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The Conservation Efforts of Wood Apple, An Identity Plant of Rembang Regency, Based on Ethnobotany Study

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Abstract

Feronia limonia (L.) Swingle better known as wood apple is an identity plant of Rembang Regency, Central Java Province, Indonesia. However, the population is very limited. In order to identify the conservation efforts, this ethnobotany study was aimed to determine traditional knowledge on the existence, economic value, utility, breeding technique and conservation of wood apple. The survey was conducted on a total of 102 local people from 10 sub-districts which were determined by proportionally stratified random sampling. Data were collected by questionnaires and individual interviews and then were analyzed descriptively. The results showed that all of respondents knew the figure of wood apple, but only 79.50% understood its status as an identity plant. Most of respondents (96%) stated that the fruits have low economic value, 80.39% respondents have utilized ripe fruit as ingredients of beverages and stems as firewood. This utilization was only equal to 29.72% compared to the potential usability based on research results. It was concluded that the traditional knowledge about the existence, economic value, and breeding technique were good and on the contrary, the knowledge about the plant's usability was bad. The results will form a basic knowledge for in-depth studies to provide a government policy of Rembang Regency in order to develop an efficient strategy of management and conservation of wood apple as plant identity.

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INTRODUCTION

All of regencies of Central of Java Province have established a species as an identity plant. It is aimed to provide the maximum effort to maintain the existence of the plant germplasm. The determining of identity plant is based on some factors, including historical value, endemicity, as well as intensity of cultivation. Rembang Regency chooses *Feronia limonia* (L.) Swingle which better known as wood apple as its identity plant. In Central Java Province, wood apple grows only in this regency. For the last 3 years, the population of wood apple is very limited, ranges from 498 - 1,042 trees (Statistics of Rembang Regency, 2016). The population of a species in a region is influenced by several factors, mainly the intensity of cultivation. The more intensive the cultivation will be resulted in a higher population. Intensity of cultivation of a species is influenced by several aspects of ethnobotany, especially the level of traditional knowledge of the community about the usefulness, the economic value, and the ease of breeding (Albuquerque, 2009).

To increase the population of wood apple in Rembang Regency, it is necessary to study the level of traditional knowledge about the three things mentioned above. It is necessary in order to maintain the traditional knowledge as well as to optimize sustainable use (Albuquerque *et al.*, 2009). