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Identification of poisonous plants and their solutions for traditional livestock in Bojonegoro District, East Java, Indonesia

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Abstract. *Pratama AM, Herawati O, Nuranisa NR, Hanifah N, Wijayanti AD, Rahmatullah S, Nurani E, Budiyanto A. 2021. Identification of poisonous plants and their solutions for traditional livestock in Bojonegoro District, East Java, Indonesia. Biodiversitas 23: 446-452.* Local farmers in Bojonegoro District use plants as the main food source and to treat several diseases for their livestock. However, they also comprise a large variety of poisonous plants known by a secondary chemical compound that causes death in the livestock. This study aims to identify the potentially poisonous plants to livestock and their veterinary importance. The study was conducted by interviewing local farmers as we require data as a source of information to provide an overview of their knowledge and experience about poisonous plants that can endanger livestock health. Respondents consisted of 40 local farmers from more than 20 livestock groups in Bojonegoro District. Data were analyzed by Frequency of Citation (Fic), Relative Frequency of Citation (RFC), Frequency of Plant Part (FPP), Symptoms of Poisonous Plants Frequency (SPPF), Livestock Affected Frequency (LAF). A total of nine plants were identified and documented to have poisonous effects on livestock animals, namely leaf of lophatheri (*Lophatherum gracile*), leaf and tuber skin of cassava (*Manihot esculenta*), leaf of jack bean (*Canavalia ensiformis*), leaf of sorghum (*Sorghum bicolor*), leaf of Chinese albizia (*Albizia chinensis*), leaf of sweet potato (*Ipomoea batatas*), leaf of peanut (*Arachis hypogaea*), rotten fruit of (jackfruit *Artocarpus heterophyllus*), and leaf of winged bean (*Psophocarpus tetragonolobus*). Leaf of *Lophatherum gracile* was the most poisonous plant part for livestock. Furthermore, the leaves of plants are frequently poisonous. Bloating, hypersalivation, frothy mouth, death, and inappetence were among the frequently manifested signs by poisoned livestock. Moreover, this study showed that ruminants species were the most susceptible to poisoned animals. Improper handling of plants for animal feed is thought to trigger poisoning. Therefore a proper feeding preparation is needed before being given as forage. Although those plants can cause toxic effects on livestock, they have tremendous potential to become herbal medicine with the proper formulation.

Keywords: Bojonegoro District, identification, poisonous plants, solutions, traditional livestock

INTRODUCTION

Traditional livestock in the Bojonegoro District has the advantage of exploiting grass, leaves, and plants waste as the main source of forage. Some of them are used as natural medicines to cure several diseases in livestock such as digestive, respiratory, skin disorders, and lactation (Pratama et al. 2020). However, not all plants benefit, because some of them contain compounds that are toxic if given continuously and excessively or are not processed before being given to livestock. Plants produce secondary chemical compounds such as alkaloid, oxalates, glycosides, nitrate, nitrite, sap, and cyanide (hydrocyanic acid, prussic acid) which are the main factor of poisoning in livestock (Gao et al. 2013; Leong et al. 2017; Serrano 2018; Welch et al. 2018; Green et al. 2019). There are many indications for the poisonous plant, the most obvious cases involve the sudden onset of disease in a group of animals (Kebede et al. 2015). The incidence of poisoning caused by poisonous plants is usually ingestion of material eaten along with grass, the introduction of grazing into new areas with different plants, grazing on newly meadow fires, consumption of contaminated hay, developing a taste for certain plants despite their toxicity and unpalatability, and most frequently occurs during unfavorable conditions when pastures are poor due to drought while most poisonous plants remain green all the year round (Kebede et al. 2015; Penrith et al. 2015).

Cases of poisoning in livestock often have an impact on decreasing livestock productivity, such as animals experiencing diarrhea, bloat, allergy, abortion, and death. These certainly result in a decrease in the economic value

of livestock, causing losses of economic benefit to farmers. For example, in the western region, the United States livestock industry loses over 500 United States Dolar (USD) annually from death losses and abortions due to poisonous plants. About 600 plant species are known to cause livestock poisoning resulting in annual losses in South Africa (Penrith et al. 2015; Welch et al. 2018). In Indonesia, a case reported in East Kalimantan where 26 deaths of etawa goats is a result of HCN poisoning after consuming *angrung* (*Trema orientalis* (L.) Blume*)* (Yanuartono et al. 2019).

Currently, there is no accurate information about the incidence of livestock poisoning caused by eating poisonous plants in the Bojonegoro District. Many local farmers complain that their livestock always dies quickly if they accidentally consume poisonous plants, and this happens frequently. The main causes of poisoning of livestock caused by poisonous plants are lack of knowledge of local farmers to identify toxic plants and process plants for forage. Meanwhile, lack of knowledge transfer from elders to younger local farmers and no documentation reports are other major contributing factors to losing the livestock.

This study is conducted to collect data of various poisonous plants that cause poisoning in livestock in Bojonegoro District to become scientific information for handling and preventing poisoning livestock in the future. The loss of local farmers due to the death of their livestock can be avoided. This study can also be used as a reference for further research of finding safe animal feed from plants and developing safe, efficacious, and appropriate herbal medicines from poisonous plants.

MATERIALS AND METHODS

Study area

The study area was located in Bojonegoro District, East Java, Indonesia (Figure 1). The area consists of 2,307.79 km² and has more than 4,520,797 livestock population (ruminants and poultry farms) (Dinas Peternakan dan Perikanan Bojonegoro 2021). A number of 1,313,722 inhabitants who living in the Bojonegoro District, around 39.52% work in agriculture and animal husbandry (Badan Pusat Statistik Kabupaten Bojonegoro 2018).

Ethical rules

There are no specific regulations governing research on ethnotoxic plants in Indonesia. The respondents knew the purpose of this study and were willing to be informants. Participants were also allowed to suspend the interview or refuse to answer questions at any time.

Data collection

The study was conducted by interviewing local farmers between July and August 2020 using semi-structured questionnaires and a random sampling method following the study of Pratama et al. (2021). The study requires data as a source of information to provide an overview of the knowledge and experience of local farmers about poisonous plants that can endanger livestock health, then compared with literature. The data were obtained from local farmer interviews, including local name, plant part, clinical sign, source of a poisonous plant, and species of animal affected. Searching for supplementary information in the form of scientific names of poisonous plants and the conservation status was also carried out on powo.science.kew.org, theplantlist.org, and www.iucnredlist.org. The data was processed using a data recorder, then summarized and arranged into Microsoft Excel tabular form.

Data analysis

Calculating of Frequency of Citation and Relative Frequency of Citation analysis followed the method used by Faruque et al. (2018):

$$\text{Frequency of citation} = \frac{\text{number of times a particular species mentioned}}{\text{total number of times that all species mentioned}} \times 100$$

$$\text{Relative frequency of citation (RFC)} = \frac{\text{Frequency of Citation}}{\text{total number of informants participating in the survey}}$$

The Relative Frequency of Citation index ranged from "0" when nobody referred to a plant as effect causing poisoning to "1" when all informants referred to a plant as effect causing poisoning.

To analyze the plant part that is most commonly mentioned to cause poisoning in livestock, the following formula was used:

$$\text{Relative of plant parts (FPP)} = \frac{\text{sum of the mentioned poisonous plant parts}}{\text{total number of poisonous plant species mentioned}} \times 100$$

The frequency of symptoms of poisonous plant poisoning in livestock was analyzed using the following formula:

$$\text{Symptoms of poisonous plant frequency (SPPF)} = \frac{\text{sum of the symptoms}}{\text{total number of poisonous plant species mentioned}} \times 100$$

To determine the percentage of Livestock Affected Frequency, we employed the following formula:

$$\text{Livestock affected frequency (LAF)+} \frac{\text{sum of the livestock species}}{\text{total number of poisonous plant species mentioned}} \times 100$$

