Park, suppressing other vegetation.

By altering biogeochemical cycles, the existence of IAS in an ecosystem can influence its functioning across a broad range of temporal and spatial scales (Mack et al. 2007). *Eucalyptus globulous* is one of the Invasive Alien Species, according to Mack et al. (2007). (IAS). Unfortunately, the (originally Australian) *E. globulous* trees dominate Entoto Park, suppressing other vegetation. Eucalyptus species have been introduced since 1895 to meet the demand for wood fuel, building materials, and to relieve pressure on remaining natural vegetation. It is unlikely that Addis Ababa would have been Ethiopia's capital and Africa's diplomatic center if Emperor Menelik II had not succeeded in introducing *Eucalyptus* (Hancock 1995). A greenbelt was built around the city as a result of the massive reforestation campaign, which solved the ever-present problem of wood scarcity. Since 1925, Acacia 'Eucalypt polis,' or eucalyptus tree city, has been extended, as has this greenbelt. The plantation area around Addis Ababa, including Entoto ridge, was about 13,500 to 15,000 ha in the 1960s and 1970s. Unfortunately, the fast-growing, water-sucking tree is jeopardizing the ecosystem's biodiversity. While trees have always been a significant part of human settlements, their true importance to city dwellers has only recently been recognized. The importance of trees and green spaces in enhancing city living conditions cannot be overstated. Government and foreign funding for urban forestry has been minimal in most developing countries. The rapid rise in urban population in these countries, along with related increases in food, fuel, and shelter needs, necessitates the development of strategies in which forestry plays a larger role in supplying these resources and improving the urban living environment (www.ecotourism.org/ties-overview). The "fuel-wood problem," "social forestry," and, most recently, the protection of biological diversity and mitigating global climate change have all become front-page news. However, forestry has remained a rural practice in the eyes of the public, despite its broadened goals. The struggle of growing populations to meet their needs for food, electricity, and construction wood has resulted in environmental degradation in towns, peri-urban areas, and even accessible rural areas (Kuchelmeister and Braatz 2000). This is also true of Addis Ababa, Ethiopia's capital. Furthermore, because of resource conflict, local views of protected areas are negative. They saw conservation areas as a hindrance to their land use. People who live near protected areas have survival needs that are diametrically opposed to the park's needs. The process of involving local people in decision-making and park management activities was not given enough consideration. Local residents, on the other hand, are blamed by conservationists as a significant obstacle to the protected area's conservation. As a result, in order to maintain protected areas through the creation of ecotourism, which heavily involves local people in decision-making and profit sharing, it is important to collaborate with local people. Addis Ababa requires ecotourism development strategies and plans that adhere to sustainable ecotourism development principles such as the active contribution of the sub-sector to the protection of environmental, historical, and cultural heritage, as well as the participation of local and indigenous communities in its planning, development, and activity, which benefits their well-being. To end this other, the proposed guidelines are expected to make a major contribution in the future to fostering sustainable ecotourism growth in and around Addis Ababa. Communities, government partners, and the private sector collaborated to develop long-term, market-driven attractions that enable residents to benefit from environmental and cultural preservation (Jennifer 2013).

Various schemes to rebuild and rehabilitate degraded areas in Ethiopia are also being led by the Ethiopian Ministry of Agriculture. Area closure, integrated community-based watershed protection, and natural forest management are among the plans. The Ethiopian Heritage Trust has embarked on a project to plant indigenous seedlings in Entoto (north of Addis Ababa) in order to preserve indigenous ecosystems and establish a natural park, with students voluntarily participating. To direct considerations for the construction of ecotourism facilities on national parks as outlined in the implementation process, the Queensland State of Australia has defined the following Practice Criteria for Ecotourism Operations. Those Practice Criteria for Ecotourism Operations are: *The Ecotourism Operation is in keeping with the natural and cultural values of national park. The natural and cultural values of the site are inventoried, and its distinctive features are highlighted. Any device limitations or stressors are established, and sensitive and vulnerable areas are avoided in development and activities. The Ecotourism Operation is designed to fit within the character of the national park. The design and layout of Ecotourism Operation complement the surrounding landscape and natural features. By considering factors such as aspect and orientation, the design and layout optimize the*

sustainability of ecotourism facility and visitor comfort. The ecosystem is made up of endangered native plants. The Ecotourism Operation leaves the smallest possible footprint on the site. The design and operation of Ecotourism Operation have minimal impacts on the Site. The Ecotourism Operation encourages water and energy conservation, and visitor activity is driven by a "leave no trace" ethic. Waste and emissions are kept to a minimum. The Ecotourism Operation contributes to protecting and positively enhancing the national park.

The Ecotourism Operation, which works in collaboration with park management and local organizations to, for example, rehabilitate disturbed areas of the national park and inform staff and visitors about fundamental park values, contributes to the long-term sustainability of national park. Traditional owners and local communities are engaged, involved, and benefited by the ecotourism process. The significance of national park to cultural and economic interests of local communities is established, and long-term relationships are sought. The interpretation and experience of indigenous cultural resources are influenced by traditional owners. Visitors are encouraged to value the national park and want to preserve and maintain it through the ecotourism operation. The natural and cultural values of the site are correctly interpreted, and visitor activities and interactions contribute to their preservation and restoration (Queensland State, 2015). Flora and fauna, environment, water bodies (ocean, sea, rivers, lakes, hot springs, etc.), scenery, landscape, and other natural eco-attractions are well-known.

The status of biodiversity in the Entoto park was assessed as possible opportunities for the creation of ecotourism in the Entoto natural park in this study. In conclusion, the success of ecotourism is dependent on the nature of the natural and human environment. If properly planned and operated, ecotourism has the potential to reduce environmental impacts while also contributing significantly to the following areas: (i) ecotourism allows for the existence of several privately owned nature reserves in the tropics. These reserves depend on ecotourism more than any other form of income, and some are entirely reliant on it. (ii) the position of Ecotourism as a driving force behind the development of these parks shows a clear connection between biodiversity conservation and ecotourism. (iii) The social, ecological, and economic problems surrounding privately owned nature reserves are emerging, but they are largely unexplored. We know very little about their impacts, aside from simple descriptive knowledge about scale, habitat type, and job development. (iv) As demonstrated by the reserves in this report, it is possible for a reserve to operate solely on ecotourism revenues. “Traditional” and “formal” information structures must be connected to achieve ecosystem protection and sustainable use.

REFERENCES

African Union Commission-Economic Commission for Africa-African Development Bank (AUC-ECA-AfDB). 2010. Land Policy in Africa: Eastern Africa Regional Assessment. ECA, PCMS, Addis Ababa, Ethiopia.

Amogne A. 2014. Ecotourism as a viable strategy for livelihood diversification and Sustainable Natural resource management in Ethiopia (from eco-development paradigm point of view). J Environ Sci Water Resour 3 (2): 40-52.

Arvaniditis PA. 2008. Economic aspects of urban green spaces: Survey of perceptions and attitudes. J Environ Technol Manag 11 (1): 144-165. DOI: 10.1504/IJETM.2009.027192.

Barber A. 2008. Start with the park: Creating Sustainable urban Green spaces in areas of housing growth and renewal. http://lifestyle.iloveindia.com/lounge/benefits-of- ecotourism-8866.html#sthash.zjToqdzF.dpuf

Beedasy J, Whyatt D. 1999. Diverting the tourists: a spatial Decision-support system for tourism planning on a developing Island. Elsevier, Int J Appl Earth Observ Geoinformation 1 (3-4): 163-174. DOI: 10.1016/S0303-2434(99)85009-0

Bunruamkaewa K, Murayama Y. 2011. Site suitability evaluation for ecotourism using GIS & AHP: A case study of Surat, Thani Province, Thailand. Procedia Soc Behav Sci 21: 269-275. DOI: 10.1016/j.sbspro.2011.07.024

Carter S. 1995. Tourists and Travelers’ social construction of Africa and Asia as risky places. Cater E. 1993. Ecotourism in the Third World: Problems for sustainable tourism development. Tourism Manag 14 (2): 85-90. DOI: 10.1016/0261-5177(93)90040-R

Congalton RG. 1991. A review of Assessing the Accuracy of Classification of Remotely sensed Data. University of California Berkeley, Berkeley, USA.

Ethiopian Biodiversity Institute (EBI). 2014. Ethiopia’s Fifth National Report to the Convention on Biological Diversity (CBD). Unpublished technical report, EBI, Addis Ababa, Ethiopia.

Ethiopian Wildlife and natural History Society (EWNHS). 2015. Important Bird Areas in Ethiopia and associated islands-Ethiopia. Addis Ababa, Ethiopia.

Faust NL. 1989. Image Enhancement. Volume 20, Supplement 5 of Encyclopedia of Computer Science and Technology. Williams. Marcel Dekker, Inc., New York.

Fedorov E. 1980. Man and Nature. The Ecological Crisis and Social Progress. Progress Publishers, Moscow, USSR.

Gebrehiwot K, Hundera K. 2014. Species composition, Plant Community structure and Natural regeneration status of Belete Moist Evergreen Montane Forest, Oromia Regional state, Southwestern Ethiopia. Momona Ethiopian J Sci 6 (1): 97-101.

Haileselassie G, Getaneh A. 1989. The Addis Ababa-Nazaret Volcanics: A Miocene-Pleistocene volcanic succession in the Ethiopian Rift. SINET Ethiopian J Sci 12 (1): 1-24.

Hancock G. 1995. The Beauty of Addis Ababa. Camerapix Publishers International. Nairobi, Kenya.

Henze PB. 2007. Ecotourism in Ethiopia. http://www.irrob.org/ecotourism in_ethiopia.html on 21.11.2015.

Holloway JC. 1991. The Business of Tourism, 3rd ed. Clays Ltd, England.

Jennifer B. 2013. Community ecotourism destinations open in Ethiopia’s central and southern. http://www.counterpart.org/ accessed on 14.09.2015.

Kazmierczak AE, James P. 2008. Urban Green Spaces: Natural and Usable. Leibniz (IOER), Dresden, Germany.

Kuchelmeister G, Braatz S. 2000. Trees for the urban millennium: urban forestry update. Unasylva 51: 50-55.

Langholz J. 1995. Ecotourism Impact on Independently Owned Nature Reserves in Latin America and Sub-Saharan Africa. Yale School For Environ Stud Bull Ser No. 99, New Haven, USA.

Logan G. 2012. Ethiopia Poised to Become Next Hot African Ecotravel Destination. http://ethiopia.usembassy.gov/pr3808.html accessed on 19.11.2015.

Mack MC, D’Antonio CM. 2007. Impacts of biological invasions on disturbance regime https://www.cbd.int/doc/world/et/et-nr-05-en.pdf accessed on 11.9.2015.

Malede B, Girma G. 2015. Review on problems, prospects and economic contribution of Wildlife Management and Ecotourism in Ethiopia. J Vet Sci Technol 6 (257): 2157-7579.

Mann S, Hawkins DE. 2006. The World Bank’s role in Tourism Development. Ann Tourism Res 34 (2): 348-363. DOI: 10.1016/j.annals.2006.10.004

McIntyre N, Williams DR, McHugh KE. 2006. Multiple dwelling and tourism: negotiating place, home and identity. CABI, Wallingford, UK. DOI 10.1079/9780845931202.0000

Mesfin T. 2009. Spatial Metrics and Landsat Data for Urban Landuse Change Detection in Addis Ababa, Ethiopia. Castellon, Spain.

National Meteorological Agency of Ethiopia (NMAE). 2014. Reports on Temperature and Rainfall characteristics of Ethiopia.

Okello MM, Wishitemi EL. 2003. Application of the protected landscape model in Southern Kenya. Parks 13 (2): 12-50.

Queensland State. 2015. Best Practice Ecotourism Development Guidelines. Queensland, Brisbane, Australia.

Rudolf PS, Ramakrishnan de G, Berg A van de, Kulenthran T, Muller S, Pitt D, Wascher D, Wijesuriya G. 2003. Cultural and amenity services. Ecosyst Hum Well-being: Curr State Trends 7: 457-462.

Shackleton CM. 2000. Biological conservation comparison of plant diversity in protected and communal lands in the Bushbuckridge Lowveld savanna, South Africa. Biol Conserv 94 (3): 273-285. DOI: 10.1016/S0006-3207(00)00001-X.

Strasdas W. 2002. Ecotourism Training Manual for Protected Area Managers. German Foundation for International Development (DSE) Center For Food, Rural Development and the Environment. Feldafing and Zschortatu, Germany.

Teressa D. 2015. Development of community-based ecotourism in Wenchi Crater Lake, Ethiopia: Challenges and prospects. J Hospitality Tourism 6 (4): 39-46. DOI: 10.5897/JHMT2014.0133

Tesfaye T. 2009. Is Eucalyptus ecologically hazardous tree species? Ee-JIRF 1: 128-134.

Theodros A. 2004. Sustainable tourism development and ecotourism. Walia 24 (3): 34-41.

Tisdell C, Wilson C. 2005. Perceived Impacts of Ecotourism on Environmental Learning and Conservation: Turtle Watching as a Case Study. In: Environment, Development and Sustainability: A Multidisciplinary Approach to the Theory and Practice of Sustainable Development, Springer, Nederland. vol. 7 (3): 291-302. DOI: 10.1007/s10668-004-7619-6.

United Nations World Tourism Organization (UNWTO) (2016), 2015 ed. UNWTO Tourism Highlight, Madrid, Spain.

Wearing S, Neil J. 1999. Ecotourism: Impacts, Potentials, and Possibilities. 1st ed. Reed Educational and Professional Publishing Ltd, Great Britain.

Whittaker RH. 1960. Vegetation of the Siskiyou Mountains, Oregon and California. Ecol Monogr 30: 279-338.

William D. 2009. Entoto Natural Park-an environmental success story in the making. Selamta 26 (3): 50-52.

World Commission on Environment and Development (WCED). 1987. Our Common Future. Oxford University Press, New York.

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Study on ethnobotany, phytochemistry, toxicity, and effectiveness of herbal remedies against *Boophilus decoloratus* in Suba, Kenya

ALFRED OJWANG ONYANGO[1], JOHN O. KOKWARO[1,♥], DANIEL W. ONYANGO[2], AMIR O. YUSUF[3]

[1]School of Biological Sciences, University of Nairobi. Chiromo Campus, P.O. Box 30197-00100, Nairobi, Kenya. ♥email: john.kokwaro@uonbi.ac.ke
[2]Department of Veterinary Anatomy and Physiology, University of Nairobi. Chiromo Campus, P.O. Box 30197-00100, Nairobi, Kenya
[3]Department of Chemistry, University of Nairobi. Chiromo Campus, P.O. Box 30197-00100, Nairobi, Kenya

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Abstract. *Onyango AO, Kokwaro JO, Onyango DW, Yusuf AO. 2019. Study on ethnobotany, phytochemistry, toxicity and effectiveness of herbal remedies against* Boophilus decoloratus *in Suba, Kenya. Asian J Ethnobiol 2: 38-50.* Plants have been found to have a variety of biological activities against insect pests, some of which have been confirmed. The ethnobotany, phytochemistry, toxicity, and acaricidal behavior of crude extracts of three selected plants against blue-tick in Suba Sub-County, Kenya, were investigated as part of this study. In Suba Sub-County, a total of 32 herbalists, ranging in age from 28 to 87, were interviewed using a questionnaire about their knowledge of acaricidal plants. The area's name, a component used, conventional planning, and administration methods were all recorded. The number of medicinal plant citations was highly correlated with the informants' age. Based on independent researches (IR), the study described 16 plants distributed among 13 families. For phytochemical tests, *Phytolacca dodecandra*, *Cissus quadrangularis*, and *Ipomoea kituiensis* were collected and extracted in methanol, dichloromethane (1:1 v/v), and distilled water separately. Terpenoids, tannins, saponins, flavonoids, and alkaloids were all present in the three plants, except flavonoids, which were absent in *P. dodecandra*.To test the efficacy of crude extracts of these selected plants, larvae of the *Boophilus* spp., the tick was used in an in vitro acaricidal activity analysis. The effects of 2.5, 5, and 10 mg/mL concentrations of water and methanol in DCM (1:1 v/v) crude extracts of *P. dodecandra* (leaves), *C. quadrangularis* (whole), and *I. kituiensis* (leaves) were compared to that produced by the standard reference acaricide, almatix® (12.5 percent amitraz) as a positive control. The extracts' activity against larvae was tested, and the extracts were most active at 10 mg/mL concentration. The death rate was determined within 24 hours. The extracts of *Cissus quadrangularis* (100 kills at 10 mg/mL) and *P. dodecandra* (100 kills at 5 and 10 mg/mL) was the most potent compared to almatix, while *I. kituiensis* methanol/DCM (1:1v/v) extract was the least potent. The variance analysis revealed significant differences in the acaricidal activity of plant extracts at all concentrations tested (2.5, 5, and 10 mg/mL) ($P \leq 0.05$). The LC50 of *Boophilus decoloratus* larvae was determined if methanol: DCM (1:1 v/v) extracts of *I. kituiensis* showed mild toxicity, whereas those of *P. dodecandra* and *C. quadrangularis* showed high toxicity. This study concluded that *C. quadrangularis* (whole), *I. kituiensis* (leaves), and *P. dodecandra* (leaves) extracts are acaricidal and as potent at high concentrations as almatix. The mortality of the larvae increases with increasing extract concentration, indicating that the extracts of the top three study plants are effective in blue-tick control. It is recommended that isolate and purify crude compounds, and bioassay of these isolated compounds be performed on the same blue-tick larvae to achieve highly efficacious conventional acaricides.

Keywords: Amitraz, *Boophilus decoloratus*, acaricidal activity, medicinal plants

INTRODUCTION

Disease transmission by external and internal parasites is one of the major constraints to livestock production and improvement in the tropics and subtropics (Belay et al., 2013). Pathogens such as bacteria, spirochetes, protozoa, viruses, and toxins are transmitted by external parasites (Rajput et al., 2006). Ticks are the most common external parasites in livestock, and their feeding and disease transmission cause significant financial losses to livestock owners (Jongejan and Uilenberg 2004).

There are many methods for controlling ticks and tick-borne diseases, but the most successful tick control approach to date is site-specific and repeated acaricide applications (Di Giulio et al., 2009). However, their use is linked to several issues, including multi-chemical resistance in pest species, application costs, poisoning of treated animals and humans, residues in meat and milk, and environmental pollution, especially in water bodies (Rajput et al. 2006). Secondary metabolites are phytochemicals found in plants that are not explicitly used by the plant but can be used as protective mechanisms against herbivorous species such as insects. Since phytochemicals have a wide range of actions, pests are less likely to develop resistance than synthetic pesticides. Ethnoveterinary acaricides are a low-cost, familiar-to-locals, locally available, and easily accessible alternative to synthetic acaricides for resource-strapped farmers (Salwa 2010). These bio-pesticides are available in various forms, including crude conditions and pure active compounds. On the other hand, scientific testing is needed to prove their safety and efficacy (Green et al. 1996).

Since they are environmentally friendly, bioactive plant extracts are gaining popularity worldwide (Sanjay and Tiku 2009). Saponins, tannins, flavonoids, terpenoids, and alkaloids are the most common insecticidal compounds found in plant extracts. They serve as antifeedants,

sterilants, repellents, and poisons that cause paralysis in many herbivores, including insects (Isman 2006).

Due to its proximity to Ruma National Park, which contains tick hosts such as buffalos, and the region's remoteness in veterinary facilities, such as cattle dips, tick prevalence in Suba Sub-County is high. To assess the ethnobotanical, phytochemical, toxicity, and acaricidal activity of anti-tick and, in particular, anti-blue tick, i.e., herbal remedies for cattle, this study was conducted on ethnoveterinary medicinal plants used by herbalists in Suba Sub-County, Kenya.

The goals of this study were (i) to identify and document the first three major plant species commonly used in traditional tick control in Suba Sub-County (by interviewing traditional herbalists). (ii) Using water and methanol in dichloromethane (1:1 v/v) to extract the three plant materials *Cissus quadrangularis* (whole), *Phytolacca dodecandra* (leaves), and *Ipomoea kituiensis* (leaves). (iii) To test the effectiveness of the anti-tick plants on *B. decoloratus* larvae (iv) Using a brine shrimp (Artemia salina) lethality assay to assess the toxicity of crude plant extracts. (iv) To identify the phytochemicals found in the anti-tick plant species of choice.

MATERIALS AND METHODS

The study area

Adult ticks of the *Boophilus decoloratus* species were collected in Kenya's Suba Sub-County of Homa Bay County, which is located between latitudes 0°30'S and 0°50'S and longitudes 34°0'E and 34°20'E. (Figure 1). The average elevation of the region is 1000 meters above sea level, with annual rainfall varying from 250 to 700 millimeters. Temperatures range from a mean minimum of 17.1° C to a mean maximum of 34.8° C annually.

According to the National Boundary Commission, Suba Sub-County is divided into nine sections: Gwassi West, Gwassi East, Gwassi South, Gwassi Central, Kaksingri West, andGwassi North, Kaksingri East, Kaksingri Central, and Ruma. To the north, it is bordered by Lake Victoria.

Suba Sub-County has a population of approximately 103,789 people, with 34 percent living in urban areas, according to the 2009 census (GoK 2009; 2012). Although the Luo ethnic group is the most populous, other ethnic groups like the Luhyia and Kisii also live in the region.

The region's main economic activities are subsistence agriculture, livestock breeding, and trade. In certain places, the vegetation is savannah-like, with shrubs and sparse trees. The study location, Suba Sub-County, was chosen because it represents a primarily free-range smallholder cattle production system and is close to Ruma National Park. The presence of wild hosts such as buffaloes and rhinos increased the risk of tick occurrence.

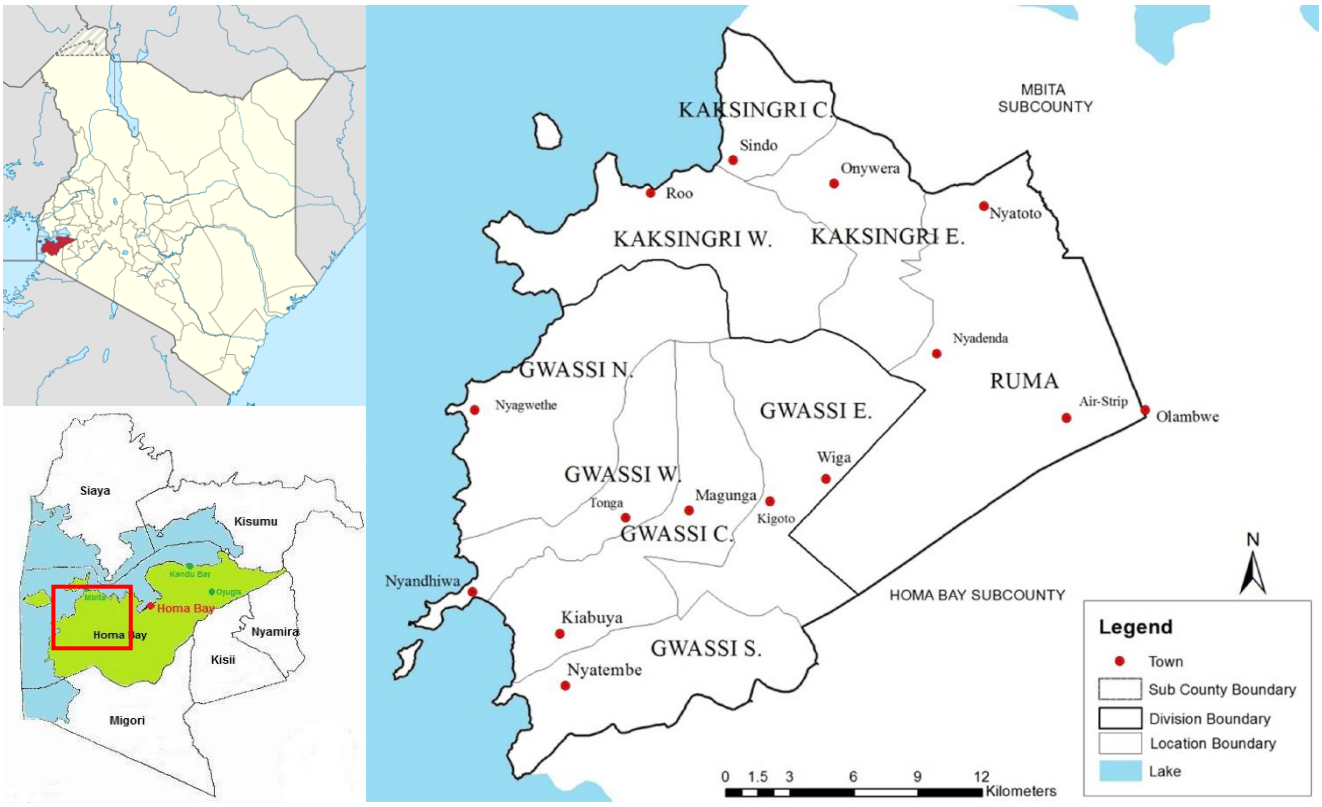

Figure 1. The map of Kenya showing Homa Bay County and Suba Sub-County

Identification of ethnoveterinary practitioners and collection of ethnobotanical data

The study site was divided into twenty strata based on their recent administrative sub-locations. A field survey was conducted with the assistance of local administration (chiefs, assistant chiefs, village elders, and the general public) to identify traditional medical practitioners and medicinal plant vendors with background information on plants that would be useful in this research. Four sub-locations, representing four villages, were purposefully chosen from among the twenty-four sub-locations because these communities rely heavily on traditional healing and have inherited many skills from their forefathers. According to Orozcoz and Lent (2005), purposive sampling obtained ethnoveterinary data from informants. This is a strategy for the sample that is not based on probability. The information was gathered from 32 people in four villages in the study area: Kiembe village in Gwassi West, Kisaku village in Gwassi North, Nyadenda village in Kaksingri Central, and Roo village in Kaksingri West. A 23-questions for the questionnaire were created and used to gather information from resource persons. Mr. Opella, the Chief of Gwassi West Place, referred me to a Kiembe village elder, who assisted me in identifying five herbalists with whom I pre-tested my questionnaire during the pre-survey. Their respective elders reported the remaining 27 informants in the remaining three villages. The questionnaire looks for local names for acaricidal species and methods of acaricide preparation, plant habits, and plant parts used in acaricide preparation. Anti-tick herbalists offered specific and high-quality details.

Plant specimens were collected in pairs; one was used for preliminary identification in the field as mentioned previously (Beentje 1994; Agnew 2013), while the other was pressed and transported to the University of Nairobi herbarium (NAI) for authentication and comparison with the permanent prepared herbarium collections.

Selection of priority plants

Priority plants were chosen based on a survey conducted in Suba Sub-County between December 2014 and January 2015. The respondents prepared a frequency report on plants that are acaricidal agents. According to the frequencies in the independent information for each plant, the information was organized in order of ranks, from highest (rank 1) to lowest (rank 16).

Three of the most common plants, *Phytolacca dodecandra* (leaves), *Cissus quadrangularis* (whole), and *Ipomoea kituiensis* (leaves), were chosen and the sections used as medicine were collected and subjected to chemical and bioassay tests. Herbalists described the details on the valuable areas of the plants—collection and drying of plant parts.

Phytolacca dodecandra* and *Ipomoea kituiensis

The leaves of the two plants were plucked and stuffed into a polythene bag, then put in a cooler box and shipped to Nairobi. After 14 days of drying in the shade, the products were ground into a fine powder using an electric mill. The dry powders of *P.dodecandra* and *I.kituiensis* were 354.7 g and 392.8 g, respectively.

Cissus quadrangularis

The entire plant was uprooted, the roots were washed first, and the whole plant was cut into pieces with an electric blender before being packed into a polythene bag and shipped to Nairobi in a cooler package. After 14 days of shade drying, the material was ground into a fine powder using an electric mill. The total weight of the dry powder was 401.9 g. extraction of plant crude extracts

In 5-litre covered buckets, air-dried ground material (160 grams) was collected separately in 2 liters distilled water, 2 liters dichloromethane (DCM), and 2 liters methanol in a 1:1 (v/v) ratio for 72 hours, then filtered using Whatman's filter paper No. 1 to obtain solvent extracts. The organic extract was dried at room temperature (26-28°C) using a rotary evaporator in a vacuum at 60°C. The aqueous extract was deep-frozen and then freeze-dried to obtain a powdered crude extract, which was then put in separate vials and stored at 4°C (Sirama et al. 2015). The percentage yield was determined as a ratio of the weight of the extract to the weight of the plant material (160 g). The weights of the organic and aqueous extracts of the plant were 14.19g and 16.38g, respectively.

Dosage preparation of 2.5, 5, and 10 mg/mL of the crude extracts and 0.0045% almatix

Preparation of 10 mg/mL

Weigh 10 g of ground crude extract and place in a 1-liter volumetric flask. Make to volume with 990 mL deionized water.

Preparation of 5 mg/mL

Take 50 mL of 10 mg/mL in a 100- mL volumetric flask. Make to volume with 50 mL deionized water.

Preparation of 2.5 mg/mL

Take 50 mL of 5 mg/mL in a 100- mL volumetric flask. Make to volume with 50 mL deionized water.

Preparation of 0.0045% almatix

Take 0.36 mL of almatix® (12.5% amitraz, almatix density 1 g/mL) and place it in a 1-Litre volumetric flask. Add 999.64 mL of deionized water and stir.

Tick collection, identification, egg incubation, and determination of the LC_{50}

Ten adult engorged female ticks were collected from cattle in Kenya's Suba Sub-County. The tick and sex authentication was performed at The International Livestock Research Institute's (ILRI) tick veterinary laboratory and verified as adult *B.decoloratus*. Eggs of blue tick reared at the institution were weighed into 1g samples, inserted into test tubes, and incubated for 28 days at a temperature range of 282°C and relative humidity of 80-90% for egg hatching using the Ducornez et al. (2005) technique with some minor modifications. One hundred (100) larvae that had been acclimatized for 8 days were exposed to crude extracts at concentrations of 2.5, 5, and

10 mg/mL for three minutes using the larval packet immersion process. Control ticks were prepared the same way as to test specimens, with 0.0045% of 12.5% amitraz (active ingredient) used as a positive control and 1% DMSO and water used as negative controls (Walker et al. 2002; Ducornez et al. 2005). Six replicates were used in the experiments. The percentage mortality of *B.decoloratus* larvae was measured as a function of crude plant extract concentrations (2.5, 5, and 10 mg/mL) over a 24-hour treatment period. The LC50 was determined (concentration killing 50 percent of the ticks). After 24 hours, the average mortalities of *B.decoloratus* tick larvae were measured as a function of crude plant extract concentrations, with the corresponding LC50 determined for each plant species. Bioassay data subjected to a probit analysis program (Finney 1971) revealed that the LC50 of crude plant extracts was based on the method of extraction.

Determination of acute toxicity of crude extracts on brine shrimp

Meyer's approach was used to conduct the acute toxicity assay on phototropic brine shrimp nauplii (brine shrimp larvae) (Musila et al., 2013). 38 grams of sea salt is dissolved in 1 liter of distilled water to make artificial seawater. A 14 cm by 9 cm by 5 cm tank with two unequal chambers and several holes on the divider was used for hatching. The chambers were packed with artificial seawater. To provide food for the *nauplii*, brine shrimp eggs were put in the larger chamber, and yeast was added. The larger chamber was then covered in the dark background paper, while the smaller chamber was lit. The incubation period was 48 hours at a temperature range of 23-29^{o}C to allow hatching, and *nauplii* were collected in the illuminated chamber. Toxicological research on brine shrimp may be extrapolated to other species.

In order to measure toxicity, different concentrations of the crude extract in seawater were used, namely 10, 100, and 1000 g/mL (see Table 1). A stock solution of 10,000 g/mL was prepared for each crude extract. The aqueous extract's stock solution of 10,000 g/mL was prepared by dissolving 0.1g of the crude extract in distilled water and then making it to volume in a 10-mL volumetric flask with the same distilled water. To make the stock solution for the organic extract, 0.1 g of sample was first dissolved in 1% DMSO and then diluted with distilled water to 10 mL in a volumetric flask.

Using Pasteur pipettes, ten brine shrimp larvae were removed from the hatching tank and put in 4.5 mL of seawater, followed by 0.5 mL of stock solution (10,000 g/mL), resulting in a concentration of 1000 g/mL. 4.95 mL of seawater and 0.05 mL of stock solution were used to make a concentration of 100 g/mL. 4.995 mL seawater and a 0.005 mL stock solution were combined to concentrate 10 g/mL (Table 1). Control experiments were conducted using artificial seawater and DMSO for organic extract, and for aqueous extract, only artificial seawater was used (Odhiambo et al., 2014). Three replicates were performed for the three serial dilutions of different crude extracts and the power. Surviving *nauplii* were counted using a magnifying glass after 24 hours, and the average mortality at each concentration was calculated because it is needed for calculating the LC50.

Phytochemical screening

The organic and water extracts of the three selected botanicals were phytochemically analyzed using standard methods defined in Jigna and Sumitra (2007) and Mariita et al. (2011). The extracts were screened for phytochemicals (saponins, alkaloids, flavonoids, tannins, and terpenoids) as follows: Saponins (Foam test)

For 10 minutes, a powdered sample of plant extract (1 mg) was applied to 10 mL of distilled water in a hot water bath. The hot mixture was filtered and allowed to cool. 2.5 mL filtrate was diluted to 10 ml with distilled water and vigorously shaken for 2 minutes. The presence of saponins in the filtrate was suggested by a stable 15-minute frothing (Jigna and Sumitra 2007; Mariita et al. 2011). The process was repeated for each crude extract.

Alkaloids (Dragendorff's test)

The dry crude plant extract (0.2 g) was boiled in 5 ml of 2% hydrochloric acid for 2 minutes and then cooled. It was then filtered, and three drops of Dragendorff's reagent were added to one milliliter of filtrate. The presence of alkaloids was suggested by a red precipitate (Jigna and Sumitra 2007; Mariita et al. 2011). The process was repeated for each crude extract.

Table 1. Brine shrimp bioassay set up for each plant extract

Volume of Artificial seawater (ml)	No of Brine shrimp larvae	Volume of stock solution (ml)	Concentration (μg/ml)	Nature of experiment	Final volume in the vial (ml)
4.5	10	0.5	1,000	Trial	5
4.5	10	0.5	1,000	Repeat	5
4.5	10	0.5	1,000	Repeat	5
4.95	10	0.05	100	Trial	5
4.95	10	0.05	100	Repeat	5
4.95	10	0.05	100	Repeat	5
4.995	10	0.005	10	Trial	5
4.995	10	0.005	10	Repeat	5
4.995	10	0.005	10	Repeat	5
5	10	0	0	Control	5
5	10	0	0	Control	5
5	10	0	0	Control	5

Tannins (Ferric chloride test)

A powdered plant extract sample (0.5 mg) was boiled for 5 minutes in 10 mL distilled water, cooled, and filtered in a test tube. The presence of tannins was identified by adding 5 drops of 0.1% ferric chloride to the filtrate and looking for brownish green or blue-black coloration (Jigna and Sumitra 2007; Mariita et al. 2011). Both of the crude extracts were subjected to the same treatment.

Flavonoids (Alkaline reagent test)

One g powdered plant extract was boiled for 5 minutes with 10 mL distilled water and filtered while still wet. The yellow color was obtained by adding 5 drops of a 20% sodium hydroxide solution to 1 ml of the cooled filtrate. As 5 drops of dilute hydrochloric acid are added to colorless, the color changes to yellow, indicating the presence of flavonoids (Jigna and Sumitra 2007; Mariita et al. 2011). Both of the crude extracts were subjected to the same treatment.

Terpenoids (Salkowski test)

Two mL chloroform was blended with 1 g powdered plant extract. To form a layer, 3 mL of concentrated sulphuric acid was applied. A reddish-brown precipitate coloration suggested the presence of terpenoids at the interface (Jigna and Sumitra 2007; Mariita et al. 2011). Both of the crude extracts were subjected to the same treatment.

Data analysis

The data were analyzed using descriptive statistics, and the MS Excel® 2010 spreadsheet program was used to perform basic calculations, assess proportions of plant families, habits, preparation methods, and create graphs. The mean, standard errors, and standard deviations of various mortalities observed after treating *Boophilus* larvae with the various extracts from the three plants at different concentrations were computed using the ANOVA program in the SPSS computer program. The data from each plant extract was then put through a one-way ANOVA to see any significant variations between the different concentrations used. Once the variations between the treatments and the positive controls were known, a Dunnett t-test was used to equate the treatments to the positive controls. The Finney computer software for brine shrimp and acaricidal activities was used to assess the lethal concentration (LC50) of the selected plants at a 95% confidence interval (Finney 1971).

RESULTS AND DISCUSSION

Ethnobotany of the identified acaricidal plants

Local authorities in the study region assisted in identifying 32 herbalists who also named 16 acaricidal species. Using independent reports, the three plants with the highest frequencies (ranks 1, 2, and 3) were chosen for the bioassay test. This research also divided the 16 ethnoveterinary medicinal plants into 13 families, complete with descriptions, traditional preparation methods, botanical names, and local names (Table 2).

The Solanaceae family was the most common (14.58 percent) among independent studies, while Capparaceae was the least popular (2.78 percent).

Table 2. Acaricidal plants identified during the study

Botanical name and voucher number	Vernacular name	Family	Habit	Parts used	Mode of preparation	Number of independent reports (IR)	Ranking
Phytolacca dodecandra AO 2015/ 003	Mahoho	Phytolaccaceae	Shrub	Leaves	Infusion	16	1
Cissus quadrangularis AO 2015/010	Minya	Vitaceae	Herb	Whole	Decoction	15	2
Ipomoea kituiensis AO2015/006	Obinju mar nam	Convolvulaceae	Shrub	Leaves	Decoction	13	3
Solanum incanum AO 2015/011	Ochok	Solanaceae	Shrub	Whole	Decoction	12	4
Aloe dawei AO 2015/014	Ogaka	Aloeceae	Shrub	Leaves	Infusion	10	4
Tagetes minuta AO 2015/ 004	Nyanjagra	Compositae	Herb	Whole	Infusion	9	6
Ocimum kilimandscharicum AO 2015/ 005	Mweny madongo	Lamiaceae	Shrub	Whole	Decoction	9	6
Melia azedarach AO 2015/012	Dwele	Meliaceae	Tree	Leaves, fruits	Decoction	9	6
Datura stramonium AO 2015/015	Koth- kiyombi	Solanaceae	Herb	Leaves	Infusion	9	6
Ricinus communis AO 2015/ 009	Obalandagwa	Euphorbiaceae	Shrub	Leaves, Fruits	Infusion	8	11
Azadirachta indica AO 2015/007	Mwarubaine	Meliaceae	Tree	Leaves	Decoction	7	12
Lantana camara AO 2015/008	Onyalo biro	Verbenaceae	Shrub	Leaves	Decoction	7	12
Senna didymobotrya AO 2015/ 002	Owino	Leguminosae C.	Shrub	Leaves	Infusion	6	14
Euphorbia tirucalli AO 2015/016	Ojuok	Euphorbiaceae	Tree	Leaves, bark	Sap	5	14
Cucumis aculeatus AO 2015/ 001	Otangle	Cucurbitaceae	Herb	Fruit	Decoction	5	15
Maerua edulis AO 2015/013	Amoyo	Capparaceae	Herb	Leaves	Decoction	4	16

Note: The coding is my personal way of plant identification. AO stands for Alfred Onyango

Cucumis aculeatus Cogn (Cucurbitaceae) – Otangle –AO 2015/001

This perennial herb is characterized by spiny yellow-hooked hairs on the stem ridges and main veins underneath the leaves. The leaves are ovate and three-lobed, either profoundly or shallowly. Male flowers are 11 mm long, yellow-green, and solitary. It has a green to yellow fruit that is 7 cm long and has scattered bristle-tipped projections. Cut the fruit, decoct it, and apply it to the animal's coat, concentrating on the infested areas.

Senna didymobotrya (Leguminosae C.) - Owino- AO 2015/002

This shrub can reach a height of 4.5 meters. The leaves are up to 45 cm long and have ten to twenty pairs of oval leaflets, each with a fine point at the top. Flowers are bright yellow, up to 1.8 cm tall, and crowded together in a 45 cm long raceme. It has ten stamens in its unopened buds, seven of which are fully developed (two or three of which are longer) and three poorly developed. Pods are flattened to a length of 12.5cm. Grasslands and scrubs are where you'll find them. Poisonous are the leaves, pods, and roots. Leaves may be used either dry or wet. This is pounded, and the resulting infusion is used to wash lice, ticks, and flea-infested animals.

Phytolacca dodecandra L. Herit (Phytolaccaceae) - Mahoho –AO 2015/003

This clambering plant can reach a height of 9 meters and has long, hanging branches and a tuberous rhizome. The leaves are oval, wide, and glossy, measuring up to 15 cm in length, with the two sides sometimes unequal. Flowers range in color from greenish-white to purple, scented, and unisexual. Male flowers have fifteen stamens, a five-celled ovary, and an infertile ovary. A five-celled ovary and eight to fifteen short infertile stamens are found in female flowers. The orange-red fruit has five lobes and is fleshy. They can be found on forest edges, scrub areas, and termite mounds. The plant is highly poisonous, and an infusion made from the leaves is used to wash livestock to suppress external parasites.

Tagetes minuta L. (Compositae) - Nyanjagra –AO 2015/004

This is a tall, stiff herb that can reach a height of 1.8 meters. The leaves are opposite and compound, with small lanceolate leaflets toothed on the edges and a heavy odor. The flower heads are yellow and elongated in a rigid, crowded inflorescence. Florets are tubular and ligulate, and each flower head has about two of each. Pappi have a small number of scales. The whole plant is pounded, and the infested animal is washed several times with the infusion until all ticks and lice are gone.

Ocimum kilimandscharicum Guerk (Lamiaceae) - Mweny madongo- AO 2015/005

This is a hairy branching shrub with erect or ascending branches that can also be used as a herb. The leaves are ovate to elliptic in shape and have spreading hairs and a rounded apex. Its racemes are simple, terminal whorls of small white to pinkish flowers with a distance between them. The spreading tubes on the petals are about 7 mm long, and the sepals are about 6 mm long.

Ipomoea kituiensis Vartke (Convolvuliaceae) - Obinju mar nam- AO 2015/006

This is a sub-erect or twining shrub that can reach a height of 6 meters. It has an ovate to reniform leaf blade 14 cm long and 13 cm wide. Flowers are borne in cymes with peduncles ranging in length from 3.5 to 20 cm. The sepals of this plant are lanceolate to ovate and have a linear shape. It has a funnel-shaped corolla that is white, cream, or yellow with a purple center and measures 5 to 8 cm long. It has an ellipsoidal capsule fruit 15 mm long and 1.3 cm thick, with an ovoid (7 mm long) seed that is hairy. The leaves are pounded, and the decoction treats ticks, lice, and fleas in livestock.

Azadirachta indica (Meliaceae) - Mwarubaine- AO 2015/007

This is a hardy, fast-growing medium-sized tree with a thick leafy oval-shaped canopy that grows from 15 to 20 meters tall. It is an evergreen plant that thrives in arid and semi-arid climates. The leaves are glossy, green, and crowded towards the ends of branches, while the bark is pale to grey-brown and rough. Long sprays of creamy white flowers hang from the plant. When fully ripe, the fruits are oval yellow berries with a diameter of up to 2 cm and a length of up to 2 cm. A solution made from pounded leaves is used as an anti-tick mist on animals.

Lantana camara L. (Verbinaceae) - Onyalo biro- AO 2015/008

This scrambling herbaceous shrub can reach a height of 2.4 meters. The stem is prickly and square, especially near the base. The opposite leaves are ovate and up to 8.7 cm long, rough, and toothed on the edges. The flowers are pink on the outside and yellowish in the center of the flattened head. When the fruits are fully mature, they have a lustrous black appearance. Open bushland, wooded grassland, and dry forest margins are good places to look for the plant. To treat lice, mites, and ticks, whole leaves are crushed, mixed with hot water, and sprayed on the animal's coat.

Ricinus communis L. (Euphorbiaceae) - Obala-ndagwa- AO 2015/009

This evergreen shrub can reach a height of up to 5 meters. The leaves are green or reddish, glabrous and glaucous, 15-60 cm wide, with alternating long-petiolate, deeply palmately lobed leaves. Male flowers are below, and female flowers are above in broad pyramidal pseudo-terminal erect panicles. Female flowers have a showy red stigma on the upper part of the spike, while male flowers have creamy yellow stamens. The fruit is round and deep red, with an ellipsoid or oblong form capsule. Cattle have been confirmed to be poisoned by the seed and seed coat (Kokwaro and Johns 1998; 2013). To control ticks and lice, mature fruit is pulverized, immersed in cold water, and then applied to the animal's coat.

Cissus quadrangularis L. (Vitaceae) - Minya- AO 2015/010

This is a climbing shrub or herb with tendrils and a succulent four-sided stem. The leaves are simple and toothed in different ways, and they are only present in the younger sections of the plant. Flowers are arranged in umbels. Ticks, lice, and mange are all treated with a decoction made from the pounded whole plant. It has a solid skin-smartening effect.

Solanum incanum L. (Solanaceae) - Ochok- AO 2015/011

This is a 2 m tall erect shrub with spiny roots, branches, and leaves. Hairs cover both surfaces of the stems, which are prickly on the midrib of the older leaves. It has mauve or purple flowers that are up to 3.8 cm long. The anthers are yellow and joined in the flower's center, with three to ten or more flowers in the inflorescence. The fruit is a large yellow berry with a diameter of up to 3.8 cm. The plant can be found on wasteland and the roadside where the soil has been eroded or scraped away. To keep ticks and other external parasites at bay, cattle are washed with a decoction made from whole pounded plants. To kill ticks, the fruit pulp is directly applied to tick-infested areas.

Melia azedarach L. (Meliaceae) - Dwele- AO 2015/012

This deciduous tree grows up to 15 meters tall and has a glossy grey-brown bark. Petioles and rachis can be up to 40 cm long, and the leaves are typically 2-pinnate. It has opposite or sub-opposite leaflets up to 5.5 cm long and 2.5 cm wide. Small flowers in a broad axillary cymose panicle with a calyx 2.5 mm long and petals up to 8 mm long adorn the inflorescence. The fruit comprises fleshy berries that can be up to 2 cm long and 1.5 cm wide. People, pets, and poultry are all poisoned by berries. Mange, tick, and lice infestations are treated with leaves and fruits.

Maerua edulis (Capparaceae) - Amoyo- AO 2015/013

This glabrous spreading shrub or woody herb grows up to 3 meters tall. The leaves are petiolate and simple. It has several flowers on pedicels that are 10 to 25 mm long. There are no petals on the sepals, 4 to 9 mm long. The stamens are 15 to 30 mm long, and the androphore is about 1 mm longer than the receptacle. The fruits are globose and yellow or orange, with a spindle-shaped ovary that is 4 to 6 mm long. As a tick prevention solution, the leaves are pounded, and the infusion is applied to the animals.

Aloe dawei Berger (Aloeaceae) - Ogaka- AO 2015/014

This densely branched, the leafy shrub grows 1 to 2 meters high. The leaves are dark green, with a 60 to 90 cm tall inflorescence. The stalks are dark red-brown, and the racemes are densely flowered with red flowers. The plant is most commonly found in western Kenya's rocky bushland. Animals are washed with a leaf decoction to cure skin diseases and control external parasites, including ticks.

Datura stramonium L. (Solanaceae) - Koth- kiyombi- AO 2015/015

This herb can grow up to 1.5 meters tall. The stem is smooth and often divides into two branches. The leaves are ovate, pointed, and lobed or deeply toothed. It has white flowers that bloom singly where the stem branches, with a calyx up to 3.8 cm long and a funnel-shaped, folded corolla with young stamens attached at the base of the corolla tube. The ovary has four cells. The fruit can grow up to 5 cm in length and is extremely prickly. The leaves poison humans and animals. They are pounded, and the resulting solution is used to treat livestock for ticks and ringworm.

Euphorbia tirucalli (Euphorbiaceae) - Ojuok- AO 2015/016

This succulent shrub or tree can grow up to 6 m tall and is found in bushland, thickets, and coastal bushland. The bark is thick and straight-stemmed. In dense masses, the branches are smooth, green, and cylindrical. It has small leaves that can grow up to 6 mm long. The flowers, which are cream or yellow-green, develop in short, terminal clusters. Its fruit is a three-lobed capsule 6 mm across, hard, and purple-green. This plant's latex is highly poisonous, particularly to the eyes, and is used as a fish poison as well as an insecticide.

Distribution in plant habit and usage as anti-tick

There were also differences in plant consumption based on their habit (Figure 2), with shrubs having the highest usage (56.25%), followed by herbs (29.17%), and finally trees (14.58%). The leaf was the most commonly used plant part (56.63%), followed by the entire plant (27.11%), fruit (13.25%), and bark (3.01%). In the independent study, the habit percentage was determined as a percent of the total number of habits listed by all informants:

Habit percentage= (Habit independent report /144) X 100;

Where; Habit= total number of times a habit is mentioned in the independent; 144= cumulative number of habits mentioned in the independent report.

Knowledge of acaricidal plants

The age groups 68 to 77 and 78 to 87 years had the most plants cited (14 each) from the 32 interviews conducted using a questionnaire on herbalists between the ages of 28 and 87 years, while the age group 28 to 37 years had the fewest (4). There was a clear association (r= 0.81) between age and the number of plants cited. The older the informants, the more plants they mentioned (Figure 3).

Traditional methods of preparation of drugs

Various methods of preparing herbal medicine were used, with decoction being the most favored form (56.25%), followed by infusion (40.28%) and sap (3.47%). Pounding proved to be the preliminary procedure for any medicinal preparation, so it was universal.

Three plants, *Phytolacca dodecandra* (leaves), *Cissus quadrangularis* (leaves and stems), and *Ipomoea kituiensis* (leaves), were chosen for chemical and bioactivity testing because they were the top three most commonly used plants (Table 3).

Yield of crude plant extracts

Phytolacca dodecandra extract yielded the highest percentage yield of 8.87% among the tested Methanol/DCM (1:1 v/v) extracts, while *I. kituiensis* yielded 7.17%, and *C. quadrangularis* yielded the lowest (6.33%). *P. dodecandra* had the highest percentage yield (10.24%) of the tested water extracts, while *C. quadrangularis* and *I. kituiensis* yielded just 8.56% and 8.22%, respectively. Water produced a higher mean percentage yield (9.01%) than methanol in DCM (1:1 v/v) solvent, which produced a 7.46% yield (Table 4). The original sample weighed 160 g.

Phytochemical analysis of crude plant extracts for secondary metabolites

Except for *P. dodecandra*, all plants tested positive for flavonoids, alkaloids, tannins, terpenoids, and saponins in organic and aqueous extracts. However, the organic and aqueous extracts of *P.dodecandra* yielded unfavorable results for flavonoids (Table 5).

Lethal concentration (LC_{50}) of brine shrimp larvae

Except for organic extracts of *I. kituiensis*, which showed comparatively low toxicity at 10 µg/ml, both aqueous extracts and organic extracts were extremely toxic at 10 µg/ml (Table 6). Similarly, at 100 µg/mL, both aqueous and organic extracts were highly toxic, whereas *I. kituiensis* organic extracts were only mildly toxic. Both aqueous and organic extracts of all plants were extremely toxic at 1000 µg/mL.

In vitro acaricidal activity of crude plant extracts

An in vitro evaluation of the acaricidal activity of each crude plant extract revealed that *P. dodecandra* leaves were the most effective, followed by *C. quadrangularis* (whole plant) and *I. kituiensis* leaves in that order (Table 3).

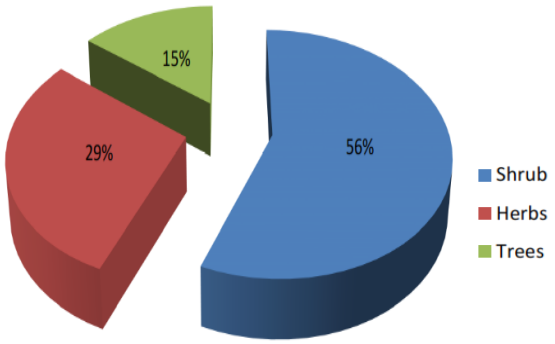

Figure 2. Plants usage according to their habit

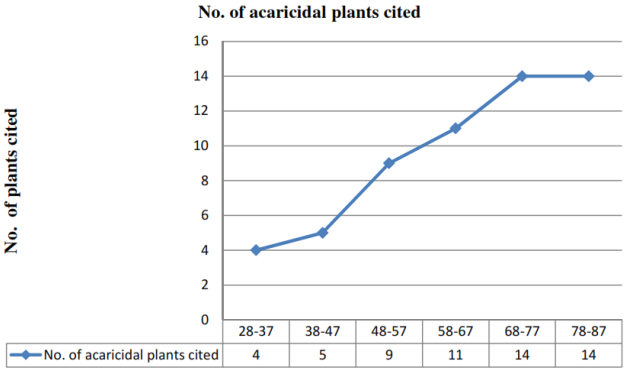

Figure 3. Age groups of informants and the number of medicinal plants cited

Table 3. Selected priority plants

Plant species	Part collected	Rank
Phytolacca dodecandra	Leaves	1
Cissus quadrangularis	Whole	2
Ipomoea kituiensis	Leaves	3

Table 4. Yield of organic and aqueous plant extracts measured in grams after extraction

Plant species	Methanol in DCM extract (1:1 v/v)		Water extract	
	Yield (grams)	Percentage yield (%)	Yield (grams)	Percentage yield (%)
Cissus quadrangularis (whole)	10.13	6.33	13.70	8.56
Ipomoea kituiensis (leaves)	11.47	7.17	13.15	8.22
Phytolacca dodecandra (leaves)	14.19	8.87	16.38	10.24
Average	11.93	7.46	14.41	9.01

Table 5. Phytochemical analysis of each crude extract for secondary metabolites

Plant	Crude extract	Alkaloids	Flavonoids	Saponins	Tannins	Terpenoids
Cissus quadrangularis	Methanol in DCM (1:1 v/v)	+	+	+	+	+
	Water	+	+	+	+	+
Ipomoea kituiensis	Methanol in DCM (1:1 v/v)	+	+	+	+	+
	Water	+	+	+	+	+
Phytolacca dodecandra	Methanol in DCM (1:1 v/v)	+	-	+	+	+
	Water	+	-	+	+	+

Note: +: Present, -: Absent

Larvicidal activity of *P. dodecandra* extracts

When the larvicidal activity of organic extracts of *P. dodecandra* at 5 mg/mL and 10 mg/mL was compared to that of almatix, both concentrations were not substantially ($p > 0.05$) different inactivity, meaning that 5 mg/mL and 10 mg/mL organic extracts of *P. dodecandra* had similar larvicidal activity to that of almatix (Figure 4). However, compared to almatix, the aqueous extracts demonstrated significantly lower activity ($p<0.05$). At 2.5 mg/mL, both *P. dodecandra* extracts had significantly lower larvicidal activity ($p<0.05$) than almatix.

Larvicidal activity of *I. kituiensis* extracts

As compared to almatix, both aqueous and organic extracts of *I. kituiensis* had significantly lower ($p<0.05$) larvicidal activity at all concentrations (Figure 5). At the lowest concentration of *I. kituiensis* (2.5 mg/mL), the difference in larvicidal activity was significantly higher.

Larvicidal activity of *Cissus quadrangularis* extracts

Except for the organic extract at 10 mg/mL, the aqueous and organic extracts of *C. quadrangularis* had significantly lower larvicidal activity ($p<0.05$) at all concentrations. Organic extract of *C. quadrangularis* demonstrated 100% mortality at a concentration of 10 mg/mL, which was not substantially different from almatix activity ($p>0.05$) (Figure 6). Compared to *P. dodecandra* and *I. kituensis*, *C. quadrangularis* crude extracts have the lowest larvicidal activity.

Acute toxicity of the crude plant extracts to tick larvae and estimation of lethal concentration (LC_{50})

Organic extracts had higher mortality in each plant species than aqueous extracts, except for *C. quadrangularis*, where aqueous was more active than organic at 5 mg/mL. Despite this, organic extracts of *P.dodecandra* showed the highest LC50 at 3.85 mg/mL. At 13.90 mg/mL, *C. quadrangularis* aqueous extracts had the lowest LC50 (Table 7).

Table 6. Lethal concentration (LC_{50}) of brine shrimp larvae

Plant name	Average mortality at various concentrations of extracts (µg/mL)								LC_{50} (µg/mL)	
	0 µg/mL		10 µg/mL		100 µg/mL		1000 µg/mL			
	Water	Org	Water	Org	Water	Org	Water	Org	Water	Org
P. dodecandra	0.0	0.0	9.66	8.33	10.0	10.0	10.0	10.0	35.98	39.97
C. quadrangularis	0.0	0.0	9.33	8.0	10.0	9.33	10.0	10.0	38.31	113.1
I. kituensis	0.0	0.0	10.0	4.0	10.0	6.33	10.0	10.0	136.96	4.17
Water	0.0		0.0		0.0		0.0		1708.23	
DMSO		0.00		0.00		0.00		0.00		1708.23

Note: LC_{50}< 100: Strongly/highly toxic, LC_{50} > 100 < 500: moderately toxic LC_{50} > 500 < 1000: weakly toxic LC_{50} > 1000: Non toxic, Org= Methanol: DCM (1:1 v/v)

Table 7. Acute toxicity and LC_{50} of crude extracts to the *B.decoloratus* tick larvae

Plant name	Average mortality at various concentrations (mg/mL)								LC_{50} (mg/mL)	
	0 mg/mL		2.5 mg/mL		5 mg/mL		10 mg/mL			
	Water	Org	Water	Org	Water	Org	Water	Org	Water	Org
P. dodecandra	0.0	0.0	7.33	15.33	78.17	100	95.66	100	4.83	3.85
C. quadrangularis	0.0	0.0	1.33	16.33	20.67	8.83	21.5	100	13.9	5.56
I. kituensis	0.0	0.0	13.67	16.5	82.33	84.83	59.83	82.5	6.65	5.23
Almatix	100	100	100	100	100	100	100	100	2.36	

Note: Aq: Water, Org: Methanol in dichloromethane (1:1 v/v)

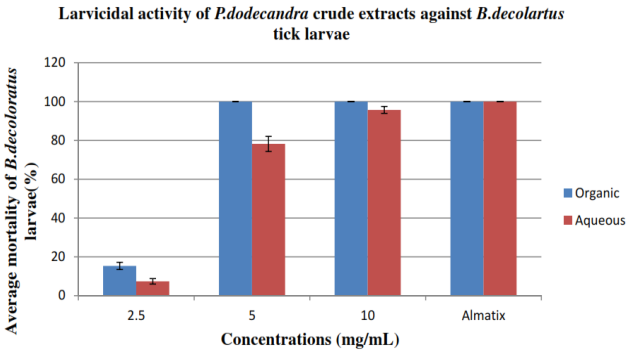

Figure 4. Average (±Standard deviation) mortality of *B. decoloratus* tick larvae due to *P. dodecandra* extracts at various concentrations

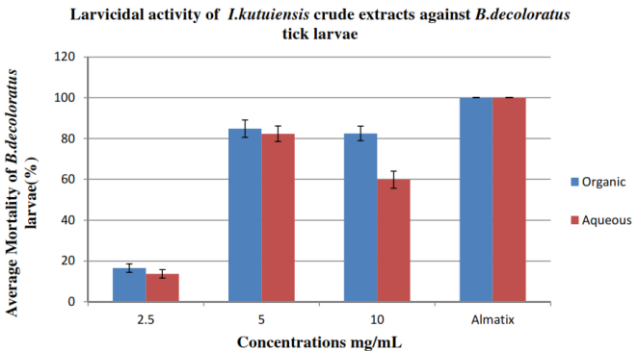

Figure 5. Average (±Standard deviation) mortality of *B. decoloratus* tick larvae due to *I. kituiensis* extracts at various concentrations

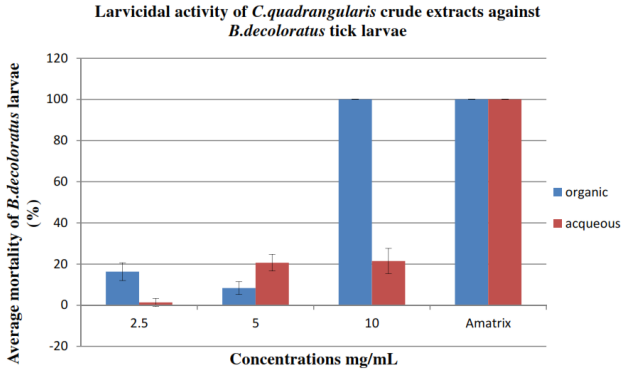

Figure 6. Average (± Standard deviation) mortality of *B.decoloratus* tick larvae due to *Cissus quadrangularis* extracts at various concentrations

Discussion

Acaricidal and insecticidal properties of plant extracts have seen widespread use against phytophagous pests over the last decade (Isman 2006). Tick management is a skill that traditional healers in Suba Sub-County have mastered. Individuals with advanced plant knowledge appeared to be the local authorities on medicinal practices. They keep the information hidden and to themselves, as previously mentioned (Wanzala et al. 2012), and only share it with others in exchange for valuables. Herbalists believe that medicines will not successfully treat various diseases if herbal knowledge is not guarded with zeal.

Nonetheless, most ethno-practitioners openly discussed and shared their information after receiving an inducement fee (ranging from $5 to $10) during this research. The majority of those interviewed in this study were men between 28 and 87, with just five women among the 32 people interviewed. The fact is, in most traditional livestock-raising cultures, it is men who tend to take care of sick livestock, owing to their masculine disposition (hence their ability to keep animals during drug administration) and more substantial knowledge of medicinal plant use in tick control (Magwede et al. 2014). People with high literacy levels were found to have the same knowledge of medicinal plants as those who were illiterate, probably due to their shared interests. This result is consistent with Beltran et al. (2014) and Mesfin et al. (2014), who discovered that the informants' level of education had little bearing on their ethnobotanical knowledge.

Due to the delicate nature of traditional medicine interviews, the questionnaires had an introductory preamble to explain the purpose of the survey to all respondents. Only one respondent per household was interviewed to prevent bias in the answers. The respondent's age and the number of acaricidal plants cited by individuals had a strong association (r=0.81). The older a person gets, the more plants they know and how to use them. Age is a factor that is highly correlated with the number and uses of plants known by individuals in many cases and in different societies, which is consistent with the findings of Beltran et al. (2014) and Magwede et al. (2014), who found that the older an individual is, the greater their knowledge of plants and their uses as anti-tick preparations because ethnobotanical knowledge tends to accumulate.

The study identified 16 acaricidal plants and provided a concise botanical description of each of the plants identified as having acaricidal properties in the Suba Sub-County. The descriptions of these plants add to what has already been known about them (Lind and Tallantine 1975; Agnew and Agnew 1994; Kokwaro and Johns 1998; 2013; Demissew 2006; Agnew 2013). *Solanaceae* (14.58%), *Phytolaccaceae* (11.11%), and *Meliaceae* were the most widely used plant families in tick control among these species (11.11%). Plants from the *Solanaceae* family were used in tick control more frequently than any other plant family in the sub-county. This can be explained by the fact that the family contains a diverse range of secondary metabolites such as alkaloids, saponins, terpenoids, and tannins. These compounds may contribute independently or jointly to the observed acaricidal activity against ticks. The various plants mentioned fall into three plant habits: shrubs had the highest percentage of total independent reports (56.63%), followed by herbs (29.17%), and trees had the lowest (14.58%). Leaves, fruits, bark, and the whole plant are among the plant parts used to make medicines. The leaf was the most frequently used (56.63%), followed by the whole plant (27.11%) and the fruit (27.11%) (13.25%). The bark was the least commonly used (3.01%). This contradicts the findings of Magwede et al. (2014), who discovered that the bark was the most preferred form of plant material in tick control, followed by leaves and fruits, and the root was the least preferred part. In some plants, such as *C. quadrangularis*, cattle were given more than one part (leaves, stems, and fruits).

In this study, drug preparation entailed extracting the active principles from the parent plants with medicinal value. The pounding was the most common and widely used primary method for all medicinal preparations. Other methods included the most commonly used ones like decoction, infusion, and sap. Among these methods, making a decoction was the most popular, with sap being used only infrequently. The decoction method is widely used because it is simple, convenient, and inexpensive (Mohammed et al., 2013). All drug preparations were applied by washing the infested cattle's coats, whatever method was used.

Phytolacca dodecandra, I. kituiensis, and *C. quadrangularis* were the three most widely used plant species in this study, and they are commonly used as acaricides. This is because these organisms possess a diverse set of biologically active elements. Flavonoids, tannins, saponins, terpenoids, and alkaloids are some of the pharmacologically essential phytochemicals researched and found to have anti-malarial, molluscicidal, pesticidal, and acaricidal properties (Parveen et al. 2014). Except for flavonoids, preliminary phytochemical screening of *P. dodecandra* crude extracts revealed positive results for tannins, flavonoids, alkaloids, saponins, and terpenoids. Following research that has been previously published (Mekonnen et al. 2012). Tannins, flavonoids, alkaloids, saponins, and terpenoids were observed in *C. quadrangularis*, consistent with a previous study by Ruskin

et al. (2014) that found related compounds. *I. kituiensis* produced positive results for all of the secondary metabolites studied, which is the first time reported. The findings of this research are consistent with those of Essiett and Obioboho (2014). They concluded that tannins, flavonoids, alkaloids, saponins, and terpenoids are the critical metabolites of *Ipomoea batatas* in a study of a member of the same genus.

Phytochemicals are gaining popularity due to exciting discoveries related to their biological activities. The three most commonly used acaricidal plants were subjected to phytochemical screening to assess the presence of tannins, saponins, flavonoids, terpenoids, and alkaloids. Tannins are widely distributed in nature and are commonly found as active principles in plants used in traditional medicine. Condensed tannins have a strong ability to interact with metal ions and macromolecules and form soluble complexes with electron-donor groups found in alkaloids (Rey et al. 1999). This may be one explanation for their toxicity to insects, fungi, bacteria, and plenty of other species. The morphological changes in the midgut epithelium of Aedes aegypti larvae caused by this active fraction are similar to those seen with tannic acid (Rey et al. 1999). On a side note, the ethanolic extract of stem barks from this Melia species has shown potential as an acaricide against the larvae of the common cattle tick, *Rhipicephalus sanguineus*, and *Boophilus* spp. (Kamani et al. 2008). Insecticidal, growth-inhibiting, anti-molting, and repellent properties have been discovered in bioactive plant compounds such as phenolics, terpenoids, and alkaloids (Ghosh et al., 2007). On a side note, the ethanolic extract of stem barks from this Melia species has shown potential as an acaricide against the larvae of the common cattle tick, *R. sanguineus*, and *Boophilus* spp. (Kamani et al. 2008). Insecticidal, growth-inhibiting, anti-molting, and repellent properties have been discovered in bioactive plant compounds such as phenolics, terpenoids, and alkaloids (Ghosh et al., 2007).

