The pattern of *Etlingera elatior* cultivation in agroforestry systems and its use as traditional medicines and food by local people of Kabanjahe, North Sumatra, Indonesia

AGUS PURWOKO[1], HELTIMALA TURNIP[1], WAHYU HARYATI MASER[2,♥]

[1]Department of Forest Management, Faculty of Forestry, Universitas Sumatera Utara. Jl. Tridarma Ujung No. 1, Medan 20155, North Sumatra, Indonesia
[2]Program of Food Science and Technology, Faculty of Agriculture, Universitas Sumatera Utara. Jl. Prof. A. Sofyan No 3 Kampus USU, Medan 20155, North Sumatra, Indonesia. Tel.: +62-61-8213236, Fax.: +62-61-8211924,♥email: maser.wahyuharyati@usu.ac.id

Abstract. *Purwoko A, Turnip H, Maser WH. 2019. The pattern of* Etlingera elatior *cultivation in agroforestry systems and its use as traditional medicines and food by local people of Kabanjahe, North Sumatra, Indonesia. Biodiversitas 20: 1998-2003.* Etlingera elatior or *kecombrang* (Indonesian name) is a native plant of Indonesia. In Kabanjahe, this plant is planted in agroforestry systems. The purposes of this study were to describe the pattern of *Etlingera elatior* cultivation in agroforestry systems, and to document the use of *Etlingera elatior* as medicines and food by the local people of Kabanjahe, North Sumatra. Data were collected with field observations and interviews, and the collected data were analyzed qualitatively. The results showed that *kecombrang* was planted in agroforestry systems in three patterns, namely (i) *kecombrang*, cinnamon, and coffee, (ii) *kecombrang*, coffee, and bamboo, and (iii) and *kecombrang*, avocado, and vegetables. *Kecombrang* has been used as medicines for cough, wound, eye problems, fever, low breast milk production, odor, and hair thinning. In addition, *kecombrang* has also been used as a food ingredient in *ubi tumbuk*, *ikan arsik*, *sambal kincung*, *getah tasak telu*, *cipera*, *terong dotak*, *gat-gat*, and *gulen manuk*. With this research, it is suggested that agroforestry systems be developed to improve economic benefits for the local people of Kabanjahe.

Keywords: *Etlingera elatior,* food, Kabanjahe, kecombrang, local people, medicines

INTRODUCTION

One of the problems in the forestry sector is the low economic productivity of land which often results in the conversion of forest land into other non-forestry uses. On the other hand, the development of the agricultural sector is constrained by the limited land owned by farmers, so the majority of farmers practice farming below the good economic scale. These two problems can be overcome with agroforestry system, which is a land use system that combines forest with agricultural crops to increase benefits, both economically and environmentally (Ruijter and Agus 2004).

As a mixed farming model, the concept of agroforestry is required to grow species, both main crops (forestry) and their combination plants (agriculture) that are able to offer high productivity and economic benefits. This starts with the selection of tolerant species when planted together with forestry crops, the economic benefits of the commodities produced, and the prospects for their use and market. Modern agroforestry is now based mainly on the combination of trees plantation infield which can be grown along with agricultural, vegetable crops species, horticultural crop species, animals' species, poultries, fisheries, etc or produced simultaneously or subsequently in combined models on the same piece of land (Himshikha 2016). Many species of agricultural crops can be planted in agroforestry systems, especially plants that are relatively tolerant to both light cover and low soil nutrient availability. One of Indonesia's local plants suitable to grow in agroforestry systems is *kecombrang* (*Etlingera elatior* (Jack) R. M. Sm). In addition, this plant species has provided many benefits for the community, especially as medicinal plants. The parts of the plant used are the pseudostems, leaves, fruit, and rhizomes (Sabilu et al. 2017). *Etlingera elatior* is native to Malaysia and Indonesia, belonging to the family Zingiberaceae (Chan et al. 2011). Yeats (2015) states that *kecombrang* generally grows in lowland wet tropics and can be found at altitudes up to 2700 m. Research conducted by Delta et al. (2013) also stated that the spread of *kecombrang* on Mount Talang ranged from 1169-1258 m. The plants of family Zingiberaceae family usually grow in colonies or clumps with very large stature such as *kecombrang*. Some *kecombrang* have adventitious roots that grow laterally and below the rhizome. Its rhizome is commonly called a rounded rhizome like taro, soft and fleshy (Delta et al. 2013). Having strong and creeping roots *kecombrang* is often found in steep soils (Yeats 2015). *E. elatior* grows up to 5-6 m tall forming clumps (Khaw 2011). Its aromatic rhizomes are stout (3-4 cm in diameter) and found just below the ground level. When crushed, the leaves emit a pleasant sour fragrance. The leaves are entirely green with a truncated base. Young leaves are sometimes flushed pink with petioles 2.5-3.5 cm in length. Inflorescences, which are shaped like a spear-head when young, are large and attractive with showy pink or red waxy bracts when in blossom. Fruiting heads are globular, greenish or red in color, bearing many black seeds (Chan et al. 2013).

Kecombrang's flowers and young leaves are generally used as a flavoring for dishes, such as *urab, pecel, sambal*, and other dishes. Young inflorescences are an essential ingredient of sour curry dishes (Larsen et al. 1999). For the people of North Sumatra, *kecombrang*'s flowers are used as a mixture of *sambal lalap* and *ubi tumbuk*. Besides being widely known as a food ingredient, this plant is also widely known as a medicinal plant. *Kecombrang*'s flower has also been widely used by the community for medicinal purposes because of the active substances contained in them such as tannins, flavonoids, saponin, and steroid (Maimulyanti and Prihadi 2015).

Most of the local people in Kabanjahe Sub-Districts are farmers who practice agroforestry, growing several species of plants, such as cinnamon, coffee, bamboo, avocado, and *kecombrang*. However, there had been no study about *kecombrang* cultivation in the agroforestry systems and its use as medicines and food. Therefore, this study was conducted to describe the pattern of *kecombrang* cultivation in agroforestry systems and to document the use of *kecombrang* as medicines and food in Kabanjahe Subdistrict.

MATERIALS AND METHODS

Study area

The study was conducted in Kabanjahe Sub-district, Karo District, North Sumatra, Indonesia. The location is flanked by 3 Sub-districts, namely, north with Berastagi Sub-district, south with Tigapanah Sub-district, west with Simpang Empat Sub-district, and east with Tigapanah Sub-district (Figure 1). Kabanjahe Sub-district is at altitudes of 1000-1300 m with a temperature of 16-27°C and an area of 44.65 km^2. Kabanjahe Sub-district covers 13 villages, with a population of 73,479 inhabitants (BPS 2017).

Procedures

Data were collected with field observations (surveys) and interviews. The surveys were done in 25 samples of agroforestry systems and structured interviews were done with the owners. The samples were selected purposively based on the research objectives. The purposive sampling technique is a type of non-probability sampling that is most effective when one needs to study a certain cultural domain with knowledgeable experts within. Informant selection is highly relevant for ethnobotanical research, as people are constantly looked upon for knowledge and information. (Tongco 2007).
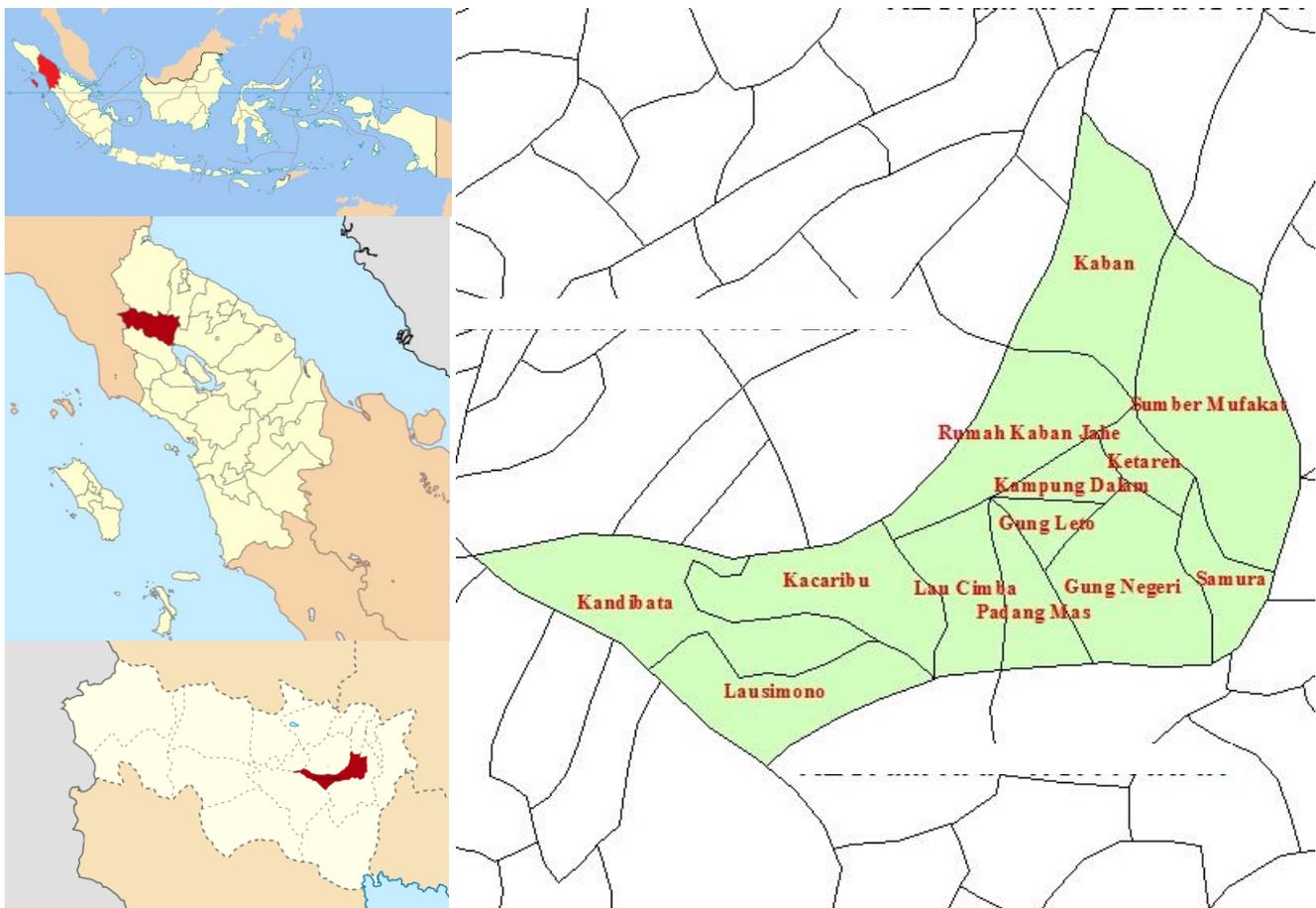