RESULTS AND DISCUSSION

Ethnotoxic plant

We interviewed 40 local farmers representing more than 20 livestock groups in Bojonegoro District. The data

of scientific name, local name, poisonous part, clinical signs, species affected, and source completely are provided in Table 1. A total of nine plants were identified and documented to have a poisonous effect on livestock. The source of the poisonous plant was found in the wild, riverbank, fields (rice, corn, sorghum, fruit), and forests. According to Frequency of Citation (FC), we found that *Lophatherum gracile* was the most often causes of poisoning in livestock with 3.33%, followed by *Manihot esculenta* (2.67%), and *Canavalia ensiformis* (1.22%) (Table 2). Relative Frequency of Citation index revealed that the top three poisonous plants were the same species as Frequency of Citation. Leaves were the major plant parts that caused poisoning in the livestock as these parts are easily accessible and frequently fed to animals, followed by tuber, grass, and rotten fruit (Table 3), while Table 4 revealed that bloat (0.89%) was the frequently manifested symptom of poisoned livestock, followed by frothy mouth (0.78%), and death (0.67%). Moreover, this study showed that the most frequently poisoned animals were bovine (100%), followed by caprine (0.67%), ovine, and poultry (0.22%) (Table 5). Based on the examination of conservation status, the nine poisonous plants that are toxic to livestock are not classified as endangered.

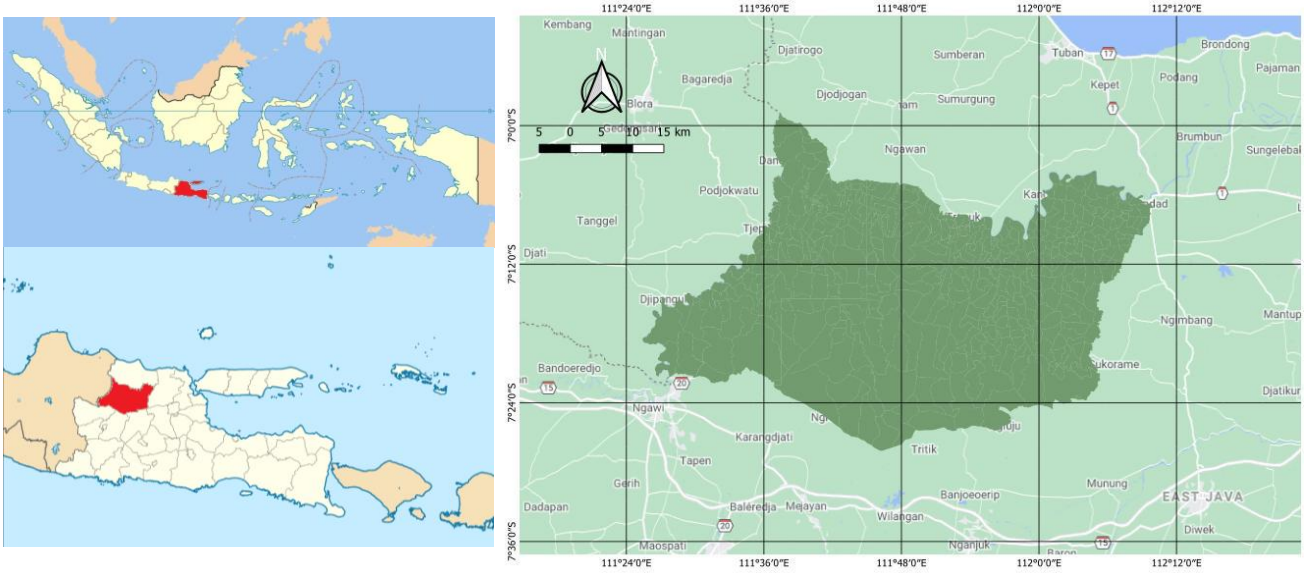

Figure 1. Map of Bojonegoro District, East Java Province, Indonesia

Table 1. Ethnopoisonous plant that causes poisoning in livestock in Bojonegoro District, East Java Province, Indonesia

Family	Scientific name	Local name	Plant part	Clinical signs	Species affected	Source
Convolvulaceae	*Ipomoea batatas* (L.) Lam.	*Ketela rambat*	Leaf	Abortus, infertile	Bovine	Field
Euphorbiaceae	*Manihot esculenta* Crantz	*Ketela daplang*	Leaf, tuber skin	Bloat, convulsion, dyspnoea, hypersalivation, intoxicated, rolling	Bovine, caprine, ovine, poultry	Field
Fabaceae	*Albizia chinensis* (Osbeck) Merr.	*Sengon*	Leaf	Bloat, exophthalmos, noisy	Bovine, caprine	Field, river bank
	Arachis hypogaea L.	*Kacang tanah*	Leaf	Anorexia, bloat, death	Bovine	Field
	Canavalia ensiformis (L.) DC.	*Koro*	Leaf	Anorexia, bloat, death, rolling	Bovine, ovine	Field, forest, river bank
	Psophocarpus tetragonolobus (L.) DC.	*Kecipir*	Leaf	Bloat, death, frothy mouth	Bovine, caprine	Field
Moraceae	*Artocarpus heterophyllus* Lam.	*Nangka*	Rotten fruit	Bloat, frothy	Bovine, caprine	Field
Poaceae	*Lophatherum gracile* Brongn.	*Rayung, rumput bambu*	Leaf	Bloat, convulsion, dyspnoea, rolling, weakness	Bovine, caprine, poultry	Field, river bank
	Sorghum bicolor (L.) Moench	*Jagung cakul, cantel*	Leaf	Bloat	Bovine, caprine	Field, river bank

Notes: Field: rice, corn, sorghum, and fruit; Forest: teak forest; Riverbank: alongside river, stream, and ditch

Table 2. Frequency of citation and relative frequency of citation index

Scientific name	Freq. of citation (%)	Relative freq. of citation (%) index
Lophatherum gracile Brongn	3.33	0.083
Manihot esculenta Crantz	2.67	0.066
Canavalia ensiformis (L.) DC.	1.22	0.030
Sorghum bicolor (L.) Moench	0.44	0.011
Albizia chinensis (Osbeck) Merr.	0.22	0.005
Ipomoea batatas (L.) Lam.	0.22	0.005
Arachis hypogaea L.	0.11	0.002
Artocarpus heterophyllus Lam.	0.11	0.002
Psophocarpus tetragonolobus (L.) DC.	0.11	0.002

Table 3. Frequency of plant used part

Parts	Frequency of parts (%)
Leaf	0.78
Tuber	0.11
Grass	0.11
Rotten Fruit	0.11

Table 4. Symptoms of poisonous plants frequency in livestock

Indication	Frequency (%)
Bloat	0.89
Frothy mouth	0.78
Death	0.67
Anorexia	0.44
Exophthalmos	0.44
Hypersalivation	0.44
Noisy	0.44
Rolling	0.33
Weakness	0.33
Convulsion	0.22
Dyspnoea	0.22
Abortus	0.11
Infertile	0.11
Intoxicated	0.11

Table 5. Livestock affected frequency

Species affected	Frequency (%)
Bovine	100
Caprine	0.67
Ovine	0.22
Poultry	0.22

Note: Bovine: cattle and dairy cow; Caprine: goat; Ovine: sheep; Poultry: chicken and duck

Discussion

Lophatherum gracile (lophatheri) is a grass that thrives in the Bojonegoro District. The plant grows wild on the banks of rivers, forests, plantation fields, to around the farms. The incidence of poisoning by lophatheri is caused by accidentally being carried away when farmers are grazing, because there is no screening on the grass that will be given to livestock, the plant is accidentally eaten by livestock and causes poisoning. Herbivorous animals and poultry have been reported to be harmed by this poisonous plant. The most common symptoms in animals experiencing lophatheri poisoning are bloat, weakness, dyspnoea, convulsion, rolling, until death. Although the plant has become a threat to livestock in Bojonegoro, the incidence of poisoning caused by lophatheri occurs frequently, this is supposedly due to lack of documentation and knowledge transfer among local farmers, and there are no local method for early handling of animals that are poisoned by poisonous plants.

There is not much information explaining that lophatheri causes poisoning in livestock in other areas. Nevertheless, Tang et al. (2014) suggested that the plant contains toxic compounds in the form of glycosides, such as coumarin, luteolin, isoorientin, apigenin, swertisin, saponaretin, swertiajaponin, and arabinopyranoside. Recently, a new glycoside compound called flavone C-glycoside from lophatheri has also been discovered which may also be equally toxic (Fan et al. 2015). This is supported by the studies of Taheri et al. (2013) and Rubini et al. (2019) which stated that glycosides from *Nerium oleander* (cardiac glycosides) caused fatal cases in rabbits and cattle. The cardiac glycosides work by triggering electrolyte disturbances and inhibiting Na+/K+-ATPase which causes electrical conductivity in the body so that it may disturb the body and result in toxicity (Rubini et al. 2019).

Manihot esculenta (cassava), *Canavalia ensiformis* (jack bean), *Sorghum bicolor* (sorghum), *Albizia chinensis* (Chinese albizia), *Ipomoea batatas* (sweet potato), *Arachis hypogaea* (peanut), *Artocarpus heterophyllus* (jackfruit), and *Psophocarpus tetragonolobus* (winged bean) are plants used as forage, especially during the dry season when not much grass is available in the fields such as rice field, cornfield, sorghum field, and fruit field. These plants are known to contain very high protein, so that they are good for the growth and development of livestock. However, the majority of farmers report that sometimes the plants cause poisoning in livestock, including cattle, goats, sheep, and poultry. The symptoms caused by the poisoning plants were bloat, anorexia, and death. This incident also occurs frequently even though the local farmers admit that they have anticipated it, with drying the plants first. In addition, farmer communities in West Sumatra treated their cattle that suffered from indigestion using guava (Harmen 2020).

The leaves and tubers' skin of cassava has long been referred to as poisonous plant parts which are deadly to ruminants and poultry due to containing highly cyanogenic acid (cyanide). Although not all individuals can experience poisoning after consuming parts of the cassava plant, unfortunately, poisoning is still frequently reported in livestock. This compound is known to inhibit hemoglobin in erythrocytes from releasing oxygen in tissues. The symptoms are the animal's blood turning cherry red, followed by convulsions, frothy mouth, and death (Kennedy et al. 2021). In the dry season, the local farmers use leaf and tuber skin of cassava as animal feed due to the difficulty of finding grass. The majority of local farmers already know how to process the agricultural waste used as

forage. A simple processing method is by drying, but poisoning incidents still occur frequently. Silva et al. (2017) revealed that cassava's cyanogenic glycosides contain linamarin, lotaustralin, and α-hydroxynitrile showing clinical symptoms on sheeps such as nervous and digestive disorders. The higher the cyanide contained, the incidence of death is higher (Kennedy et al. 2021). Cassava leaves are a favorite vegetable for Indonesian people, but they have never been reported to be poisoned by consuming the leaves, perhaps because of the process of boiling before consuming them.

Jack bean, peanut, and winged bean are vegetable legume crops that grow a lot in tropical areas (Alalade et al. 2016; Akande 2016; Candela et al. 2020). These plants are widely used by people because they are rich in vitamins, proteins, and minerals. Likewise, the plant waste (leaf and tuber skin of cassava, leaf of jack bean, leaf of sorghum, leaf of Chinese albizia, leaf of sweet potato, leaf of peanut, rotten fruit of jackfruit, and leaf of winged bean) is often the mainstay of local farmers in Bojonegoro District when not much grass grows in the field such as rice field, cornfield, sorghum field, and fruit field. According to Akande (2016), jack bean is reported to contain anti-nutritional substances, namely cyanogenic glycosides, trypsin inhibitors, concanavalin, canavanine, canaline, phenols, and saponins. Peanuts have substances of secondary metabolites, such as linoleic acid, oleic acid, and palmitic acid, also anti-nutritional substances, such as tannins, cardiac glycosides, and nitrates (Candela et al. 2020), whereas winged beans conceive tannin, oxalate, and phytate as anti-nutritional compounds (Alalade et al. 2016). Not much information is reported that these three plants cause severe poisoning in livestock. Merely some information obtained stated that some of these anti-nutrients can cause a toxic effect on the blood marrow cells of mice, anorexia, bloat, rolling, to death in livestock (Akande 2016; Candela et al. 2020). The legume plants have the potential to be developed as a highly nutritious animal feed, certainly with the proper processing of agricultural waste (Akande, 2016; Andriati et al. 2018).

Sorghum is one of the plants that is widely produced especially in the dry season used as forage, whereas it has been widely reported to cause death. This plant waste is still relied on by local farmers in Bojonegoro District if they have difficulty finding the grass. Lack of knowledge to treat waste is thought to be the main triggering factor for poisoning in livestock. Keyata et al. (2020) found that sorghum contains anti-nutritional substances, namely oxalate, phytate, and tannin. Several studies informed that the incidence of livestock poisoning is due to consuming the plant which contains mycotoxins, which happens due to improper storage for a long time (Palacio et al. 2016).

Chinese albizia is a woody legume plant that is widely cultivated by people on the Java island as industrial raw materials. The leaves are very often used as the main forage for livestock, especially on sheep (Stewart and Dunsdon 2000). Giving young leaves or harvested when rain and have not been dried are prone to causing livestock to experience bloat, many are reported to have died. Buragohain (2015) revealed that the leaves also contain tannins as anti-nutritional substances. Through proper processing, it is believed that these anti-nutrients can be reduced. The leaves are also familiarly used by local farmers as a mixture in making fermented feed.

Sweet potato is a multi-nutrient plant that has been widely used globally. Similar to cassava leaves, sweet potato leaves are also widely used by Indonesian people as vegetables. The process of boiling before consumption is believed to be able to reduce anti-nutritional levels, so there have never been reports of people being poisoned by consuming the leaves. The main nutritional of this plant are flavonoids, terpenoids, saponins, coumarin, and phenolic acids, whereas anti-nutritional components such as tannins, glycosides, alkaloids, oxalate, and trypsin inhibitors (Ayeleso et al. 2016). There is not much information that sweet potato leaves cause poisoning in livestock, but anti-nutritional compounds are believed to be toxic agents. This plant is strictly avoided to be given to animals that are impregnated because it often causes abortion and infertile. Mawhinney et al. (2009) revealed that cattle in the United Kingdom experience atypical interstitial pneumonia after consuming sweet potatoes containing ipomeanol toxins and contaminated with *Fusarium solani* mold. In Kenya, furanoterpenoid ipomeamarone is known to be the main cause of poisoning in cattle that consume sweet potato (Wamalwa et al. 2014). Not all animals in Bojonegoro District are poisoned due to consuming sweet potato leaves, it is just that poisoning often happens.

Jackfruit is a familiar plant found in Asia, Africa, and South America. This plant also thrives on Java Island, including in the Bojonegoro District. The leaves and fruit waste are common as animal feed for goats and sheep. Unfortunately, there have been cases where livestock given fruit waste were found to be poisoned. This is supposedly due to the tannins and oxalates contained therein (Ndyomugyenyi et al. 2015). However, Kusmartono (2002) has proven that giving jackfruit waste (aerial, skin, seed, and heart) can increase sheep's appetite without causing side effects. The sap found in the fruits is believed to not cause poisoning in livestock. Therefore, the processing of fruit waste is suspected to be the main factor causing poisoning.