According to the World Health Organization, over 200,000 people die each year due to pesticide poisoning (Christine et al., 2015). A brine shrimp test was recommended to predict crude plants' toxicity, pharmacological actions, and pesticide effects (Nguta et al., 2013). A crude plant extract is considered active up to a 240 g/ml concentration. The brine shrimp bioassay is a recommended simple method because it is fast, effective, and inexpensive, and it correlates relatively well with drug cytotoxicity in mammals in most cases (Odhiambo et al., 2014). The treatment calculates the median lethal concentrations of active compounds and extracts (Nguta et al., 2013). The plants under review showed high toxicity levels using brine shrimp larvae. Organic extracts of *C. quadrangularis* with LC50 values of 113.10 g/mL and aqueous extracts of *I. kituiensis* with LC50 values of 136.96 g/mL were both mildly toxic. Secondary metabolites, especially alkaloids, saponins, and tannins, are responsible for toxicity. Alkaloids interact with cell membranes and damage cell integrity, leading to apoptosis or cell death since the cells' membranes are broken and can no longer withstand osmotic forces (Rosenkranz and Wink 2007). *P. dodecandra* water and organic extracts were extremely toxic in this sample, with LC50 values of 35.98 g/mL and 39.97 g/mL, respectively. This contrasted with a study by Namulindwa et al. (2015), who found aqueous leaf extract of *P. dodecandra* to be moderately toxic. The aqueous extracts of *C. quadrangularis* were extremely toxic, with LC50 values of 38.31 g/mL, while the organic extracts were moderately toxic, with LC50 values of 113.1 g/mL. This contradicted Enechi et al. (2013) findings, who found that *C. quadrangularis* ethanol extract is non-toxic. To the brine shrimp, *I. kituiensis* aqueous extracts were moderately toxic (LC50 = 136.96 g/mL), while its organic extracts were extremely toxic (LC50 = 4.17 g/mL). While toxicity reports on some *Ipomoea* species have been published previously, this is the first recorded toxicity analysis on this plant species. *Ipomoea carnea*, for example, is a poisonous plant that grows in tropical areas (Guilherme et al., 2012).

Using *Boophilus decoloratus* tick larvae, the in vitro acaricidal behavior of the selected plant species from the region was checked. The in vitro acaricidal activity requirements were modified from Ducornez et al. (2005). Larvae mortality was determined by lack of movement after 30 minutes of observation after exposure to rudimentary extracts *(I. kituiensis, P. dodecandra,* and *C. quadrangularis)* and the standard medication, almatix. The data showed that the concentrations of the treatments were strongly linked to the mortality of the larvae ($p<0.05$). The mortality of the larvae increased as the concentration of plant extracts increased. This finding is consistent with Belmain et al. (2001), who found that lower concentrations of 5 to 10% dose resulted in fewer tick deaths in *Lippia javanica* trials than higher doses. In this study, the lowest dose (2.5 mg/mL) resulted in low mortalities (less than 20%), while higher doses resulted in higher mortalities.

The larvicidal behavior of all the aqueous extracts examined differed substantially from almatix. Only organic *C. quadrangularis* extracts at 10 mg/mL, and organic *P. dodecandra* extracts at 5 mg/mL and 10 mg/mL were significantly different ($p > 0.05$) from the positive control among the tested organic extracts for larvicidal activity. Except for two concentrations (5 and 10 mg/mL) of *P. dodecandra*, which were not significantly different because they evoked 100% kill ($p>0.05$), there were substantial differences in larvicidal activity among various concentrations of each plant in both aqueous and organic extracts. There was a considerable difference in bioactivity between the three classes of plants, according to the results of a one-way ANOVA followed by a Dunnet t-test. The efficacy of drugs is determined by the types of secondary metabolites contained in plant extracts. The larvicidal effect of these plant extracts on larvae may be due to the direct coercive action of ascaridole monoterpenes on the cardiovascular and respiratory systems, as well as potential nervous system attacks. The nervous system of *Rhipicephalus lunulatus* is affected by this drug (Miegoue et al., 2013).

According to the results of the organic extracts of P. dodecandra, C. quadrangularis, and I. kituiensis were significantly ($p<0.05$) affected by plant species and crude

plant extract concentration at the end of 24 hours contact toxicity bioassays. At doses of 5 and 10 mg/mL, *P. dodecandra, C. quadrangularis,* and *I. kituiensis* elicited a maximum (100%) kill of tick larvae for organic extract. This may be explained by the chemical constituents of the other similar member of the same genus, *Ipomoea alba*, having contact toxicity properties. This plant was discovered to be high in indolizidine alkaloids, which were found to cause acute toxicity to the central nervous system in mice and rats, resulting in convulsions and tremors, among other symptoms (Guilherme et al. 2012). The findings estimated the real vulnerability of tick larvae populations to the effects of botanicals using bioassays and concentration-mortality regression. The LC50 of all the plant extracts was between 3.85 and 6.65 mg/mL, suggesting that *Boophilus* spp. was highly vulnerable to the effects of the crude plant products. The highest LC50 was found in a water extract of *C. quadrangularis* (whole), which can be clarified because the extraction method used did not adequately concentrate active ingredients before use, as the same plant in organic solvent had a lower acute lethal concentration. Organic extracts of *C. quadrangularis* had a threefold higher LC50 than aqueous extracts of *P. dodecandra*. Both organic extracts had a higher acaricidal effect than aqueous extracts. The LC50 estimates suggested that the crude extracts were toxic to the study tick. The populations of larvae tick stages were more susceptible to botanical extracts.

In conclusion, the findings provide a theoretical basis for using botanicals to reduce the burden of blue ticks in cattle. Both organic and aqueous crude extracts of *P. dodecandra* (LC50: aqueous, 4.83 and organic, 3.85 mg/mL), *C. quadrangularis* (LC50: aqueous, 13.90 mg/mL and organic, 5.56 mg/mL), and *I. kituiensis* (LC50: aqueous, 6.65 mg/mL and organic, 5.23 mg/mL) show larvicidal effects in ticks *C. quadrangularis* (LC50: aqueous, 13.90 mg/mL and organic, 5.56 mg/mL) and *I. kituiensis* (LC50: aqueous, 6.65 mg/mL and organic, 5.23 mg/mL) both have larvicidal effects in ticks, and thus could be used in vitro to mitigate the blue tick issue, which justifies why these medicinal plants have been used to manage this type of tick that affects cattle in Suba Sub-County. Intriguingly, crude extracts had a substantial mean percentage of larvicidal activity against the study tick at higher concentrations. It supports the common use of these plant materials as cattle protectants against harmful tick pests. The findings confirm the acaricidal efficacy of the three plant species in blue tick control, making all of the extracts attractive candidates for evaluation as livestock protectants against *B. decolocrotus* ticks in general.

In DCM (1:1 v/v) solvent, water gave a higher yield than methanol, so it should be favored over the latter. Phytochemical analysis revealed that all of the tested plants (except *P. dodecandra*, which lacked flavonoids) contained compounds linked to acaricidal activity, confirming their utility as an anti-blue tick strategy in Suba. Toxic to brine shrimp were *P. dodecandra, C. quadrangularis, and I. kikuiensis*. The crude plant extracts are expected to be viable alternatives to traditional acaricides. Since the plants they cited had the potential to control blue ticks, this demonstrates the expertise of the herbalists as a repository of acaricidal plant information. This would most certainly aid in improving livestock health and, as a result, improved livelihood. For humans, this means less hunger and better nutrition.

REFERENCES

Agnew ADC, Agnew S. 1994. Upland Kenya flowers: A flora of the Ferns and Herbaceous Flowering Plants of Upland Kenya Second Edition. East African Natural History Society, Nairobi, Kenya.

Agnew ADQ. 2013. Upland Kenya Wild Flowers and Ferns, Second Edition. East African Natural History Society, Nairobi, Kenya.

Beentje HJ. 1994. Kenya Trees, Shrubs, and Lianas. National Museums of Kenya, Nairobi, Kenya.

Belay D, Getachew E, Azage T, Hegde BH. 2013. Farmers' perceived livestock production constraints in Ginchi watershed area: Result of participatory rural appraisal. Intl J Livest Prod 4: 128-134. DOI: 10.5897/IJLP2013.0164.

Belmain SR, Neal GE, Golob P. 2001. Insecticidal and vertebral toxins associated with the use of ethnobotanicals used as post-harvest protectants in Ghana. Food Chem Toxicol 39: 287-291. DOI: 10.1016/S0278-6915(00)00134-4.

Beltran RL, Ortiz SA, Reyes GV. 2014. Factors affecting ethnobotanical knowledge in a Mestico community of the Sierra de Huautla Biosphere Reserve, Mexico. J Ethnobiol Ethnomedicine 10: 1-66. DOI: 10.1186/1746-4269-10-14.

Christine T, Nyabayo CT, Matasyoh JC, Mwendia C. 2015. Chemical composition and acaricidal activity Of *Salvia nilotica* essential oil against *Rhipicephalus appendiculatus.* Adv Med Plant Res 3: 46-54.

Demissew S. 2006. Convolvulaceae. Flora of Ethiopia and Eritrea 5: 227-231.

Di Giulio G, Lynen G, Morzaria S, Oura C, Bishop R. 2009. Live immunization against East Coast Fever. Trends Parasitol 25: 85-92. DOI: 10.1016/j.pt.2008.11.007.

Ducornez S, Barre N, Miller RJ, de Garine-Wichatitsky M. 2005. Diagnosis of amitraz resistance in *Boophilus microplus* in New Caledonia with the modified Larval Packet Test. Vet Parasitol 13: 285-292. DOI: 10.1016/j.vetpar.2005.04.018.

Enechi O, Igbonekwu N, Ugwu P. 2013. Effects of ethanol extract of *Cissus quadrangularis* on induced gastric ulcer in rats. Afr J Biotechnol 12: 6197- 6202. DOI: 10.5897/AJB2013.12898.

Essiett UA, Obioboho GE. 2014. Phytochemical, nutrients, and antinutrients of the *Ipomoea triloba, Ipomoea batatas, Ipomoea involucrata* leaves. Intl J Res 1: 1412-1418.

Finney DJ. 1971. Probit Analysis, Third Edition. Cambridge University Press, London, UK.

Gakuya DW, Mulei CM, Wekesa SB. 2005. Use of ethnoveterinary remedies in the management of foot and mouth disease lesions in a dairy herd. Afr J Tradit Complement Altern Med 8: 165-169. DOI: 10.4314/ajtcam.v8i2.63204.

Ghosh S, Azhahianambi P, Yaday M. 2007. Upcoming and future strategies of tick control. J Vector Borne Dis 44: 79-89.

Government of Kenya (GoK). 2009. Summary of Livestock Data 2002-2006. Ministry of Planning and National Development, Department of Resource Survey and Remote Sensing, Nairobi, Kenya.

Government of Kenya (GoK). 2012. Kenya's Population and Housing 2009 Census. Kenya National Bureau of Statistics, Nairobi, Kenya.

Green LW, Richard L, Potvin L. 1996. Ecological foundations of health promotion. Am J Health Promot 10: 270-281. DOI: 10.4278/0890-1171-10.4.270.

Guilherme E, Riad N, Antonio D, Edna F, Mateus L, Ingrit E, Maria M, Suzana P, Ivana B. 2012. Toxicity of *Ipomoea alba*. Pharmacologyonline 3: 29-41.

Isman MB. 2006. Botanical pesticides, deterrents, and repellents in modern agriculture and an increasingly regulated world. Ann Rev Entomol 51: 45-56. DOI: 10.1146/annurev.ento.51.110104.151146.

Jigna P, Sumitra C. 2007. Antibacterial and phytochemical studies of twelve species of Indian medicinal plants. Afr J Biomed Res 10: 175-181.

Jongejan F, Uilenberg G. 2004. The Global Importance of Ticks. Cambridge University Press, London, United Kingdom. DOI: 10.1017/S0031182004005967.

Juliet S, Ravindran R, Ramankutty S, Gopalan A, Nair S, Kavillimakkil A, Bandyopadhyay A, Rawat A, Ghosh S. 2012. *Jatropha curcas* leaf extract-a possible alternative for population control of *Rhipicephalus* (*Boophilus*) *annulatus*. Asian Pac J Trop Dis 10: 225-229. DOI: 10.1016/S2222-1808(12)60051-6.

Kamani J, Yidawi JP, Onovoh E, Mohammed S, Pam DA, Awulu JS, Fernandez-Salas A. 2008. In vitro comparative acaricidal efficacy of azadirachtin and amitraz on *Boophilus decoloratus* larvae. Niger Vet J 3: 975-980.

Kokwaro JO, Johns T. 1998. Luo Biological Dictionary, First Edition. East African Educational Publishers Ltd, Nairobi, Kenya.

Kokwaro JO, Johns T. 2013. Luo Biological Dictionary, Second Edition. East African Educational Publishers Ltd, Nairobi, Kenya.

Lind EM, Tallantire AC. 1975. Some Common Flowering Plants of Uganda, Second Edition. Oxford University Press, Nairobi, Kenya.

Magwede K, Tshisikhawe MP, Luseba D, Bhat RB. 2014. Ethnobotanical survey of medicinal plants used in treatment of ticks. Intl J Exp Bot 83: 155-165. DOI: 10.32604/phyton.2014.83.155.

Mariita RM, Ogol CKPO, Oguge NO, Okemo PO. 2011. Methanol extract of three medicinal plants of Samburu in northern Kenya shows significant antimycobacterial, antibacterial, and antifungal properties. Res J Med Plant 5: 54-64. DOI: 10.3923/rjmp.2011.54.64.

Mekonnen N, Mekonnen E, Ameni G. 2012. Evaluation of berries of *P.dodecandra* for growth inhibition of *Histoplasma capsulatum* and treatment of cases of epizootic lymphangitis in Ethiopia. Asian Pac J Trop Biomed 2: 505-510. DOI: 10.1016/S2221-1691(12)60086-0.

Mesfin F, Seta T, Assefa A. 2014. An ethnobotanical study of medicinal plants in Amaro Woreda, Ethiopia. Ethnobot Res Appl 12: 341-354. DOI: 10.17348/era.12.0.341-354.

Miegoue E, Tendonkeng F, Payne VK, Lemoufouet J, Kouam KM, Boukila B, Pamo TE. 2013. Acaricidal effect of foam soap containing essential oil of *Ocimum gratissimum* leaves on *Rhipicephalus lunulatus* in the western highland of Cameroon. Bull Anim Hlth Prod Afr 61: 535-541.

Mohammed AH, Khulood AS, Zawan HM, Afaf MW, Qasim AR. 2013. Study of total phenol, flavonoids contents and phytochemical screening of various leaves crude extracts of locally grown *Thymus vulgaris*. J Nat Prod 3: 705-710. DOI: 10.1016/S2221-1691(13)60142-2.

Musila MF, Dossaji SF, Nguta JM, Lukhoba CW, Munyao JM. 2013. *In vivo* antimalarial activity, toxicity and phytochemical screening of selected antimalarial plants. J Ethnopharmacol 146: 557-561. DOI: 10.1016/j.jep.2013.01.023.

Namulindwa A, Nkwangu D, Oloro J. 2015. Determination of the abortifacient activity of the aqueous extract of *Phytolacca dodecandra* leaf in Wistar rats. Afr J Pharm Pharmacol 9: 43-47. DOI: 10.5897/AJPP2014.4227.

Nguta J, Mbaria J, Mvula W. 2013. Brine shrimp toxicity and in vitro antimicrobial activity of *Piliostigma thonningii* from Kenya and Malawi against some pathogens of human and veterinary importance. J Vet Med Anim Health 5: 251-256.

Odhiambo J, Dossaji S, Lukhoba C, Yenesew A. 2014. Antifungal activity, brine shrimp cytotoxicity, and phytochemical screening of *Gladiolus watsonoides* Baker (Iridaceae). J Pharm Res 8: 1218-1222.

Orozco OL, Lentz DL. 2005. Poisonous Plants and their uses as insecticides in Cajamarca, Peru. Econ Bot 59:169-173. DOI: 10.1663/0013-0001(2005)059[0166:PPATUA]2.0.CO;2.

Parveen S, Godara R, Katoch R, Yadar A, Verma PK, Katoch M, Sign NK. 2014. In vitro evaluation of ethanolic extract of *Ageratum conyzoides* and *Artemisia absinthium* against cattle tick, *Rhipicephalus microplus*. Sci World J14: 6-14. DOI: 10.1155/2014/858973.

Rajput ZI, Hu S, Chen W, Arijo A, Axiao C. 2006. Importance of ticks and their chemical and immunological control in livestock. J Zhejiang Univ Sci B 7: 912-921. DOI: 10.1631/jzus.2006.B0912.

Rey D, Pautou M, Meyran JC. 1999. Histopathological effects of tannic acid on the midgut epithelium of some aquatic Diptera larvae. J Invertebr Pathol 73: 173-181. DOI: 62110.1006/jipa.1998.4810.

Rosenkranz V, Wink M. 2007. Induction of apoptosis by alkaloids, non-protein amino acids, and cardiac glycosides in human promyelotic HL-60 cells. Z Naturforsch C J Biosci 62: 458-466. DOI: 10.1515/znc-2007-5-621.

Ruskin S, Kumari V, Gopukumar T, Praseetha K. 2014. Evaluation of phytochemical, antibacterial, and anti-cancerous activity of *Cissus quadrangularis* from south-western Ghats regions of India. Intl J Pharm Sci Rev Res 3: 12- 15.

Salwa HM. 2010. Ethno-veterinary and medicinal knowledge of crude plant extract and its method of application (traditional and modern) for tick control. World Appl Sci J 11: 1047-1054.

Sanjay G, Tiku AK. 2009. Botanicals in pest management: Current status and future perspectives. Intl J Biomed Life Sci 3: 317-320. DOI: 10.1007/978-1-4020-8992-3_12.

Sirama V, Kokwaro J, Owuor B, Yusuf A, Kodhiambo M. 2015. *In-vitro* anthelmintic activity of *Vernonia amygdalina* (Asteraceae) roots using adult *Haemonchus contortus* worms. Intl J Pharmacol Res 5: 1-7.

Walker JB, Keirans JE, Horak IG. 2002. The Genus *Rhipicephalus* (Acari. Ixodidae): A Guide to Brown Ticks of the World. Cambridge University Press, London, U.K.

Wanzala W, Takken W, Mukabana W, Pala A, Hassanali A. 2012. Ethnoknowledge of Bukusu community on livestock tick prevention and control in Bungoma district, Western Kenya. J Ethnopharmacol 140: 298-324. DOI: 10.1016/j.jep.2012.01.021.

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Study of Javanese philosophical values in Kliwonan batik from Sragen District, Central Java, Indonesia

PURYANTI, J. HERMANU, SRI WAHYUNI♥
History Education Program, Faculty of Teacher Training and Education, Universitas Sebelas Maret. Jl. Ir. Sutami 36A Surakarta 57 126, Central Java, Indonesia. Tel./fax.: +62-271- 669124, ♥email: uni_hs@yahoo.com

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Abstract. *Puryanti, Hermanu J, Wahyuni S. 2019. Study of Javanese philosophical values in Kliwonan batik from Sragen District, Central Java, Indonesia. Asian J Ethnobiol 2: 51-69.* The research objectives are to describe: (i) The background of Kliwonan batik in Sragen District. (ii) The history of creating the Kliwonan batik motif in Sragen District. (iii) Javanese philosophical values contained in Kliwonan batik in Sragen District. This research was conducted in Kliwonan Village, Masaran Sub-district, Sragen District, Central Java, Indonesia. This study used the descriptive qualitative method. The sample used is purposive sampling. Meanwhile, interview, observation, and document analysis used the data collection technique. The validity of the data used is a triangulation technique, namely triangulation of data sources and triangulation of methods. The data analysis technique in this study used a qualitative analysis model and interactive analysis. Based on the results of this study, conclusions can be drawn: (i) Kliwonan batik craft in Kliwonan Village is related to Ki Ageng Butuh. For the services of Ki Ageng Butuh, finally, the village of Kuyang (Koni Kliwonan) and the village of Butuh (now the village of Gedongan), which are separated by the Bangawan Solo river, are used as bounty villages, so in this village, the palace culture also developed, namely batik, starting from the Abdi dalem kriya who become a batik worker in the palace. These skills were then developed in the village of Butuh-Kuyang and passed down from generation to generation in the Butuh and Kuyang areas which the Bengawan Solo River only limits. (ii) The process of creating batik motifs includes several aspects until the creation of a motif: function, material, form, technique or process, and aesthetics. All of these aspects start with an idea. In traditional written batik in Kliwonan, the idea of making motifs is influenced by external factors in the form of cultural factors. Traditional batik motifs are designed based on traditions passed down from generation to generation as a form of cultural preservation and to fulfill requests related to traditional needs. So in traditional batik motifs and visual beauty, there is also meaning. The internal aspects of making traditional batik motifs and new creations are the same, but different creative ideas affect the overall visual form. (iii) Kliwonan batik is part of Surakarta batik, so the motifs in batik are also full of Javanese philosophical values. The traditional written batik motifs in Kliwonan Village consist of: (a) The *semen* motif is a classic batik of Semen Surakarta, which is full of symbolism that shows the worship of fertility and the order of the universe, the aims, and objectives of the semen classic batik are manifested and contained in the names of batik the classics themselves, such as *semen rama, semen cuwiri*, and *semen gendhong*; (b) the *Parang* and *Lereng* motifs are traditional batik motifs with a line pattern, the name parang is closely related to the existence of Ingkang sinuhun Panembahan Senopati, the founder of the Mataram Kingdom, after the move of the center of government Java from Demak to Mataram, which is the place of "*teteki*" or the meditation of the first Mataram king who inspired the emergence of batik *lerengan* or *parang* as a feature of Mataram ageman which is different from the previous batik; (c) Ceplokan motif means a piece which has the meaning of "power," the interpretation of symbolism. This is inspired by the concept of power in the four main ornaments and one point in the middle of the *ceplok* motif, which describes the king's power over his people and the people who always surround and protect him.

Keywords: Batik, Javanese philosophy, Kliwonan, Sragen

PRELIMINARY

The Indonesian nation is a nation that has various kinds of wealth. Whether it's natural wealth, a wealth of art, a wealth of crafts, and many others. One manifestation of this wealth is batik. Batik is a craft made of cloth decorated with motifs, colors, and ornaments made by writing or stamping. Batik is also the most popular handicraft because of the beauty displayed from a piece of batik cloth. From that beauty, it gives rise to various meanings that the public, as batik connoisseurs and fans, do not know. These meanings are usually used by Javanese people, especially those who highly respect Javanese customs, such as Yogyakarta, as a kind of provision, law, or guidance used in their lives (http://vitoz89.wordpress.com).

Batik art is one of the typical Indonesian arts that has lived and developed for centuries, so it is one of the pieces of evidence of the cultural heritage of the Indonesian nation. Batik is a flexible Indonesian culture because batik can quickly adapt and absorb new elements from the surrounding culture (Septiana and Sarwono 2018). Many things can be revealed from the art of batiks, such as cultural background, beliefs, customs, nature, order of life, natural environment, taste, skill level, and others (Djoemena 1990).

Batik is also a means of cultural acculturation because, in its development, many changes have occurred, and it exhibited the culture that existed at that time. During the Hindu era, batik tended to be colored by motifs and patterns related to Hinduism; during the Islamic period, Islamic motifs and patterns also colored the batik. The

motifs and patterns of Hindu heritage still exist, and Islamic motifs as additional. Thus, until now, batik is colored by various kinds of cultures that develop in society. (http://vitoz89.wordpress.com).

In the past, batik-making activities in Java were exclusive to the royal family and the aristocrats. Ordinary people who can make batik are those palace servants or work for the aristocrats. People have the opportunity to learn batik by accompanying or serving batik masters, then take their knowledge outside the palace walls. Therefore, there are two parallel-known batik-making traditions: the palace and folk batik (Fraser-Lu in Dwiyanto and Nugrahani 2000). Over time, batik was imitated by the closest-related people and expanded into women's spare time work. Batik, which used to be only the clothes of the royal family, later became popular among women and men (mepow.wordpress.com).

The study of batik is endless because batik is a noble culture. Batik is one of Indonesia's textile cultures that has become a symbol of national culture. For the Javanese, the art of batik is not a strange new item in cultural life because this batik art is considered an inseparable part of everyday life. The existence of batik art has been recognized as a cultural system of very complex symbols full of values.

Batik, as a work of art produced by batik makers, is the embodiment of the surrounding, expressed as an outpouring of feelings and thoughts about forces outside themself. The batik was designed through a process of self-determination and meditation to get the whispers of their conscience, like getting a revelation. Religiosity plays a major role in forming noble values through this art process. Written batik is not only a physical activity but has a depth dimension, containing prayers, hopes, and lessons. With written batik, someone could trace back the "fibers" of life and string them to a woven framework of events that are in harmony with the realities of life (Yayasan Harapan Kita 1997).

Every creation of classical batik motifs was created with symbolism in Javanese philosophy. The purpose of creative work was to provide prosperity, peace, authority, and glory as a sign of social status in society for the user. Batik motifs are not made haphazardly but follow strict rules. This could be explained that batik-making is often associated with mythology, expectations, gender markers, social status, and clan members, and it is believed to have supernatural powers. Javanese batik motifs relate to social status, beliefs, and expectations for the wearer (Haake in Dwiyanto and Nugrahani 2000).

Likewise, the Kliwonan batik craft is found in Kliwonan Village, Masaran Sub-district, Sragen district. Kliwonan batik also has certain motifs with Javanese symbolism, which determines the characteristics of the Kliwonan area. Most people are farmers, and the batik motifs or patterns created are also closely related to the local community's culture.

The emergence of hand-drawn batik in Kliwonan Village, Sragen District, around 1975 is hereditary. Besides Kliwonan Village, Masaran, another batik center in Sragen District is Plupuh Sub-district. Activities as batik artisans/craftsmen in Masaran and Plupuh Sub-districts have been carried out for decades and passed down from generation to generation. The emergence of batik in the area is related to Ki Ageng Butuh as ruler of Butuh-Kuyang region (Suranto 1995).

Initially, the Butuh-Kuyang region was not a batik community; the batik pioneers in this village did not pursue batik business as a way of life. Like other villages, the people of Kliwonan make a living as farmers, and the growing season does not occur all year round. Several decades ago, the Bengawan Solo flowing through the village became the trade center in the Surakarta area and its surroundings, and one of the commodities is batik. Initially, four Kliwonan residents got into the batik business by learning the batik art and then developing it simply. Over time, the number of Kliwonan residents pursuing batik increased. (http://www.sragenkab.go.id).

The aims of this research are: (i) Describe the background of Kliwonan Batik in Kliwonan Village, Masaran Sub-district, Sragen District, Central Java, Indonesia. (ii) Find out the history of the Kliwonan Batik motif creation. (iii) Explaining the Javanese philosophy values in Kliwonan Batik motifs.

MATERIALS AND METHODS

Place and time of research

This research was conducted in Kliwonan Village, Masaran Sub-district, Sragen District, Central Java, Indonesia, to consider that Kliwonan Village is the batik center in Sragen District. This research was conducted for 8 months (November 2009 to June 2010).

Research form

This study uses descriptive qualitative research to include Javanese philosophical values in Kliwonan batik motifs.

Research strategy

The single fixed model was used to contain a single sense that there is only one location, namely the Sragen District. In contrast, the fixed model objective means what is being researched, limited to aspects that have been selected before conducting field research. This study focused on knowing the values of Javanese philosophy in Kliwonan Batik motifs.

Data source

Informant

In this study, people chosen as informants are considered to understand batik Kliwonan motifs. They can be trusted as data sources and have the knowledge, i.e., formal leaders of the Kliwonan Village community and batik entrepreneurs.

Places and events

In this study, the information can be extracted by careful observation of the condition of the daily life of the residents in Kliwonan Village. Meanwhile, the daily activities could lead to creating batik motifs and

craftsmanship. In this study, researchers know someone who makes batik and batik motifs because they witnessed it firsthand.

Documents and archives

This research will obtain documents and archives containing information about Kliwonan batik in Sragen District. Demographic data in the research include socio-economic and detailed physical information, namely area, number, and population density. These data were obtained from the Kliwonan Village office.

Sampling technique

In this study, researchers use purposive sampling to choose informants considered to know and could be trusted as data sources. In addition to purposive sampling, this study also uses snowball sampling. Snowball sampling is a technique that is initially small but gradually increased until the information is sufficient to stop. This technique is applicable because the potential respondents are difficult to identify.

Data collection technique

Deep interview

Interviews were conducted with Kliwonan batik entrepreneurs, local people, and figures with batik knowledge that the researchers selected. Data obtained intended to the history, the motifs, and the Javanese philosophical values in Kliwonan batik motifs.

Observation

Observation is interpreted as systematic observation and recording of the symptoms in the research; the object under study is Kliwonan batik. The researcher observed the Javanese philosophical motifs and values contained in Kliwonan batik.

Document analysis

Document analysis is written material to complete data that is considered lacking. It is used to justify the theory or read documents and previous research results related to the object being studied, namely Kliwonan batik in Kliwonan Village, Masaran Sub-district, Sragen District.

Data validity

This study used the data triangulation method and review of informants to test the data's validity by conducting interviews and observation techniques. Researchers collect data through informants compared to the field sources such as the place, events, archives, and documents using triangulation of data sources and methods. While the Informant Review is checked by holding discussions with sources in the field to re-examine the information that has been given previously. In other words, the researcher will match information obtained with the sources in the field.

Data analysis technique

The analytical technique used is qualitative analysis. That is to analyze data based on the relationship between each other in a causal relationship to explain an event. The qualitative analysis uses an interactive analysis technique, a cyclical process that moves between the three main components: data reduction or selection, data presentation, and conclusion drawing; this refers to Sutopo (2002).

RESULT AND DISCUSSION

History of Kliwonan batik in Kliwonan Village, Masaran Sub-district, Sragen District

Sragen is one of Surakarta's former residencies, consisting of 20 sub-districts. Sragen has regional potential from various sectors, i.e., agriculture, animal husbandry, industry, and handicrafts. These potentials include batik, watermelon, melinjo chips (*emping*), furniture, and limestone. Currently, batik is a great potential for Sragen.

Sragen has batik areas located in Masaran and Plupuh Sub-districts. Especially in Masaran, there are approximately 4.000 batik makers and several batik artisans (entrepreneurs) scattered in several villages, including Kliwonan Village. Masaran has located 16 km from the city of Sragen District and 22 km from the city of Solo. This village has an area of 337.4060 ha and is located at 87 m above sea level. Most of the area is rice fields that use water from the Bengawan Solo tributary for irrigation. This is why the residents look for other livelihoods, namely batik, which is spread in almost all hamlets in Kliwonan Village.

Masaran Sub-district batik skill is spread in the villages of Kliwonan, Pilang, and Sidodadi. According to data from the Industry Office of Sragen District, there are around 7,000 batik workers in Masaran and Plupuh Sub-districts (Sragen Regional Industry Service Level II 2009).

The existence of batik in Kliwonan is probably beginning a century ago. According to Ms. Towirejo (the oldest living batik maker), she started batik craftsmanship in Solo when she was 10 years old, around 1940. Even her parents were first familiar with batik and became batik workers before (Interview on 29 April 2010).

Kliwonan Village is a center for the written batik in the Masaran Sub-district, Sragen District. The history of the Kliwonan Village's journey shows its traditional nature. The population's standard of living could characterize this, most of them farmers.

According to Karmanto, a Kliwonan Village official, at first, the people in Kliwonan were only batik workers who took batik materials (sanggan) from batik masters in Solo and made batik in their village. After the completion, the batik cloths in the form of rengrengan are returned to Solo for further processing until they become the real batik. Others also worked at the batik skippers in Solo (Interview on 29 April 2010).

According to Mr. Samto, batik has been integrated with the Kliwonan community; almost everywhere, we could find women who were batik artisans. The men also participate in batik activities, mostly coloring or color-craftsmen, drawing artisans, or preparing white cloth before batik-making. Knowledge about batik is obtained from generation to generation from childhood; that's why

even children can make batik by themself (Interview on 29 April 2010).

The emergence of hand-drawn batik in Sragen District has been hereditary for a long time, and Masaran is one of the centers. At first, the pioneers of this batik craft were Kliwonan Villagers who became batik laborers in the city of Solo. According to local people's stories, some people first became batik laborers for batik masters in Solo. Subsequently, many residents became batik workers in Solo, too. The job as a batik worker at a *juragan besar* (big batik entrepreneur) in Solo lasted for a long time. Usually, those who become batik workers in Solo at young ages, and most of them are women. While returning from Solo, batik workers bring cloth in case their mother could make batik at home (Interview with Mr. Suwanto on 29 April 2010). At first, batik in Kliwonan was only a part-time job for homemakers besides working as a farmer. Usually, when they have free time, for example, after planting rice that they are not working in the fields, they use their spare time to make batik.

Regarding the origin of batik in Kliwonan Village, according to Mr. Suwanto's statement (Interview on 29 April 2010), batik in Kliwonan Village has been there for a long time and has become an ancestral heritage. Residents in Kliwonan Village did not know for sure when the emergence of batik was in this area. The existence of batik in the Kliwonan cannot be separated from the story of Ki Ageng Butuh. During the Pajang Kingdom, the Villages of Butuh and Kuyang (now Gedongan and Kliwonan Villages) were used as "*Perdikan* Villages." The name "*Perdikan*" comes from the word "*Merdika*" from the Sanskrit "*Mahardika*" which means free (Soetardjo in Surianawati 1999).

According to Mr. Suwanto, the village of Butuh and Kuyang was made to be a Perdikan Village because of Ki Ageng Butuh's merit, who helped Joko Tingkir to become the King of Pajang Kingdom. Ki Ageng Butuh for the Butuh community is believed to be Ki Ageng Kebo Kenongo, Joko Tingkir's father, who eventually became the King of Pajang. The story of the boat or gethek "Tambak Boro," which is considered a legacy of Joko Tingkir, is still there (Interview with Suwanto on 29 April 2010)

By making Butuh and Kuyang Villages "*perdikan*," many people became palace courtiers, including women. Finally, many courtiers became batik makers in the palace. Batik mastery then spread to their original area, namely the village of Butuh-Kuyang, so that many people, especially women, could make batik themselves. Batik's mastery skills have been passed down from generation to generation in the villages of Butuh and Kuyang, which the Bengawan Solo River borders (Interview with Mr. Muljoto on 29 April 2010). The batik skill eventually expanded to surrounding areas such as Pilang and Sidodadi villages in the Masaran Sub-district.

The batik artisans then began to buy their materials and make batik. The batik work was not ready to be sold directly to customers because it was still a semi-finished product that needed further production. Initially, batik traders did not want to accept batik from Kliwonan, so they had to sell it through batik entrepreneurs in Solo. Later, the Kliwonan batik became known and even included its name, besides working on special orders (*tempahan*) from other artisans. Currently, "batik" is no longer just a part-time job for villagers, especially women, but has become their main livelihood. Some of them even become batik artisans who can employ batik workers.

The batik made by the artisans in the Kliwonan area was initially still semi-finished, and processing batik products took about one month. Because batik processing requires other processes such as *dikelir* (dyeing) and *dilorod* (washing), it is impossible for homemakers who make batik to finish the production process until it is ready to sell. As long as there is no batik processing in the Kliwonan area, the artisans usually make batik semi-finished and then sold to batik processing/skipper (*juragan batik*) in Solo. However, the price of semi-finished to the skipper in Solo is below the market. Solo's skipper (*juragan batik*) usually only accepts batik from their fellow entrepreneurs. The batik makers from Masaran are forced to sell their batik at a very low price. The batik is also marketed using the brand of the Solo batik master (Interview with Suwanto on 29 April 2010).

The Kliwonan Village people's job, in general, is farming, so batik craftsmanship for the community is a spare-time job only. Batik craftsmanship has been done by people in the Kliwonan area for a long and is a legacy from their ancestors, although it is not ready to be directly sold to customers. This condition is due to the processing of the batik cloth through a long process.

The undeveloped batik processing and the craftsmanship status, just as workers motivated some people to begin establishing a batik industry in their area, consideration in the Kliwonan area, there are many batik experts, especially women. Some factors such as the production process, cheap labor, and close to raw materials could be obtained to start an industrial batik. An additional consideration is that the emergence of the batik industry in the Kliwonan area is expected to increase women's wealth, who previously only relied on their husbands' income from farming. In the batik industry, women could improve their family's standard of living (Interview with Mr. Sumarsono on June 5 2010). One of the batik artisans, Mr. Supardjan from Kuyang hamlet, Kliwonan Village, who was a small batik maker, tried to accommodate batik workers and founded a batik company called "Brotoseno" in 1968 (Interview with Ms. Thessa on 17 May 2010).

Kliwonan batik product characteristics could be distinguished from other types of batik. The characteristics of written batik are signs that are easily recognizable visually in both traditional and non-traditional batik. Those characteristics, e.g., in the written batik design pattern, there is no feature of back and forth *raport (sanggit)* that is repeated quickly. The forms of motifs, lines, and isen-isen do not repeat both in a *raport (sanggit)* design and in a repeated *raport* design afterward. Written batik cloth smells of batik wax. If there are crumbs of wax (especially those that are intentionally made), it will not be able to be regularly and repeatedly. The color of the batik on both sides is the same.

Table 1. Names of batik artisans in Kliwonan Village, Masaran Sub-district, Sragen District, Central Java, Indonesia

UKM batik name / owner	Address
Teratai	Dk. Kuyang RT 01/1 Kliwonan
Winda-Sari	Dk. Kuyang RT 03/1 Kliwonan
Brotoseno	Dk. Kuyang RT 04/1 Kliwonan
Walisongo	Dk. Kuyang RT 01/1 Kliwonan
Sadewo	Dk. Kuyang RT 01/1 Kliwonan
Cengkir Jaya	Dk. Kuyang RT 01/1 Kliwonan
Puntodewo	Dk. Kuyang RT 02/1 Kliwonan
Sumber Bengawan	Dk. Kuyang RT 02/1 Kliwonan
Permata Tujuh	Dk. Kuyang RT 01/1 Kliwonan
Punokawan	Dk. Kliwonan RT 03/II Kliwonan
Dewi Arum	Dk. Kliwonan RT 03/IV Kliwonan
Romadhon	Dk. Kliwonan RT 03/IV Kliwonan
Purnama	Dk. Kliwonan RT 03/VII Kliwonan

Note: DK: Hamlet. Source: Girli Batik Center-UKM Data Report 2009

Continuous development drives human needs to increase as well. As a medium, batik has a relationship with traditional ceremonies, rituals, and daily activities, also an important trade factor throughout history. Textiles clothing, including batik, always needed to meet customer demands. The demand for Kliwonan batik is increasing. Changes and renewals occur in several forms, namely in terms of design or motifs, processes, materials, and user demand. All developments in the written batik show its existence as a delicate, complex, and beautiful work of art always needed.

The development of batik in Kliwonan Village

The development of Kliwonan batik could be traced from the various motifs made by several batik industries in the Kliwonan area. There are traditional motifs, namely *semen rama, semen rante, parang baron, parang rusak*, and so on. In addition to traditional motifs, Kliwonan batik artisans also make new batik motifs; according to Mr. Sumarsono, because of the many motifs made, he cannot name them one by one because there are so many motifs. The data of the increasing batik industry could be traced from the production in a batik company from year to year (Interview on 5 June 2010). Table 1 shows some batik artisans in Kliwonan Village, Masaran Sub-district, Sragen District, Central Java, Indonesia.

Small industries and household artisans act as alternative jobs to increase people's income in rural areas. This is due to the increased number of workers/job hunters and the relatively reduced agricultural land. In addition, small industries and household crafts usually use a lot of raw materials from nearby sources. Many workers in rural areas tend to lower labor costs, allowing small industries and household crafts to survive. It is possible to cover demand for several types of commodities that could not be produced optimally, such as batik.

The process of making batik

In general, the current process of making written batik takes not too long compared to the past production. The overall time of making written batik ranges from 1-1.5 months for batik with synthetic dyes, while batik with natural dyes takes between 4-6 months. The process of making written batik starts from the preparation stage and ends at the *pelorodan* stage, as is what the batik makers in Kliwonan do.

Preparation

Batik material derived from cotton is firstly processed before the making of batik. The cloth that has been cut is folded and dipped so that the threads become loose and limp. Now the mori-cotton doesn't need to be dipped in low starch content to be limp.

Silk fabrics, both ATM (machinery loom) and ATBM (manual loom), do not need to be firstly processed because the fibers are fine. Especially for fabrics dyed with natural dyes, they are soaked in alum solution *(tawas)* overnight. The fabrics are then scratched or drawn with batik motifs using a pencil. A new design or motif image (new creation) is made for about 5-10 pieces of fabric or more. This motif image is not accompanied by isen-isen images, only in the form of the frameworks *(klowongan)*.

Depiction

The making of written batik begins with writing or making with batik wax. The process of batik is step by step and processed at different times. The stages in making batik are *Nglowongi*, namely making batik frameworks. Often called *mola* (making a design) using *canting klowong*. *Ngisen-iseni*, which is to fill and check the areas of the motif. The batik fabrics that are complete with isen-isen are called reng-rengan.

Nerusi is making batik on a different cloth surface that has been done by following the first batik motif. This stage is only carried out on batik made from mori-cotton, while batik from silk does not use the *nerusi* stage.

Nembok covers the parts of fabrics that are not colored or will be given various colors during the finishing process. In written batik, it can be continued with the nerusi (continuity) process of embossed batik wax (*tembokan*). The fabric parts that are not drawn are completely closed, which is called *bliriki*. Like *nerusi*, *bliriki* is only done on batik from mori-cotton. The time required for nglowongi (embossed the design with batik wax) and *ngisenni* (fulfill the design with batik wax) is about 10 days. Usually, these two stages are done by one batik maker. *Nerusi* or *nemboki* could be done faster.

Coloring

Batik coloring is done by cold-dyeing and is divided into 2 ways based on the dye used.

(i) For batik with natural dyes, the dyeing lasts longer. First, the reng-rengan batik fabric is colored a dark blue using naphthol. After this first dyeing, the batik is soaked with water to soften the wax, then the batik is scraped *(dikerok)* or scraped using a knife *(dikerik)*, and add soda ash on the part that will be dyed by soga. The batik fabric is then stirred or washed with clean water and crushed with the feet, then make it blue (*dibironi*) and *disuluri* (strew, fixing the damaged wax) in case other colors are not mixed. Furthermore, the fabric is colored using soga genes. The fabric is repeatedly dyed in a bath containing a soga

extract solution for about 15 minutes, then drained and aerated. After the fabric is dry, it could be dyed again. When the desired color has been achieved, the fabric is treated with a solution of lime, kayu tiger, jambal, and tawas (alum) without washing it first. The fabric is soaked in the solution for 2 hours, then smoothed over the bath overnight. The next day the fabric is dried in the shade, and then the fabric can be dyed again in the same way. Staining can take place dozens to dozens of times, depending on the smoothness of the batik fabric.

(ii) Coloring using synthetic dyes is easier to work with. When using naphthol dye, the fabric is moistened with water (especially mori-cotton) and then dipped in the naphthol solution while pressing gently until the fabric is yellowish and smoothed out. After it is sufficiently damp, the fabric is dipped in the salt solution for a few minutes until the color appears. The colored fabric is aerated, then washed with clean water. Naphthol-dyed fabrics should not be dried or placed in direct sunlight, which could cause color changes. Each color dyeing could be done 1-2 times, according to the desired color and the amount of dye used.

(iii) The dyeing color with indigosol through 2 stages; the first is the batik fabric is dyed in an indigosol and nitric solution with light pressure until evenly distributed. The fabric is then smoothed and dried in a hot place; after it is dried, the fabric is *disareni* or enlighted color coldly using acid and then washed.

The dyeing process on batik with synthetic dyes is generally around 3-5 dyeing times, according to the desired color. The first color is the basic, then followed by coloring from light to darker colors.

Pelorodan

Written batik uses 2 ways to remove batik wax: lorodan (remove batik wax with hot water) and *kerokan* (scrapings batik wax). The batik process with synthetic colors through the *lorodan* process, where the *nglorod* (*lorodan* process) is done 2 times during batik making. The first pelorodan is carried out after the batik's first coloring, or basic color, is done. At the same time, the second nglorod is carried out at the end of the batik-making process after the entire dyeing process is complete. This nglorod process uses hot water mixed with *waterglass* (sodium silica) or soda ash. *Waterglass* is often used for both cotton and especially silk batik because it doesn't dissolve color as much as soda ash. After the *dilorod* is finished, the batik fabric is washed and dried.

The second way is to go through the scraping process (*kerokan*). The fabric, after basic coloring, is scraped using a knife on the part you want to soga dyed so that the wax does not completely disappear but only partially. At the end of the batik-making process, the fabric is dilorod (*lorodan* process) with hot water.

The history of the creation of the Kliwonan batik motif

Surakarta batik motifs

According to Theresia Widiastuti, the batik motif is a picture frame that embodies batik as a whole. Batik motifs are called batik patterns or batik designs. According to its elements, batik motifs are divided into two main parts, namely batik motifs, and ornaments which act as a medium to beautify and glorify a finished work, even though some have certain symbolic values. Currently, the number of motifs is very large in various artistic expressions, variations, and colors (Interview on 17 May 2010).

Batik ornaments

Generally, there are two groups of batik ornaments: geometric ornaments and non-geometric ones. (i) Geometric groups include Slanted lines or *Parangs* (patterns arranged according to oblique lines or diagonal lines), Cross lines or *Ceplok* (drawing flowers from the front, fruit cut across, threads and leaves arranged in a rosette, animals arranged in a circle) and *Kawung* (a pattern composed of circular, oval or elliptical shapes, the arrangement extends according to diagonal lines sloping to the left and right, alternating), woven (*Jlamprang*) and *Limar* (Djoemena 1990). (ii) The non-geometric category includes *semen* which is a classical pattern that is freely arranged in which there are ornaments of plants, animals, volcanoes, *pohon hayat* (tree of life), and *lunglungan*, which is a pattern with a plant motif, and Buketan is a pattern with an animal motif

The creators of batik ornaments in ancient times not only created something that was only beautiful but also had a meaning or got mean, which was closely related to the philosophy of life within. The creators create something decorative with a message and sincere hope from the wearer, depicted in batik motifs.

Symbolic decorations that are closely related to Hindu-Javanese philosophy include (i) *Sawat* or *Lar* (Figure 1.A), symbolizing the crown or high ruler, (ii) *Meru* (Figure 1.B), symbolizing mountains or land (earth), (iii) *Naga* (Dragon) (Figure 1.C), symbolizing water which is also called *tula* or *banyu*, (iv) *Burung* (Bird) (Figure 1.D), symbolizing wind or the world above, and (v) *Lidah api*, Tongue of Fire or Modang (Figure 1.E), symbolizing a flame called *geni*. (Djoemena 1990).

Batik grouping

Batik can essentially be grouped into two parts: (i) Batik motifs are rooted in the cultural philosophy and the Javanese mind, which presents various decorations as symbols and philosophies originating and developed by the kingdoms in Java. Therefore, batik in this group is often referred to as "Karaton batik," "Solo batik," Yogya batik" or "classic batik." Pattern expressions tend to be symbolic, static, and even magical in their arrangement on fabric surfaces and coloring. The colors are limited to soga-brown and indigo blue on a white or ivory background; and (ii) Batik motifs are more free and independent in expression and are not bound to a certain realm of thought or philosophy. This kind of decoration grows and develops outside of the palace boundary, especially in the northern coastal areas of Java. The colors are not limited to soga-brown or blue indigo but also apply to red, green, and yellow. Batik in this style is commonly referred to as "Coastal Batik" (Yayasan Harapan Kita 1997).

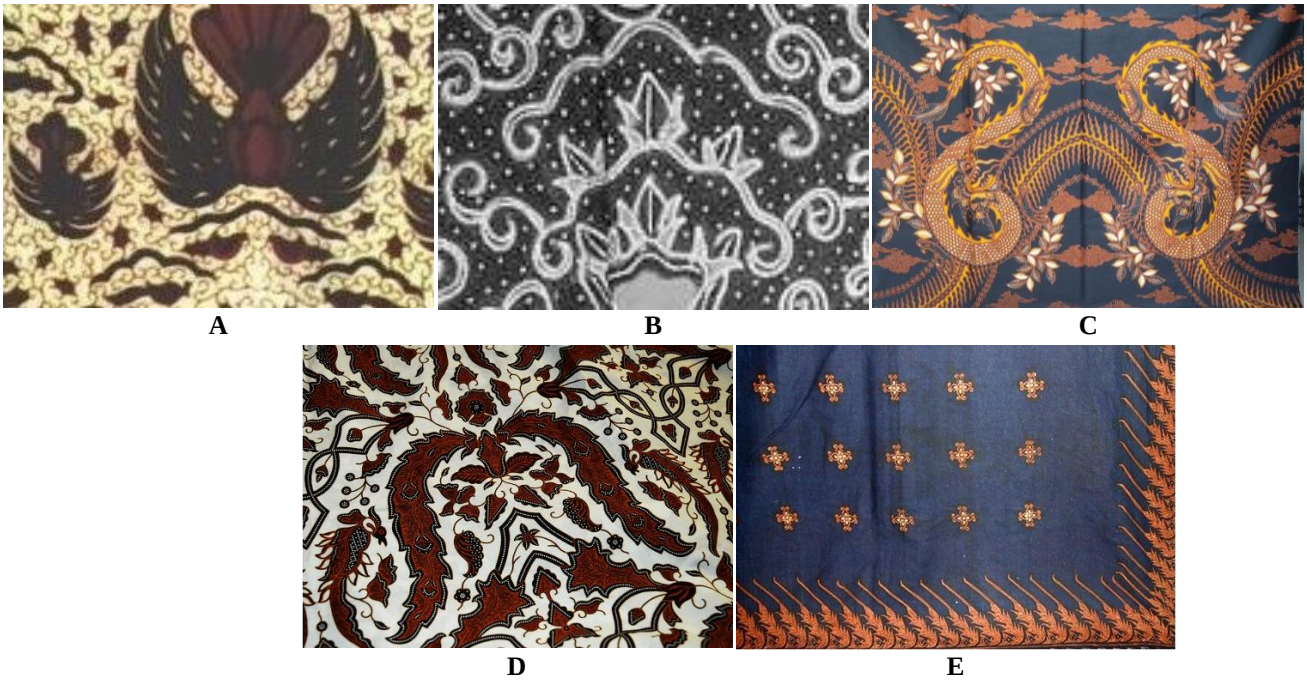

Figure 1. Some symbolic decorations of Hindu-Javanese philosophy on batiks: A. *Sawat, Lar*; B. *Meru* (*gunung*); C. *Naga*; D. *Burung*; E. *Lidah Api, Modang*

Among the two types of decoration mentioned above, classical batik is a batik rooted in the Javanese cultural philosophy, which developed in the Yogyakarta and Surakarta palaces. The motifs in batik contain a highly symbolic meaning.

Grouping of batik in the Dutch colonial era

Since the Dutch colonial era, the grouping of batik from the batik area production has been divided into two major groups: (i) *Vorstenlanden* batik that is from Solo and Yogya regions. In the Dutch colonial era, these two areas were royal sovereignty and called *Vorstenlanden*. Batik Solo-Yogya (*Vorstenlanden)* has the following characteristics: decorative motifs are symbolic of the Hindu-Javanese culture background, and the colors used: are *sogan, indigo* (blue), black, and white; and (ii) Coastal Batik is all batik whose production is done outside the Solo and Yogya areas. The division of the origin of batik into these two groups is mainly based on the nature of the decoration and color. Coastal batik has the following characteristics: naturalistic ornamentation, the strong influence of foreign cultures, and various colors being used.

Because of these characteristics and colors, batik from Garut, Banyumas, Ponorogo, and others are included in the coastal batik group, even though these areas are no longer located on the coast. In the various coastal batik regions, the coloring pattern and colors of blue and white (*kelengan*), red and white (*bang-bangan*), red-blue (*bang-biru*), and red-white-green (*bang-biru-ijo*) are always present. A few differences in shades of color according to the area's tastes are also concerned. For example, the red color of Pekalongan has a brighter and lighter nuance than the red color of Indramayu, which tends toward dark red.

The decoration, color, and color scheme or style, of coastal batik that stands out and is popular are batik motifs from the regions: Indramayu, Cirebon, Pekalongan, Lasem, Garut, Madura, and Jambi. The Madura and Jambi regions are located outside Java. Even though only a few batiks' craftsmanships in Jambi province, they stated batik as a way of living (Djoemena 1990).

The Solo area during the Dutch rule was one of the two areas called *Vorstenlanden*. This area is a royal kingdom with all the traditions and customs of the palace and is a center of Hindu-Javanese culture. The palace is not only the king's residence but also the center of government, religion, and culture. This situation affects and is reflected in the art of batik, both in terms of decoration and color and the rules for its use.

The color meaning of batik

Besides the ornamental motifs, the batik color has its philosophical meaning. The color of batik motifs includes: Dark green-red, *klabang ngantup*, which means stinging centipedes, is considered sacred and is used for wrapping and decorating heirlooms. *Klabang* symbolizes the power to protect sacred objects from bad things (disaster). Dark green-light green, *mayang mekar* (mayang blooms), or coconut flowers starting to bloom like grown-up virgins. The green-white color, *godong melati* (jasmine leaves), which means jasmine leaves and flowers, is a symbol of prosperity, representing the color of *Nyi Roro Kidul* from the Javanese princess legend on the South coast. The red-purple-yellow color, *podang nyesep sari*, symbolizes maturity, like a man who has grown up and begins to feel the turmoil of his male instincts or puberty. The green-yellow color, *pare anom*, which means a young bitter-melon fruit, is a symbol of prosperity. Black and white

color, *bangun tulak* or *tolak bala*, which means ward off misfortune. The motifs combination is found in various types of batik fabrics, such as (i) *Dodot Bangun tulak*, a prestigious dress previously worn by the royal family only. (ii) *Lurik tuluh watu* dan *lurik tumbar pecah*, used in the *mitoni* ceremony or the seven-month pregnancy ceremony. (iii) Various *tritik bangun tulak* are usually used as headbands and put under the pillow. This is done to avoid bad dreams during a night of deep sleep, except being worn as clothing.

Honggopuro (2002) stated that Surakarta batik motifs have philosophical meanings. The philosophical meaning is contained in the color combination, which is described as follows: (i) *Pengantin anyar* (New brides), a color combination of batik within the edges of the cloth, are green and red in the middle, while the center is white. This color combination always means together besides the youthful character, whether in joy or sorrow. (ii) Gunung Sari is a color combination of green on the side of the cloth, purple in the middle, and yellow in the center. This combination symbolizes the *hidup mukti wibawa* living, which means having a highly respected a valuable living in society. Parents and women could use Batik Fabrics with this color combination. *Onengan* is a color combination fabric on the edge of the green, purple in the middle, and white in the center. This combination means other people (opposite sex) are indecisive/tend to love them. This color is suitable for young people. *Panji Gandrung* is a color combination of the edge of purple and red in the middle. This means that *panji* is a title given to the king's great-grandson that became a residency regent. *Panji Gandrung* means being in love, in an all beautiful life and fun living, normally for young and older groups. *Panji Wuyung* is a combination of purple on edge, and green in the middle of the cloth, within the center of the red cloth. Its philosophy is the same as *panji gandrung*. *Puspa Kencana* is a combination of purple on the edge of the cloth and yellow in the middle, within the center of the red cloth. This means showing a chivalrous character, confidence, skillfulness, and excellence. This motif could be used by young and old alike. *Puspandara* is a color combination of batik on the edges of purple and pink or light red in the middle, within the center of the dark red cloth. This color combination shows excitement in life and enthusiasm and has a quick and skillful character. This color combination is suitable for young people, and so on (Honggopuro 2002). *Panji Wilis* is a combination of *gadhung* green color with purple drag / *plisir*; this means contemplation and patience for the young and old. *Klabang Ngantup* is a combination of *gadhung* green with red drag. It describes the alertness, enthusiasm, and patriotism inside (*watak ksatriya*). This combination is for young people. *Siwalan Pocat* is a combination of purple with drag or white plisir. The meaning describes physical freshness, cheerful and refined expertise. It could be used for young and old.

At last, we will understand that classical batik motifs, both in the form of decoration and basic colors, are symbols or symbolism that have deep meanings. Classical batik is a cultural artwork that is not only created but its existence accompanied by aims and objectives. One objective is for various traditional ceremonies.

The history of the creation of the Kliwonan batik motif

According to Mr. Sumarsono, the owner of Dewi Arum batik, the idea of making traditional batik in Kliwonan is influenced by external factors such as cultural and customary. Traditional batik motifs design is based on traditions passed down from generation to generation, preserving Javanese culture (particularly) and related traditional needs fulfillment. In the traditional batik motifs, besides to visually beautiful, some meaning is contained within. New batik motif creations are driven by the market or customers that demand written batik that can keep up with existing developments. It is also driven by awareness of the continuity of preserving the nation's culture (Interview on 5 June 2010).

The spirit contained in traditional batik, as well as new batik motif creations, are the same. The difference in intellectual creation affects the overall motif in visual form. In traditional written batik, the functional usefulness is intended for tradition-related purposes, such as traditional clothing, and a complement to traditional ceremonies, such as long clothes *(kain Panjang)* or sarongs. The new batik motif creations have a wider function for fashion, household, and interior accessories, including shirts, scarves, curtains, and ties (Interview with Thesa on 17 May 2010).

According to Mrs. Parinem, the manager of Sadewo Batik, there are differences in the motifs based on the batik function. Traditional batik has traditional motifs, permanently isen-isen, and fixed design arrangements. Traditional batik design cannot be produced as the batik maker desire. The batik motifs and isen-isen in new batik creations are freely designed and arranged according to the batik maker or the customer's desire. Because in the new batik creations, there is no symbolic meaning to be conveyed through these motifs, even though the existing forms are mostly based on traditional motifs that have been changed, variation developed, and combined with other compositions or even new motifs (Interview on 17 May 2010).

Another consideration is the materials, which are the same main ingredients for traditional and new design/creation batik, mori-cotton or silk, batik wax, and dyes ingredients. This dye ingredient consists of synthetic, namely naphthol and indigosol, and natural dyes with soga genes. The technique or process used in traditional batik making (written batik) consists of the preparation stage, depicting motifs with canting tools, coloring, and pelorodan. The difference occurs in the coloring stages, i.e., the first staining stage. In natural dyes, the scrapping process is during the first staining (coloring stages), while in synthetic dyes, scrapping is carried out at the nglorod process (finishing stages).

The aesthetic consideration of batik relates to the decorative variety, which includes elements of shape and color, placement of repetition motifs, and the material selected. This decorative variety making is as harmoniously possibilities balanced according to their purposes or

function. The beautifully traditional work in written batik has an attractive and appropriate decoration between their visual characteristics and symbolic meaning. The colors are limited to dark blue or black, brown, and white, giving a distinctive look while blending with the classic pattern forms. The planned pattern and intricate isen-isen motifs become traditional batik, not just a fabric to use but also a beauty element contained. The new creations/motifs of written batik have aesthetic considerations regarding the material's color, motif, and texture. Even simple motifs, such as broken wire or insect motifs, with the right composition of shapes and colors, will produce beautiful motifs. The material's surface texture or the woven design arrangement would make the batik's overall appearance much more beautiful. Kliwonan hand-drawn batik, both traditional decorative and new creations/motifs, even in simple motif patterns, are strived to fulfill predetermined considerations.

Kliwonan batik ornaments

The batik decoration in the Surakarta area tends to be a combination of geometric and non-geometric decorations in smaller sizes. Surakarta batik is famous for its fine sawutan and *parang* (machete) motif. The Surakarta batik color has Hindu-Javanese symbolism, namely *sogan, indigo* or blue, black and white colors. Classical batik function could be classified by features (variety of decoration, color, and wearing rules of procedure), which involves the batik user's social position (Djoemena 1990).

Ornamental batik design variety as a medium for expression in society could be represented the feelings embodied in visual form. In contrast, the design process cannot be separated by environmental influences (Toekio 1987). In decorative batik design, elements support the visual forms that occurred, consisting of lines, fields, textures, and even colors.

Those elements (part) of visual form manifest in the batik motifs as main ornaments, filler, and isen-isen. The motif is the base or principal of the pattern; after the motif has been achieved/chosen, then undergoes a process of arrangement and spreading over to obtain a pattern. The patterns applied to a fabric/object, such as cloth, will become a decorative design.

According to Ms. Theresia Widiastuti, a staff member of Batik Brotoseno, Masaran batik's ornamentation is varied and heavily influenced by Solo batik motifs. It is possible because the location of the two areas is quite close; there is a relationship between them. It was the beginning of the batik industry in Sragen. The creativity of the artisans in designing new motifs enriches the existing decorations (Interview on 17 May 2010).

Kliwonan batik consists of geometric and non-geometric ornaments. Based on the patterns, it could be grouped into traditional decorations/ornaments and new creation motifs. According to Mrs. Parinem, traditional ornaments are decorations based on existing customs and continue from generation to generation. The decorations on Kliwonan batik are mostly based on the Solo batik decorations, including *sido mukti, sido luhur, sido drajad, parang kusumo, parang baron, madu bronto, baboon angkrem, and wahyu tumurun*. This traditional decoration is made with certain rules, has a fixed shape, and does not change. Among the fixed rules are, for example, the main ornament for the *truntum* decoration is animal-like combined with *isen cecek pitu* or *cecek pita*. Those shapes cannot be replaced with another, such as a flower or circle, nor could the isen-isen be changed arbitrarily (Interview on 17 May 2010).

Traditional decorations have symbolic ornaments closely related to Javanese philosophical values, including *meru*, fire or *modang*, dragon, bird, and *sawat* or *garuda*. *Meru* depicts a mountain as a symbol of earth or land, dragons and birds symbolize wind, fire symbolizes flames, and *garuda* symbolizes power or crown (Susanto 1980).

The elements (parts) of traditional decoration could not be modified or added because it could damage the values and meanings implied in batik. Likewise, in terms of color, batik with traditional decorations usually has *soga* brown, *indigo* blue or black, and cream or white colors. These colors could not be replaced with the others. The decoration name in traditional batik is the batik itself because the decoration name was made for image-theme expressed on the batik cloth. Many new decorative creations are produced at Kliwonan batik because of limitations to the use of traditional-patterned batik (bound to existing symbolic values). Another factor/drive is to avoid the customers' boredom with existing batik motifs because it will affect the continuity of subsequent batik production.

According to Mr. Sumarsono, the owner of Dewi Arum batik, the new batik creations design, even various design styles, has a short circulation/production period. A new decorative creation is usually once produced and can be reproduced if there is customer demand. Artisans can make new ornaments motifs up to 3 to 4 times weekly, depending on demand in need (Interview on 5 June 2010). The decorations that exist on the new batik creations generally consist of forms/objects such as:

Plants or flora. One form of inspiration in batik motifs making that never ended is flora. Various flora or plants used as batik patterns can consist of stems, leaves, flowers, or whole plants. Plant or flora motifs are not generally produced based on a particular/typical type. The creations are based on the will of *tukang nyorek* (a picker/crafter) or motifs that combines several forms of leaves, flowers, and even the whole fruit.

Animals or fauna. Animals or fauna that become batik motifs in Masaran are various birds, such as cranes, peacocks, phoenixes (*miros* birds in Chinese stories), and doves. Various insects, butterflies, grasshoppers, cockroaches, and cows could become an exciting batik motif. The fauna and flora motifs are distilled to be a flexible and beautiful shape.

Combination of animal and plant motifs. Animal and plant motifs rarely stand alone but combined. Animal motifs are the main ornament, and plants are the filler ornaments or vice versa. Most combined motifs are birds, and various plants arranged harmoniously as a whole design.

A combination of traditional motifs and new creations designs. Most of the existing motifs in the new batik creations designs are traditional motifs combined with new creation motifs, such as plants or animals. Traditional motifs that are often combined are various types of *parang*, *kawung*, and *lapis* (motifs or isen-isen that are arranged obliquely or straightly), which have been modified to be integrated with new creative motifs designs, such as animals or plants. Also, the combination of traditional motifs with ornaments or *isen-isen* is made by themselves according to the batik artisans' imagination (non-standardized ornament or *isen-isen*).

The combined motifs of traditional motifs and new creations are the common types of motifs created in Kliwonan batik; the other is abstract and wayang motifs. Those two motifs are produced when there is an order, possibly because those motifs are less attractive to the public.

Except for the existing motifs, there are also batik patterns that are pre-patterned batik motifs, namely batik motifs that are produced based on the fabric's texture that has been woven-designed. For example, woven or webbing without the same density results in a fabric with holes or textured protruding and forming distinctive patterns. This motif is often a geometrical shape such as a rectangular box, octagon, or zigzag lines such as a floral motif.

In new batik creation motifs, often on the main ornament, there are scratches along the edges of the ornament, called the granite motif. New creations of decorative batik are usually produced vary in colors, unlike traditional batik, which is color limited. The colors widely used in Kliwonan batik are red, brown, golden brown, black, gray, blue, green, orange, and violet. There is also a variety of new creations motif that is soga colored, usually used as a batiks' long cloth or shirt.

According to Mr. Sumarsono, the decorative motifs of new creations motifs did not have product names like traditional motifs. Certain rules do not bind their shapes. Even the *isen-isen* and coloring of batik are also freely according to the maker's imagination or the customer's wishes. Almost all batik isen-isen were used in new batik creation motifs. Some of *isen-isen* that are often used are various cecek, such as *cecek sawut, cecek telu, cecek pitu' pita, sawut, galaran, ukel, pacar, mrutu, and gringsing* (Interview on 5 June 2010).