Figure 1. The location of research, Kabanjahe Subdistrict, Karo District, North Sumatra, Indonesia

Structured interviews were carried out using questionnaires that had been prepared and filled out by researchers while conducting interviews with respondents. The observation was done by observations up close, note taking and documentation in the form of photographs.

Data analysis

The data were analyzed qualitatively. Qualitative data analysis is the process of classical basic methods of research such as data collection, documentation, analysis, and interpretation (Akinyode and Khan 2018). The process runs through research design, fieldwork, and analysis (Braun and Clarke 2006; Attride-Stirling 2001).

RESULTS AND DISCUSSION

Characteristics of respondents

Respondents in Kabanjahe Subdistrict adhere to various religions, namely Islam, Protestant, and Catholicism and belong to several tribes, namely Javanese, Simalungun Batak, Toba Batak, and Karo Batak. Based on Table 1, it can be seen that the highest percentage of respondents who used *kecombrang* were 41-49 years old (28%), high school graduates (64%), and having 400 m^2-6800 m^2 agroforestry land (84%). Respondents who used a lot of *kecombrang* came from relatively old age groups because younger people are less interested in local knowledge about medicinal plants and food (Voeks 2007; Guimbo et al. 2011). The area of land used by the community for kecombrang agroforestry was mostly not extensive, but the land will produce good crops, because of the planting is more intensive, decreases overall land use (Assunção et al. 2016).

Respondents had used parts of *kecombrang* as food and medicine (Figure 2), and the most commonly used part was the stem (17 respondents). The stem was used for various kinds of medicines to cure health problems such as cough, eye, fever, hair thinning and it was also used as ingredient of foods such as *ikan arsik* and *terong dotak*. In addition, the essential oils from the stem can also be used for medicine and food (Jaafar et al. 2007; Abdelwahab et al. 2010).

The patterns of *kecombrang* cultivation in agroforestry systems

There were three crop patterns in agroforestry systems where *kecombrang* was planted, namely (i) *kecombrang*, cinnamon, and coffee, (ii) *kecombrang*, coffee, and bamboo, and (iii) *kecombrang*, avocado, and vegetables (Figure 3). Communities in Kabanjahe Sub-district planted *kecombrang* in the middle of the land. This was intended to get shade from other plants planted. In general, well-managed agroforestry systems have positive effects on soil fertility compared with monocultures because of the contributions of trees. Tree plantation-crop combinations, in which (for example) tea, coffee or cocoa are cultivated under trees, and home gardens, in which a high diversity of tree and crop species is grown on the same piece of land,

are examples of agroforestry systems that exhibit higher soil fertility than monocultures of the same crops (Hillbrand et al. 2017). Because of tree shade in agroforestry systems, not all species of plants can be planted with trees. Therefore, the choice of plants that are tolerant to shade in agroforestry systems is necessary. Farmers planted forestry and agricultural crops (agrosilvicultural) and the dominant forestry plant was cinnamon (*Cinnamomum verum*). Other crops were coffee, bamboo, avocado, and vegetables.

Figure 4 shows that 52% of respondents planted *kecombrang*, cinnamon, and coffee in their agroforestry land because the income obtained with this pattern was greater than with other patterns. The yield of cinnamon and coffee had high economic value. The bark of cinnamon is widely used as a spice and flavoring material. Moreover, it is used in the preparation of chocolate, desserts recipes (apple pie, doughnuts, and cinnamon buns), spicy candies, tea, hot cocoa and liqueurs (especially in Mexico, the main importer of true cinnamon) (Bandara et al. 2011). Furthermore, coffee is a beverage that is often consumed by the public. In addition, coffee is also used as a mainstay commodity in the plantation sector. Many people process coffee to make beverage and foods that are of high quality and have a selling price (Fujioka and Shibamoto 2008).

Kecombrang for medicines

Table 2 shows that *kecombrang* has been used as a medicine for cough, wound, eye, and fever, and to improve breast milk production, remove odor, and fertilize hair. Several studies have shown that *kecombrang*'s flowers had antibacterial activity (Maser et al. 2017; Ghasemzadeh et al. 2015; Wijekoon et al. 2013; Abdelwahab et al. 2010; Lachumy et al. 2010). *Kecombrang* contains bioactive compounds such as polyphenols, alkaloids, flavonoids, steroids, saponins and essential oils which are thought to have potential as antioxidants and also alternative natural preservatives (Wijekoon et al. 2011). Table 3 shows several studies on the bioactivity of *kecombrang* which indicate that *kecombrang* has the potential to be used as medicine.
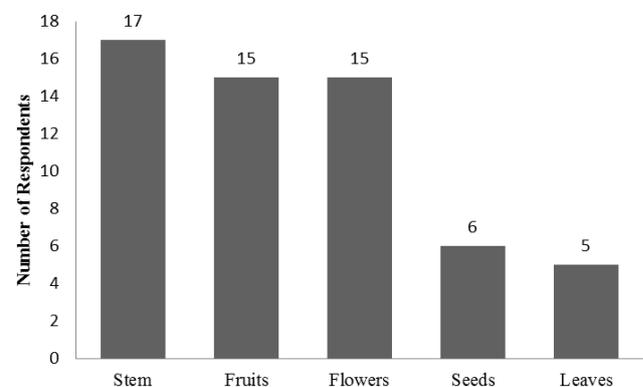

Figure 2. Parts of plants used as foods and medicines by local people Kabanjahe, North Sumatra, Indonesia

Table 1. The Characteristics of respondents based on age, level of education, and *kecombrang* agroforestry land area.

Characters of respondents					
Age		Level of education		Kecombrang agroforestry land area	
Interval of age (years)	Percentage of respondents (%)	Level of education	Percentage of respondents (%)	Interval of land area (m^2)	Percentage of respondents (%)
23-31	8	Elementary School	8	400-6800	84
32-40	24	Middle School	16	7200-13600	12
41-49	28	High School	64	≥14000	4
50-58	20	College	12		
59-67	12				
68-76	8				