Processing plant waste before being given to livestock is very important because the process can reduce the content of anti-nutrients in a plant. The lethal dose of an anti-nutritional substance cannot be determined precisely because it depends on various factors, such as season, weather, plant age, plant part, the amount consumed by livestock, and the process used before being given to livestock (Skládanka et al. 2011; Desta 2019). Some methods of processing agricultural waste that can be carried out are counting, withering, boiling, steaming, fermentation, natural heating, and dry heating. Usually, high levels of anti-nutrients are found in plants harvested at the beginning of the rainy season, the end of the rainy season, and the dry season. The drying process carried out by local farmers in the rainy season also becomes riskier to high humidity and low sunlight. This can result in a decrease of nutritional quality due to susceptible to mycotoxin contamination (Apata and Babalola, 2012;

Penrith et al. 2015; Yanuartono et al. 2019; Penagos-Tabares et al. 2021). A few cases have been reported that mycotoxin-causing fungi are very easy to grow in forage (Riet-Correa et al. 2013; Gallo et al. 2015; Palacio et al. 2016).

Leaves are the highest plant part causing poisoning in traditional livestock in the Bojonegoro District. This is certainly in accordance with the main source of feed for livestock by local farmers. These findings are similar to studies conducted by Kabede et al. (2015) and Desta (2019) in Ethiopia, who also said that leaves are the main cause of poisoning cases in livestock. Likewise with livestock, bovine is the most common livestock reported poisoning toxic plants, followed by caprine and ovine. This is probably related to the breeding system. Also in America, Brazil, and China have been reported that thousands of livestock have died due to poisonous plants because this livestock is grazed in wild grasslands so that monitoring the grass eaten by livestock becomes essential to be controlled (Penrith et al. 2015; Welch et al. 2018; Zhao et al. 2012). Some of the symptoms caused by poisonous plants vary greatly, depending on the number of poisonous plants eaten and the content of toxic compounds in the plants. If not treated quickly will lead to death (Kennedy et al. 2021; Yanuartono et al. 2019).

Besides having toxic substances in livestock, the nine plants have tremendous potential as herbal medicine if employed with a good mode of preparation. Lophatheri has long been used as medicine by the Chinese people referred to as the treatment of pyreticosis, hydrodipsia, ardor urinae, and urinary tract inflammation (Tang et al. 2014). The compounds of lophatheri also have a great potential to be developed as an agent that inhibits the growth of cancer cells and suppresses the development of viruses that attack the respiratory tract (Chen et al. 2019; Kim et al. 2016). According to the study conducted by Bahekar and Kale (2016) who obtained that cassava contains high antioxidant compounds and is well used as an anticancer. Jack beans contain flavonoids and phenolic acids which are a rich source of antioxidants (Andriati et al. 2018; Sutedja et al. 2020). According to Sutedja et al. (2020), jack beans can be used as an ingredient to reduce the risk of chronic diseases in the human body such as hypertension and diabetes mellitus. Sorghum has potential as an alternative medicinal plant because it contains various antioxidant activities derived from polyphenolic compounds if processed properly (Espitia-Hernandez et al. 2020). The Chinese albizia leaves are known to have various chemical compounds such as polyphenols, flavonoids, terpenoids, saponins, alkaloids, phytosterols, and quinone which play an important role in treating various disorders via various biological activities (Buragohain, 2015; Chitra and Balasubramanian 2016; Sharmin et al. 2014). By good agricultural waste management methods such as extraction, phenolic and flavonoid contents in the sweet potato leaves can be used as radical scavenging, antimutagenic, anticancer, and antibacterial activities (Hue et al. 2012). The peanut contains antioxidant, antiinflammatory, antifungal, and antibacterial activities. The total phenolic content in the peanut hydroalcoholic extract is able to act as an antioxidant and anti-inflammatory without causing toxicity to mice (Cossetin et al. 2019). Ranasinghe et al. (2019) revealed that jackfruit contains various phytochemical compounds such as volatile acid sterols, flavonoids, and carotenoids which can be used as an anti-inflammatory, hypoglycemic properties, antifungal, antimicrobial, and anti-carcinogenic.

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