Currently, no decoration or motif has been typical of Kliwonan batik motifs. The existing decorative designs are mostly based on modified traditional motifs. The ornament in the new creation motifs did not have specific meanings and names, as traditional motifs did

Traditional batik and new creations motifs

Traditional written batik motifs

There are many traditional written batik motifs in the Kliwonan area. Some traditional written batik motifs are often produced in Kliwonan batik areas because of high customer demand in the market. According to Thessa (22 years old), who is a staff of Batik Brotoseno, the traditional written batik motifs include (Interview on 17 May 2010):

Semen motif. For example, the *semen rama* motif. Based on the story, the *semen rama* symbolizes the loyalty of a wife. The motif is an image of animals and plants. The batik's *isen-isen* usually leaves pictures. The ornaments are sometimes in the form of stems and leaves. The color is usually black with white *isen cecek-cecek*. In addition, there is also a flame ornament and a row of dark brown leaves with black *isen sawut*. Other ornaments are in a series of floral images which are additionally ornaments to the *semen* batik motif, such as *semen rama, semen rante, semen gendong, semen bondet, semen baboon angrem, semen sida raja, semen naga raja, semen prabu, semen wijaya kusuma, semen klewer, semen nagasasra, and srikaton.*

Parang motif. The parang motif is classified as a traditional line-patterned batik. Consists of a composition of forms arranged lengthwise to form a line. The parang motif is often produced and is the most widely sold market. The parang motif consists of black base color on an ivory yellow ornament with dark brown contours. There is also a lot of white in the parang motif. The motifs of these parang include *parang rusak, parangkusumo* dan *parang baron*.

Truntum motif. The truntum motif is a line motif and is classified as a plant motif, which consists of a composition of flowers arranged in a row and parallel. Still, there are also pictures of small flowers interpreted as animals. Additional ornaments in the form of the white *cecek-cecek* blend to resemble the image of small seaweed flowers. The colors in the *truntum* motif are black, dark brown, light brown, and white.

Sidomukti motif. Sidomukti motif is a combination of plant motifs and animal motifs. Consists of bird wing ornaments, plants, and lines forming wavy oblique boxes. In a closer look, the ornaments are limited by wavy lines that resemble the shapes of crossed ropes or ropes. There are also *lung-lungan* ornaments or small leaves with *cecek-cecek*.

Sidomukti motif color consists of black, dark brown, light brown, and white. The color is black as the contour of the *lung-lungan* and the shape of the boxes and *sawats*. At the same time, the plant motif consists of stems of leaves and flowers contoured in black and dark brown. The ornaments on traditional batik motifs are sometimes different; some use butterflies and tongues of fire, but sometimes there are only *lung-lungan* and *sawat*.

Kawung motif. *Kawung* motifs consist of plant and line motifs. The leaf shape arranged in *Kawung* consists of a matching slanted line with a rectangular shape ornament and curved lines to adjust the shape of the leaf decoration. With isen *cecek-cecek putih* (white *cecek-cecek*) and small circles. Color consists of light brown, dark brown, or black, with white dominant.

Newly created batik motifs

The new (modern) handmade batik motif is a renewal of the traditional written batik motif. The renewals are being made to improve motifs, materials, colors, and marketing.

In Kliwonan batik, there are many new batik motifs. So many motifs are produced that the motif makers and

business owners cannot mention all the motifs that have been created. Usually, batik owners make motifs by combining ornaments, then reproduce and market them to customers. This new creation of written batik is sold more than traditional motifs because the patterns and motifs vary according to the times.

This new batik creation only consists of three motifs: animal, plants, and mixed motifs between animals and plants. According to Mr. Sumarsono, the drive that motivates the new creations motifs is as follows (Interview on 5 June 2010):

Animal motif. Animal motifs often used as modern batik motifs are birds with various backgrounds and traditional batik *isen* that have been modified and combined with new ornaments and creations according to the batik creator. The colors often used include gray, dark blue, light blue, yellow, black, dark brown, light brown, dark green, and light green.

Plant motifs. Plant motifs usually consist of stems, leaves, and flowers of *lung-lungan* that are arranged according to the inspiration of the batik creator. The stems, leaves, and flowers are usually drawn with *isen-isen*. Compared to traditional motifs, new creative motifs undergo rapid modification and development. The plant types are more varied. The leaf motifs include cashew leaves, shoe flowers, reeds, hibiscus leaves, guava, roses, and grasses. Plant motifs are an inexhaustible source of inspiration.

The colors used in the plant motifs include dark red, pink, dark green, light green, black, gray, dark brown, light brown, yellow, and a combination of the colors above.

A combination of animal and plant motifs. There are ornaments consisting of animal and plant motifs that are combined harmoniously. Plant motifs that are often used are flowers and small elongated leaves. On animal motifs, birds are usually in pairs. In Kliwonan batik, a combination of animals and plants is often produced because of customer preference compared to animal or plant motifs. This combined motif of plants and animals is more difficult and careful to make by designing and making. Those combined motifs must support the harmony of two different motifs therein.

The colors used are the same as in animal or plant motifs. According to Thesa, batik motifs' new creations appeared in the 1980s. Newly created batik motifs include *parang walang, gringsing kembang, parang kembangan, kawat rusak* (broken wire*), wiji pecah* (broken sesame seeds), and *wajik* (diamonds) (Interview on 17 May 2010).

The batik motifs' role, especially classical batik, is greatly determined by the visualization of the whole batik. The motifs on batik show the cultural background and its development. Batik in various regions has variations and types of patterns. The classification of classical batik motifs consists of *semen, parang, kawung,* and *ceplok*. In discussing classical batik motifs, their meanings cannot be separated by symbols on batik motifs themselves. As part of the Surakarta batik, the Kliwonan batik motifs are full of Javanese philosophical values.

Javanese philosophical values contained in Kliwonan batik

Semen batik motifs

The classic batik of Semen Surakarta is symbolism to show the worship of fertility and the order of the universe. There are many types of semen batik, such as *semen rama, semen cuwiri,* and *semen gendhong*. The main motif in *semen* batik is a tree or plant with roots and tendrils. The tree or plant is a sacred place for ancestral spirits, a place of meditation to purify oneself. The wings symbolize a legend or a warning of an event.

The pavilion is one of the important paintings in semen batik motifs. The small house is shaped with a triangular roof, sometimes accompanied by stairs or a walking place. It is considered a place of meditation to attain enlightenment. At the same time, the tendril symbolizes fertility and growth. This symbol is related to the Javanese philosophy of *nunggak semi*, which means creating new things from the old or the old (the connotation of regeneration or renewal). At the same time, the image of a bird is a symbol of heaven and God's living.

The intent and purpose of the *semen* classic batik are manifested and contained in the names of the batik itself. The aims and objectives could be different or varied, but in essence are the same, which means the core of the best attitude to life.

Batik motif "semen gendhong" (Figure 2)

Semen gendong batik means contained by the meaning of the "*gendhong"* itself. *Gendhong*, in the Javanese language, means "*burden*" or to burden. In general, the batik motif of *semen gendhong* has a meaning or to means that human lives are always burdened by various problems that never end. Through those various problems, people would deal with the burden of living and become the winners.

Semen gendhong batik has elements of supporting motifs, namely plant, temple, tree of life, wing, thrones, or buildings motifs. The motif of the throne or building symbolizes a just, protective, and wise power which symbolizes the honorable. The wing motif symbolizes the nature of might, masculinity, tenderness, and magic. The *meru* motif symbolizes the earth or earth element, which describes the process of life growing on the ground, called semi (growing). The temple motif symbolizes the seeds of life that are expected to be born or arrive by the motif that it carried (the wing-shaped motif), namely mighty, manly, gentle, and powerful. The tree of life motif symbolizes something sacred and majestic.

By functionality, the *semen gendong* batik motif, with its specialty symbolic meaning, is usually given by the mother to her daughter before marriage. This is intended for the bride could pass through various problems in her life while longing for the marriage household smoothly and wellness. All the burdens that are faced on her shoulders can be weighed down, resolved, and passed with victory.

The *semen gendong* batik motif has a deeper meaning, namely a hope that it is not only dealing well with a problem but is exceeding the best to be achieved. *Semen gendong* batik motifs could be used as daily clothing

because it means more widely in social life. The essence of the batik motif of *semen gendhong* has a deep meaning about human relations with various life problems. The purpose for all that is a hope to get through, face, and solve all problems well. The motif of Semen Gendong batik can be used for special events like a wedding reception or the first-time bride's meeting in ancient times. Also, the bride ceremony by their parents while returning to their own home.

Batik motif "semen rama" (Figure 3A)

The *semen rama* batik motif contains guidance. This batik motif was made during the period of Paku Buwana IV from 1787 to 1816. The motif of *semen rama* was to remind his son, who had been appointed as the crown prince, of his successor. Rama's semen-patterned batik was inspired by the story of Prabu Ramawijaya who discoursed to Raden Gunawan Wibisana, the younger brother of Prabu Dasamuka from Alengka, when he will inaugurate to become a king. The discourse is known as "*Hastha Brata*," a must-have leader attitude. The contents-teachings of "*Hastha Brata*" are as follows: (i) Indrabrata is teaching about dharma to provide prosperity and protect the earth which is symbolized in the form of plants or life, (ii) Yamabrata is a teaching to be fair to others which is symbolized in the form of mountains or clouds motifs depicting a high position, (iii) Suryabrata is a teaching of courage, not half-hearted in making policies like the sun which is symbolized in the form of eagle motif, (iv) Sasibrata means giving *papadhang* (enlightment) to those who are suffering from *pepeteng* (disaster/difficulties) which is simbolize in the form of animals, (v) Bayubrata is a teaching about nobility or highly manner attitude that does not emphasize power which is described in the form of "*iber-iberan*" or birds, (vi) Danababrata or Kuwerabrata which is the meaning of giving appreciation or grace to their society which is symbolized in the form of heirlooms, (vii) Barunabrata or Pasabrata contains the meaning of being forgiving, such as the breadth of the ocean or the "ocean-large of compassion" which is symbolized in the form of a dragon, boat or water-related motif, and (viii) Agni Brata has the meaning of supernatural powers to quell great-angry manner in order to protect the weak which is symbolized in the form of fire, tongue of fire or *cemukiran*.

In general, the symbolism of the *semen rama* batik motif has the means and use as the teaching of virtue. While virtue is deeply internalized, it will become the guide to obtaining the truth and achieving eternal happiness, as Pabu Rama exemplifies. The community will indirectly be reminded of lessons from the Ramayana story about Rama as a symbol of a perfect human body and soul that could be used as an example in everyday life.

The meaning of the "*semen rama*" batik is guidance to obtain the truth and could achieve eternal happiness, which Prabu Rama has exemplified. Hopefully, people are reminded of lessons from the Ramayana story about Rama as a symbol of a perfect human body and soul that could be used as an example in everyday life. Traditional ceremonies are used in the ruwatan tradition to remind participants that participants could be role models for themselves and their environment. In addition, Ruwatan participants could implement the Ramayana story in their everyday lives.

Another significance of the *semen rama* batik motif to the meaning of symbol or symbolism at the wedding of a pair of brides to become a couple, as Rama and Sintha alike. However, some people are reluctant to wear it at a wedding ceremony. Because they thought being afraid that their spouse would experience bad luck, like the goddess Sintha who Ravana kidnaped. There are also *semen rama* batik motifs that are used during deaths or funerals. The *semen rama* batik motif with a black background is often used for mourning.

Batik motif "semen naga raja" (Figure 3B)

Semen naga raja (semen dragon king) batik belongs to the middle category that developed during the reign of Paku Boewono IV at the end of the 18th century. The dragon depicts a large snake with a crown on its head, symbolizing peace. In comparison, the king shows a high position or sublime negligence as a symbol of power. The *semen naga raja* motif means maintaining peace in domestic life. This *semen naga raja* batik symbolizes peace in power, regulating and providing protection to the people on the love bases. Inside the Keraton, *semen* batik with a white background is worn by courtiers at regent and above ranks.

Batik motif "semen prabu" (Figure 3C)

Semen prabu name means a high position in one's social status/position. Contain the meaning of a request to achieve "*Kalenggahan luhur* (sublime social status)," which provides lifetime protection. Following the meaning of semen or bersemi (springing up) in the form of plants that live on earth, which can be "*ngayomi marang bumine* (protector to the earth)" or a symbol of prosperity.

Batik motif "semen wijaya kusuma" (Figure 3D)

The "*wijaya kusuma*" name is taken from an heirloom of flowers belonging to King Kresno in *wayang*. The meaning is beauty like a flower, which contains the power of carrying as a symbol of "panguripan (spirit of life)." The purpose of the *semen wijaya kusuma* motif is that humans have a beautiful or fulfilled life and a position that is respected in society. *Wijaya kusuma*'s batik includes white semen, used by the Regent's servants; it can be used by all social groups, young and old.

Figure 2. *Semen gendhong*

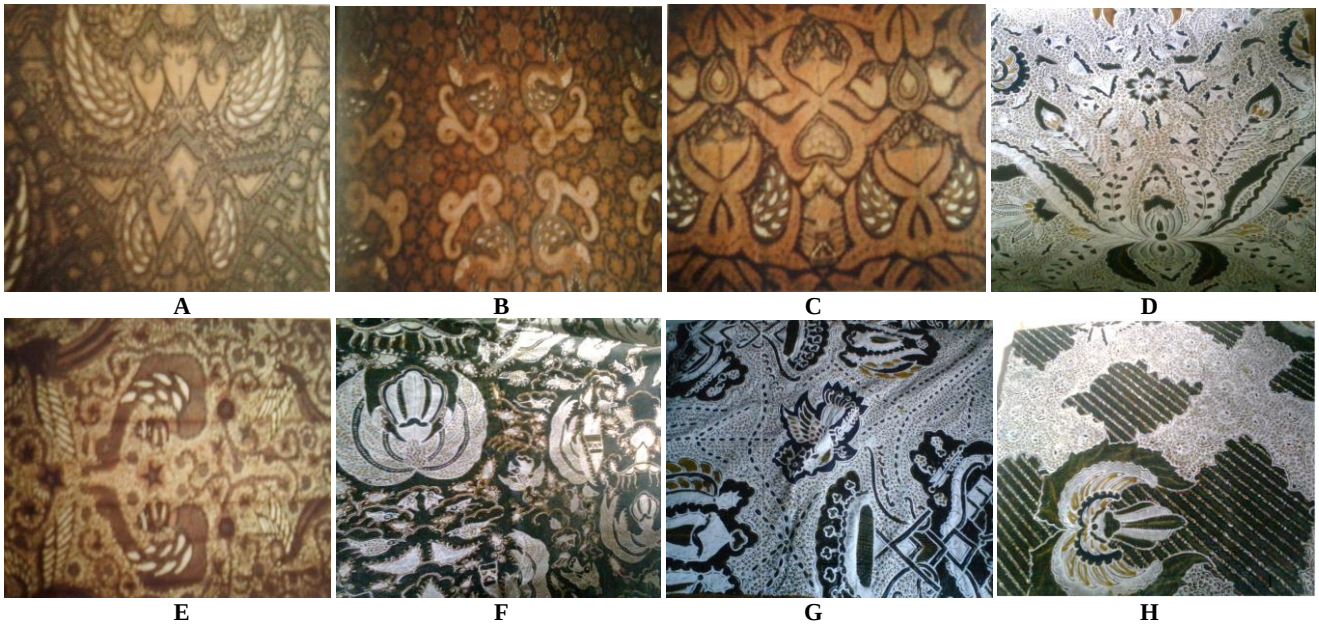

Figure 3. A. *Semen rama*; B. *Semen naga raja*; C. *Semen prabu*; D. *Semen wijaya kusuma*; E. *Semen nagasasra*; F. *Semen cuwiri*; G. *Semen rante*; H. *Semen buntal*

Batik motif "semen nagasasra" (Figure 3E)

Naga (dragon) means a big snake with a crown; taken back from Javanese philosophy, it symbolizes the guardian of peace, while *sasra* means a thousand. The purpose of the *Nagasasra* batik motif is to symbolize that many people participate in fortifying or maintaining the peace in the household. It can be used by all groups and ages and is a tool for traditional ceremonies.

Batik motif "semen cuwiri" (Figure 3F)

It is one of the small nuanced batik motifs. Therefore, the motif of *semen cuwiri* batik is small looked. The meaning of the *cuwiri* decoration is that the wearer of cuwiri batik is expected to have an appropriate look and harmony in nature.

Batik motif "semen rante" (Figure 3G)

This batik usually worn by the woman's family when welcoming an application. *Rante* which means chain is a symbol of a strong bond. It can be understood that if the application has been accepted, as a woman, we certainly want a close and strong relationship that cannot be separated.

Batik motif "semen buntal" (Figure 3H)

Buntal in Javanese tradition means an ornamental puff of layers such as banyan leaves. The *semen buntal* motif depicts a repellent against bad luck and the diversity of plants on earth. It means getting rid of the bad things, getting closer to the good things that come from outside, and bringing the subtle things closer. In society, *semen buntal* batik is worn by anyone, both young and old.

Batik motif "kusuma wibawa" (Figure 4A)

Kusuma means noble blood or noble life, whilw *wibawa* means "*kawibawan* (authority)". The meaning of batik *kusuma wibawa* is expected to achieve a dignified life and have authority over other people or society. Batik *Kusuma wibawa* belongs to the white background *semen* group and is commonly used by Regents. The *kusuma wibawa* motif developed during the SISKS Pakoe Boewana IV era in the late 18th century.

Batik motif "babon angrem" (Figure 4B)

The meaning of *baboon angrem* is a hen that is incubating eggs. The baboon angrem belongs to the "*semen*" category, which is classified as middle-class batik. The meaning contained in hope or request to be given offspring as a historical descendant. It is used for adults of any status. This type of black background semen has a large pattern, so it is unsuitable for children.

Batik motif "wahyu tumurun" (Figure 4C)

The *wahyu tumurun* batik motif contains hope and requests to get direction and guidance from Allah SWT and avoid suffering. *Wahyu tumurun* batik is worn by the bride during the *midodareni* event. In addition, it is also used by prospective mothers in the *siraman mitoni* ceremony with the intention that born tobe children could be strong "*kedunungan wahyu*" (received revelation) and kept away from all temptations and obstacles.

Batik motif "jamur sedupo" (Figure 4D)

Jamur sedupo is a kind of plant from the ground inside. *Jamur sedupo* batik means being a leader who could protect ordinary people (the humble).

Batik motif "sri katon" (Figure 5A)

Sri katon's motif is inspired by the Javanese philosophy, which contains the dharma of prosperity and protecting the earth with good hopes or goals. *Sri katon* batik wearers are expected to look beautifully attractive.

Batik motif "ratu ratih" (Figure 5B)

The *ratu ratih* (queen ratih) comes from the word Ratu Patih. Also, there is an interpretation as the white *tunjung* or the queen the Patih upholds at her young age. *Ratu ratih* batik contains a wishful meaning (*sesotya ing embanan*), manifested by a gold diamond ring. It is associated with a glorifying, personal majesty that can be adapted to its natural environment. *Ratu ratih* batik can be used by anyone from all groups and is good for banquets. Considering its name, *ratu ratih* batik appeared during the reign of Pakoe Boewono VI, when He was a young age, and accompanied by his patih in 1824 AD.

Batik motif "semen kakrasana" (Figure 5C)

Semen kakrasana batik is a new batik motif that emerged during the reign of Pakoe Boewana IX in Surakarta in the middle of the nineteenth century. Kakrasana is taken from the name of the puppet character, the nickname of King Baladewa, the son of King Mandura, namely Prabu Basudewa. The meaning of the *semen kakrasana* batik describes the determination to have a *kumala* or populist spirit. *Semen kakrasana* batik can be used by anyone in society, both the old and young.

Batik motif "semen klewer" (Figure 5D)

Semen klewer batik is classified as a young batik, which only developed during the Pakoe Boewana IX reign. The motif consists of the free plants hanging (*pating klewer*). It also describes fertility that leads to prosperity (loh jinawi). *Semen klewer* batik meaning is a hope to fulfill the clothing and food need, not always depend on their parents for their living. All society members can use *semen klewer*'s batik at any event.

Parang and _Lereng_ batik

Parang (machete) and *lereng* (slope) batik for the Surakarta Palace is an *ageman luhur* (nobble wearing) which means that it is only used by *Ageman dalem Sinuhun* (his majesty king) and Putra sentana dalem (his majesty son), and is prohibited for courtiers. Some argue that the "parang" name is identified with a sharp weapon as a machete or a kind of sword. In its considerations, the word "*parang*" is a synonym of the word "*pereng*," or the edge of a cliff in a "*lereng*" (curved slope edge). Supposedly, the slope on the highlands goes through the lowlands in a diagonal shape. Based on cliffs on the southern coast of Java picturesque, *Parangupito*, *Parangkusumo*, and *Parangtritis*.

The *Parang* name is closely related to the existence of *Ingkang sinuhun Panembahan Senopati (*His majesty Panembahan Senopati), the Mataram Kingdom founder, which moved the Javanese kingdom administrative center from Demak to Mataram. Mataram area is the location of "*teteki*," or the meditation of the first Mataram king. That inspired the emergence of *lereng or parang* motifs as the characteristic of Mataram ageman (Mataram wearing), which is different from the previous batik.

The *parang* batiks that had developed before the founding of Mataram-Kartasura kingdom were the *parang rusak, parang baron, parang rusak baron, parang kusuma, parang pamor,* and *parang klithik*. The "*lereng udan riris*" batik, appeared during the reign of Pakoe Boewana III in Surakarta in the mid-18th century.

Batik motif "parang kusuma" (Figure 5E)

Kusuma means flower, which is interpreted as the queen's blood, called royal blood. The *parang kusuma* batik motif only existed during the reign of *Ingkang Sinuhun Panembahan Senopati*, the founder of the Mataram Kingdom in the 16th century. As the name implies, the *parang kusuma* motif has only been used by the descendants of the *Ingkang Sinuhun Mataram pancer* (straight-lined blood) generations.

Batik motif "parang barong" (Figure 5F)

This *parang* motif applies the mlinjon decorative arrangement derived from the mlinjo (*Gnetum gnemon*) word. The mlinjo plant is very popular because it can be utilized in all plant parts. Rocks symbolize hardness and steadfastness. Thus, the parang baron batik meaning is to become a strong and populist leader.