Pattern of kecombrang, cinnamon, and coffee

Cinnamon
Coffee
Kecombrang

Pattern of kecombrang, coffee, and bamboo

Bamboo
Coffee
Kecombrang

Pattern of kecombrang, avocado, and vegetables

Avocado
Vegetables
Kecombrang
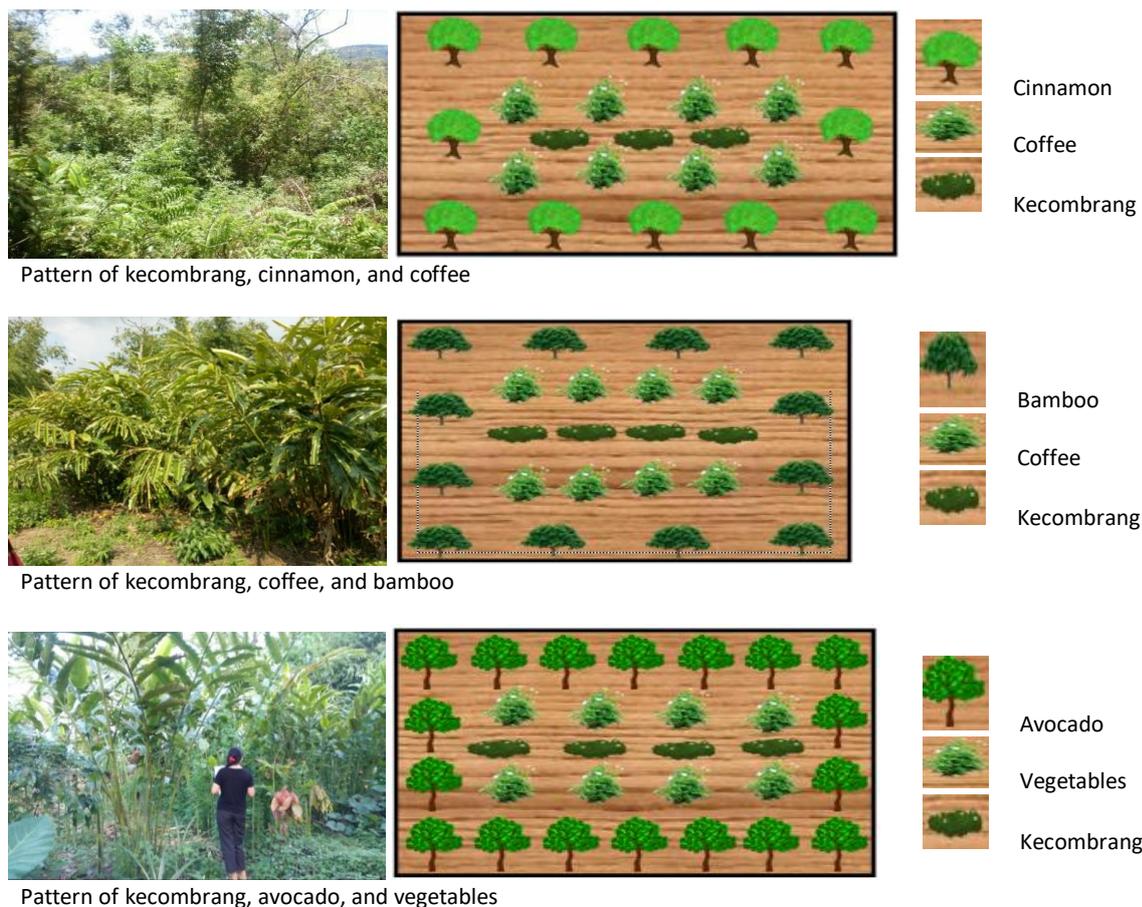
Figure 3. The patterns of crop cultivation in agroforestry systems by local people of Kabanjahe, North Sumatra, Indonesia
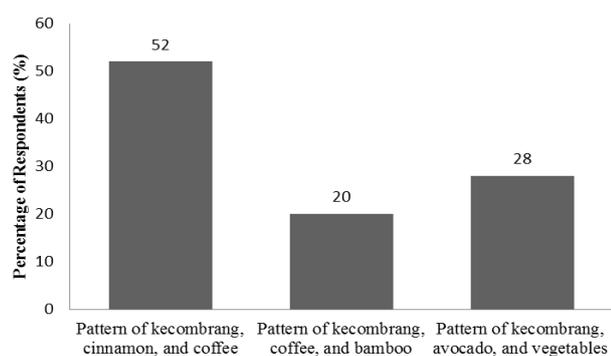
Figure 4. Percentage of respondents (%) using each agroforestry patterns

Kecombrang for foods

Kecombrang was used as a food ingredient in *ubi tumbuk*, *arsik*, *sambal kincung*, *getah tasak telu*, *cipera*, *terong dotak*, *gat-gat*, and *gulen manuk* (Table 2). *Kecombrang* has good nutrition, so very suitable to be processed as food. The kecombrang had a significant amount of crude protein (12.6%), fat (18.2%), fiber content (17.6%), high level of unsaturated fatty acids (palmitoleic acid 16.4%, linoleic acid 14.5%, and oleic acid 5.2%), essential amino acids dominated by leucine and lysine (7.2 and 7.9 mg/100 mg protein, respectively), and major minerals like: K (1589 mg/100 g), Ca (775 mg/100g), Mg (327 mg/100 g), P (286 mg/10 0g) and S (167 mg/100 g) (Wijekoon et al. 2011).

Table 2. List of kecombrang utilization as medicine and food by local people Kabanjahe, North Sumatra, Indonesia

Parts of kecombrang	Utilization Types	Purposes of use	Specifications	Processing
Stem	Medicine	Cough	30-40 cm long, young shoots, 4 months old with ± 2 leaves.	The stem was burned then pounded and squeezed to get the water. Then the water was drunk
		Eye	8 months old.	The stem was pounded and squeezed to produce water then the juice was filtered. The water was used as eye drops.
		Fever	young shoots, 4 months old.	The stem was cut and the young shoots were peeled, then pounded to produce water. The water was placed on the wool material to be attached to the body that feverish.
		Thinning hair	30-50 cm long, 8 months old.	The stem was cut and the young shoots were peeled then pounded to produce water. The water was used as a shampoo.
	Food	*Ikan arsik*	30 cm long, 1-year-old.	The stem was sliced into small pieces and mixed into *ikan arsik*.
		Terong dotak	30 cm long, 1-year-old.	The stem was sliced into small pieces and mixed into *terong dotak*
Fruit	Food	*Cipera*	-	The fruit was sliced into small pieces and mixed into cipera.
		Terong dotak	-	The fruit was finely ground and mixed into terong dotak.
Flower	Medicine	Improve breastmilk production	young, 4 months old, having shoots, blooming.	The flowers were thinly sliced and mixed into the food.
		Remove odor	young, 4 months old, blooming.	The flowers were boiled with water and used for bathing.
	Food	*Ubi tumbuk*	8 months old, having buds	The flowers were sliced into small pieces and mixed into *ubi tumbuk*
		Ikan arsik	8 months old having buds	The flowers were sliced into small pieces and mixed into *ikan arsik*.
		Sambal kincung	The 1-year-old, having buds	The flowers were milled and mixed with *sambal kincung*.
		Getah tasak telu	4 months old, blooming	The flowers were sliced into small pieces and mixed into *getah tasak telu*.
Seed	Food	*Gulen manuk*	1-year-old and brown	The seeds were finely ground and mixed into *manuk gulen*.
		Getah tasak telu	8 months old and brown	The seeds were finely ground and mixed into *getah tasak telu*.
Leaf	Medicine	Wound	Young	The leaves were pounded coarsely and taped to the wound

Table 3. Several studies on the bioactivity of kecombrang plants

Parts of kecombrang	Bioactivity	Reference
Whole plant	Antioxidants (IC50 = 995.1 μg/mL) and antibacterial (MIC values for Methicillin-resistant *Staphylococcus aureus* (MRSA) = 10 mg/mL)	Abdelwahab et al. (2010)
Whole plant	Antiproliperative (IC50 = 170 ± 0.05 μg/mL inhibits CHO cell proliferation)	Mai et al. (2009)
Flower	Antioxidants (IC50 = 34.5 μg/mL), anticancer (IC50 = 173.1 and 196.2 μg/mL in kelombrang flower extract of Kelantan inhibited the growth of MCF-7 and MDA-MB-231) and antibacterial cells in Kelantan flower extract (MIC Value; *Staphylococcus aureus* = 40.0 μg/mL, *Bacillus subtilis* = 80.0 μg/mL, *Listeria monocytogenes* = 40.0 μg/mL, *Escherichia coli* = >10.0 μg/mL, *Salmonella typhimurium* = 50.0 μg/mL, and *Pseudomonas aeruginosa* = 60.0 μg/mL)	Ghasemzadeh et al. (2015)
Flower	Total antioxidant serum (± 5 μmol/mg protein)	Jackie et al. (2011)
Flower	Antimicrobial (*Bacillus subtilis* with MIC value = 0.78 mg/ml and *Klebsiella pneumoniae* with MIC value = 1.56 mg/ml)	Wijekoon et al. (2013)
Flower	Antimicrobials (MIC values in various microbes ranging from 1.563-50,000 mg/mL) and antioxidants (IC50 = 2.52 mg/mL)	Lachumy et al. (2010) Maser et al. (2017)
Flower	Antibacteria (*Staphylococcus aureus* with DIZ = ± 3,78 mm in 500 mg/mL chloroform fraction)	

In conclusion, *kecombrang* has many benefits, both as food and medicine, so agroforestry systems with *kecombrang* should be developed to improve the economic benefits for the community.

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