Batik motif "parang gondosuli" (Figure 5G)

In this motif, *parang* means coral, and *gondosuli* is a type of flower name. The *parang gondosuli* motif depicts violence/power with good intentions. The rock symbolizes the hardness and determination of everyone who has a steadfast personality.

Batik motif "parang pamor" (Figure 5H)

Parang pamor batik is the early parang batik motif, which was included in Mataram Kuthagedhe's reign in the sixteenth century. *Pamor* (prestige) means emitting light or radiant. In kris terms, *pamor* is a mixture of wilahan-making materials in the form of a design that exudes beauty and brings "*daya perbawa*" (authority power). Likewise, in *parang pamor,* batik symbolizes the ageman luhur (noble wearing) who has "*perbawa*" (authority) and "*wibowo*" (authoritative).

Figure 4. A. *Kusuma wibawa*; B. *Babon angrem*; C. *Wahyu tumurun*; D. *Jamur sedupo*

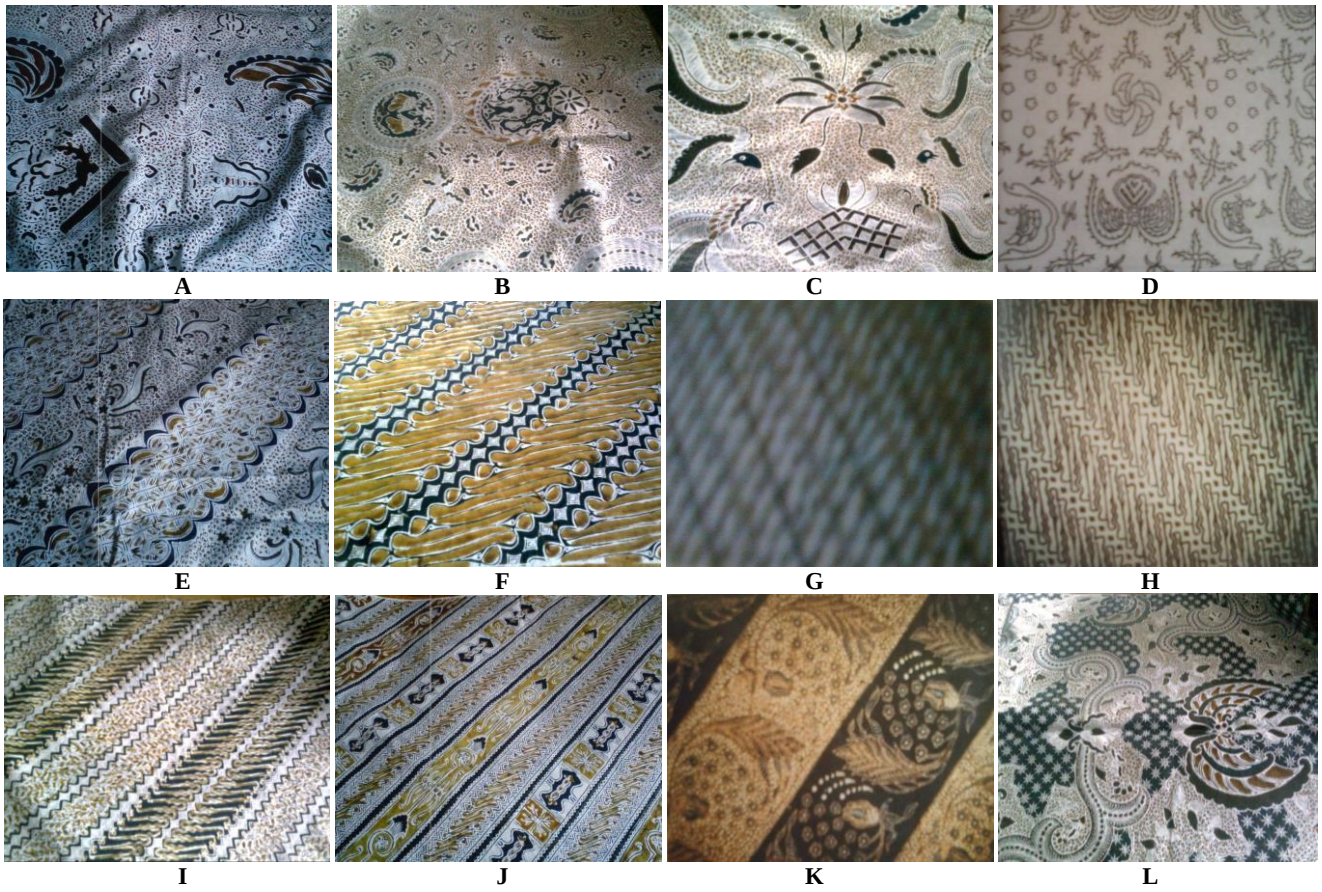

Figure 5. A. *Sri katon*; B. *Ratu ratih*; C. *Semen kakrasana*; D. *Semen klewer*; E. *Parang kusuma*; F. *Parang barong*; G. *Parang gondosuli*; H. *Parang pamor*; I. *Parang rusak*; J. *Lereng udan riris*; K. *Sari ngrembaka*; L. *Truntum*

Batik motif "parang rusak" (Figure 5I)

This batik motif was originally used only by the palace circles; now, it is generally used. This *parang* motif is classified as a motif arranged in slanted or diagonal lines.

Parang (machete) means a sharp weapon bigger than a knife but smaller than a sword. *Rusak* (damaged) means to perish, bad, and irregular. *Parang rusak* describes a row of machetes in irregular slanted lines. The "*parang rusak*" batik motif means that human life is not lasting or eternal. Everything depends on the will of God Almighty. This means that humans are expected to keep doing and trying in everyday life. This motif is used by the *sentana dalem* (His Majesty's son) or the royal family. This motif is used only by people who still have descendants from the king of Mataram. According to the belief that the making of this parang batik motif could not be mistaken or made just once (one-way ticket). When there are mistakes in production, then the magical power will loose.

The *parang* batik's meaning is giving nobility to the wearer. So in the *ruwatan* traditional ceremony, the treated people are expected to have nobility in dealing with life in the world. Another intention of this *parang* batik motif is a symbol to reject interference.

Batik motif "lereng udan riris" (Figure 5J)

The background of the *udan riris* motif making concerns Pakoe Boewana III. After the Giyanti agreement, Mataram was divided into Surakarta and Yogyakarta. The governance condition was not established yet, but many civil service improvements were needed. By the time

Pakoe Boewana III practiced *teteki*, one of which was kungkum or bathing in the Premulung River, Laweyan village, which flows near the ancestral grave of Kyai Nis (ki Ageng Pemanahan's parents). This Teteki Pakoe Boewana III is illuminated with *lampu teplok* (kerosene lamp). Suddenly rains started to drizzle, and the wind blew, which inspired him to create a batik motif which was later namely "*udan riris."*

Udan riris batik has the meaning to symbolize fertility or lead to prosperity. According to the Surakarta palace, the parang (machete) and lereng (slope) batik were only worn by the king's relatives. This has been passed down for generations as the shape is slanted diagonally from top to bottom, symbolizing Mataram lineage where Panembahan Senapati is the founder.

Batik motif "sari ngrembaka" (Figure 5K)

Batik *sari ngrembaka* motif is defined as a sweet taste development. *Sari* is defined as a developing child or offspring. *Sari ngrembaka* Batik is classified as "*glebagan*" with a slope of a white feature and a black background. *Sari ngrembaka* batik contains the philosophy that human life will not be separated from padhang (light) and peteng (dark), happiness, and difficulties, but should always get a sweet or harmonious living.

***Ceplokan* batik**

The meaning of *ceplokan* is a flower, usually used to refer to a unit of flowers. For example, *saceplok*, which means a unit of flowers. The *ceplok* batik motif is related to kejawen philosophical beliefs. This motif meaning basis is the concept of power which is believed to arise from the universe, apart from human power.

The ceplok batik motif symbolizes that the king' is a symbol of world power. The king, as a means of giving revelation, is realized by giving the rank of position to his people. The king is a protector through the enforced law. The motifs are depicted, which meet in four meeting points in the form of a rhombus, as a symbol of the king surrounded by his assistants called "*Pancaniti*." The king is pangarsa (judge), patih as a prosecutor, poet as a clerk, senapati, and ulama as the basis for decisions balancing harmony. In the Javanese philosophy, those four points of matter represent the universal energy, which is also called *purwa, daksina, pracina,* and *untara*. *Purwa* means east which is associated with the rising sun, which means the beginning of everything. *Daksina* means south. *Pracima* means west which symbolizes the sunset. *Untara* means north which symbolizes the end of life in the world. Those four directions in Javanese culture are called "*pat ju pat*" or "*macapat*."

The *ceplok* motif has the meaning of "power." The interpretation of this symbolism is inspired by the concept of power in the four main ornaments and a single point in the middle of the *ceplok* motif. The king's power over his people is inspired by the shape of the *ceplok*, which is the central point in the middle of the main ornament. The four oval circles motif symbolizes the people that always surround and protect the king.

The power of *Sang Hyang Jagadnata* (God the ruling) also could be inspired by the center point in the middle of the motif. This means that Javanese society believes that Sang Hyang Jagadnaga is the center of every living thing, including human life. While the four main ornaments are the symbolism of all living things and their breath outlined by Sang Hyang Jagadnaga, the human discretion from birth to death.

Batik motif "Truntum" (Figure 5L)

Truntum's batik motif is in kembang tanjung (mimusops elengi / cape flower) batik type with a black background. Some interpret it as the word *truntum* or the re-emergence of love or the re-establishment of an agreement between husband and wife. *Truntum* batik illustrates that there are always two kinds of humans living, namely *bungah-susah* (happy-sad), *padhang-peteng* (enlightenment-darkness), *suami-istri* (husband and wife), *siang-malam* (day and night). As the "*kembang tanjung latar ireng*" (cape flower with black background) "depicts the stars in the night sky. That humans will not be separated from "*pepeteng*" (darkness), even if only "*sagebyaring lintang*" (a flick of starlight or little) may be given "pepadhang (light). Truntum batik is the foundation of Kangjeng Ratu Kencana or better known as Kangjeng Ratu Beruk, prameswari dalem (her majesty) SISKS Pakoe Boewono III.

Truntum is a "*sinjang manton*" batik cloth, which means batik cloth used in traditional wedding or wedding ceremonies. Considering the traditional wedding are a big celebration for the Javanese people, an ordinary batik cloth could not be used in that ceremony. Truntum batik is used in wedding ceremonies as one of the *ubarampe paningset* (wedding gifts).

During the wedding ceremony, the bride and groom's parents wear Truntum batik cloth with a *sabuk kemben* and *sindur* which symbolize hope for eternity in fostering brotherhood between the bride and groom parents'. The good relationship that continues to grow is the base of the continuity of brotherhood, as *truntum*'s meaning is to grow.

Truntum batik motifs' meanings are considered very important, namely: (a) *Truntum* batik motifs can give a sense of beauty from a harmonious and perfect combination of colors contained, and (b) *Truntum* batik motifs provide an understanding of the word "*tumaruntum*." The truntum motif pattern meaning of symbolizes advice that parents must always guide their children so they can handle family problems smoothly and have an adaptable life to society.

From another perspective, the truntum motif depicts the arrangement of the small cape flower on a plain black background, as if the truntum motif depicts stars in the night sky. This symbolizes the dark time of their child's preparation and marriage ceremony. Hopefully, there will be enlightenment from relatives and neighbors in the moral assistance and material support so that the wedding ceremony runs smoothly without any obstacles. The *truntum* motif also glorifies the Javanese people who perform wedding ceremonies, such as the flower cape fragrance in bloom (Sarwono 2008).

Batik motif "satriya wibawa" (Figure 6A)

In Javanese teachings, this type of "*ceplokan*" batik motif, in its rectangular shape with a center middle point, is the concept of power which symbolizes "king" as a means to give the revelation. The "*satriya wibawa*" batik means a young person with high authority. To carry out justice assisted by four *priyagung* called "*pancaniti*." The *satriya wibawa* has shown "authority," whose character is calm and wise.

Satriya wibawa Batik is commonly used in the *Ruwatan* ceremony. Thus, the *Ruwatan* traditional ceremony participants are expected to have high authority daily. Besides that, the ruwatan participants could avoid the *sukerta* that existed. Everyone, both young and old, can use it.

Batik motif "ceplok sriwedari" (Figure 6B)

The Sriwedari name symbolizes a beautiful and attractive garden that could make fall in love so that it can captivate someone to get rid of boredom in everyday life. *Ceplok sriwedari* batik has the meaning to be able to create coolness and peace for the family wearing it. *Ceplok sriwedari* batik can be used by all status groups in society who are married.

Batik motif "ceplok prabu anom" (Figure 7A)

Ceplokan is a cup of flowers, usually referred to as a flower unit. *Ceplokan* means a rectangle with a central point in the middle. In Javanese teachings, the concept of power symbolizes the "king" as a means to give revelation. To carry out justice assisted by four priyagung called *pancaniti*. Prabu Anom means a high position by someone, with the hope that he will become a person who has a high position and his name popular, which smells like a flower.

Batik motif "ceplok ukel" (Figure 7B)

It consists of a box with a *ukel* pattern, which depicts the life of *Jagad Gede* (the big world), and another box with a *lung* pattern, which depicts Jagad Cilik (the small world). This means that becoming a king (leader) requires support from various parties.

Batik motif "sido mukti" (Figure 7C)

Sido means continuous, and *mukti* means a life of contentment and happiness. *Sido mukti* batik symbolizes the hope of a good future and eternal happiness for the bride and groom.

Batik motif "sidoluhur" (Figure 7D)

The *sido luhur* motif is inspired by the Javanese philosophy of life. *Sido* in Javanese means to be or becoming, while *luhur* means noble. So the sido luhur motif symbolizes the glory and nobility of the wearer's character.

Batik motif "sidomulyo" (Figure 7E)

"Sido" in Javanese also means finished or continuously, while *mulyo* means noble. Batik cloth with a *sidomulyo* motif is commonly used by the bride and groom in marriage; both men and women hope that later in life, if there are difficulties, then with prayers and good efforts, those difficulties will be overcome so that the bride and groom remain as spouses (*sido*) that awarded glory. It symbolizes a sincere and noble prayer for the recipient as a gift.

Batik motif "sido asih" (Figure 7F)

The *sido asih* motif is worn by the groom and the bride at a reception or wedding ceremony. This motif is also worn during the "*mitoni*" ceremony. *Asih* means love, so it is hoped that the Sido Asih batik wearer is always full of love in their marriage.

Batik motif "wirasat" (Figure 7G)

Wirasat means a symbol associated with a request. This batik is a renewable pattern from *sidomulyo,* containing various batik patterns, such as "*batik cakar, truntum, sido luhur,* and *sido mulya*." *Wirasat* batik means that all requests to Allah SWT are granted, achieve a high position, and could be fulfilled their need materially independently. Also, a request for guidance from God while in the darkness to be given an enlightenment pathway.

Wirasat batik emerged at the same time as batik *sidamukti,* namely during the reign of Paku Boewana IV in the 1800s. At first, *wirasat* batik was only worn by the elderly, but in its society, renewal is often used by the bride and groom's parents in the *mbesan* ceremony. The geometrically patterned batik motifs such as *sido luhur, sido mukti,* and *wirasat* are related to Javanese beliefs. The *kejawen* base belief is the concept of power, which is believed to arise from the universe, apart from human power.

The geometric pattern of batik symbolizes the king as a world power symbol. The king is a means of giving revelation, which is realized by giving the rank of position to the king's people. The king is also a protector through the enforced law. *Wirasat* batik is worn at the reception.

Batik motif "grompol" (Figure 7H)

Batik "Grompol" means "*nglumpuk*" (to become one), a drive for the community to be able to "*keklumpuk*" (to unite). The point is to teach to like "*anggemeni*" when there is something big or a lot because of little by little. Besides, the meaning of "*nglumpuk*" itself means harmony with relatives and others. The Grompol motif belongs to the *ceplok* batik group used by the Panewu or Mantri servants and the downward.

Batik motif "bokor kencana" (Figure 7I)

Bokor is usually for watering flowers means as a complementary to the ceremony. *Kencana* means gold. The *bokor kencana* batik motif is taken from the king's ceremony equipment. When the king sits on the throne, he is always accompanied by equipment called the *ampilan* ceremony, which is brought by the king's little sons or grandsons. The little son or grandson of the king is called *jaka palara-lara,* which means he is still learning manners.

The *bokor kencana* batik meaning of a hope that will bring authority and majesty so that it is respected in the community. Bokor Kencana batik could be used by all societies rank, both young and old. The *bokor kencono*

motif emerged during the reign of Pakoe Boewana IX at the end of the 19th century and belonged to *gagrak anyar* batik (newer batik pattern motif).

Batik motif "madu bronto" (Figure 7J)

Batik *Madu Bronto* is worn during offerings at wedding ceremonies. *Madu bronto* means sweet love like honey. So by wearing a *madu bronto* batik motif, it is hoped that the romantic relationship of the bride and groom would last sweetly.

A **B**

Figure 6. A. *Satriya wibawa*; B. *Ceplok sriwedari*

A **B** **C** **D**

E **F** **G** **H**

I **J** **K** **L**

Figure 7. A. *Ceplok prabu anom*; B. *Ceplok ukel*; C. *Sido mukti*; D. *Sidoluhur*; E. *Sidomulyo*; F. *Sido asih*; G. *Wirasat*; H. *Grompol*; I. *Bokor kencana*; J. *Madu bronto*; K. *Sekar jagad*; L. *Batik kawung*

Batik motif "sekar jagad" (Figure 7K)

"*Sekar jagad*" means "*kusumaning*," the earth's life. The meaning is expected to be a "*pinunjul*" person with the noble character of pakarti utami (great expertise). *Sekar jagad* batik developed at the end of the 18th century in Surakarta. It could be used for all social groups and traditional ceremonies.

Batik motif "batik kawung" (Figure 7L)

The *kawung* batik is a motif composed of a round, oval or elliptical shape. The arrangement extends to a diagonal line sloping to the left and the right, alternatingly. According to several sources, the origin of the *kawung* name is taken from the *kawung* fruit, namely from the *kawung* tree or sugar palm. *Kawung* batik has a rectangular geometric shape. In the Javanese culture, "*kawruh*" symbolizes the teaching of "*sangkan paraning dumadi*" or teaching about the occurrence of human life, which is associated with "*sedulur sekawan gangsal pancer*," which always protects Javanese human lives. Four motifs are symbols of brotherhood which are four, and one dot motif in the middle is considered the central power of the universe as well as a symbol of the people's unity, nature, and belief to serve the king, who is considered the incarnation of a god who is the central world power. The batik motif is taken from *kolang-kaling* (sugar palm fruit) also implies that humans always have to remember God, and this life returns to its beginning in nature.

In the *kawung* motif, the ornament consists of four symmetrical circles surrounding small ones that symbolize the central power's four energy source directions. The four sources of energy are (i) east, symbolizing the rising sun, which is the source of life's energy on earth, and (ii) west, sunset, symbolizing the descent of luck because there is no longer a source of energy for all life, (iii) south is the zenith, which is the peak of everything, and (iv) north, representing the place of death.

Kawung batik has a special symbolic meaning in Javanese philosophy and Old Javanese governance, namely the concept of harmony in life between the world and heaven. The meaning implied in the ruwatan ceremony is an expectation that the person is treated with a firm determination and understanding of the whole in a sequence. Remind people always to remember God and maintain togetherness and brotherhood as long as they live in the world. *Kawung* batik, taken from the *kolang kaling* fruit, implies that humans are always aware of God. The *kawung* name means that this life will return to the realm of *suwung* (non-existence).

Based on the research, it can be understood that batik motifs initially had a very large influence on the degree and existence of the wearer. In various regions of Java, there have been differences in the batik motifs creation. For the Javanese, the batik motif is one of the life completeness, which has a special meaning. That relates to spiritual matters to bring enthusiasm and hope for future happiness. Classical batik motifs contain philosophical values that reflect the past knowledge generations. The role of the batik motifs, especially classical batik, will greatly determine the visualization of the whole batik. The batik motifs could be shown the cultural background and its renewal development.

REFERRENCES

Djoemena NS. 1990. Ungkapan Sehelai: Its Mystery and Meaning. Djambatan, Jakarata. [Indonesian]

Dwiyanto D, Nugrahani DS. 2000. Perubahan konsep Gender Dalam seni Batik Tradisional Pedalaman dan pesisiran. Pusat Studi Wanita Universitas Gadjah Mada, Yogyakarta. [Indonesian]

Honggopuro K. 2002. Batik Sebagai Busana Dalam Tatanan dan Tuntunan. Yayasan peduli Keraton Surakarta Hadiningrat, Surakarta. [Indonesian]

Sarwono. 2008. Hermeneutik Simbolisme Motif Parang dalam Busana Wayang Kulit Purwa Gaya Surakarta Etnografi: J Budaya Etnik 5 (6): 56-65. [Indonesian]

Septiana U, Sarwono.2018. Study of traditional batik decorative patterns in Bakaran Village, Pati District, Indonesia. Asian J Ethnobiol 1: 91-101. DOI: 10.13057/asianjethnobiol/y010205.

Suranto. 1995. Etos Kerja Buruh Wanita Batik Tulis di Pedesaan (Studi Kasus Buruh Batik Tulis di Desa Kliwonan, Kecamatan Masaran, Kabupaten Sragen). Fakultas Sastra dan Seni Rupa, Universitas Sebelas Maret, Surakarta. [Indonesian]

Surianawati R. 1997. Prospek dan Perkembangan Batik Tulis Brotoseno di Desa Kliwonan, Kecamatan Masaran, Kabupaten Sragen. Fakultas Keguruan dan Ilmu Pendidikan, Universitas Sebelas Maret, Surakarta. [Indonesian]

Susanto S. 1980. Seni Kerajinan Batik Indonesia. Balai Penelitian dan Pengembangan Batik dan Kerajinan, Yogyakarta. [Indonesian]

Sutopo. 2002. Metodologi Penelitian Kualitatif. Universitas Sebelas Maret Press, Surakarta. [Indonesian]

Toekio S. 1987. Mengenal Ragam Hias Indonesia. Angkasa, Bandung. [Indonesian]

Yayasan Harapan Kita. 1997. Indonesia Indah Buku Ke 8 “Batik”. Yayasan Harapan Kita, Jakarta. [Indonesian]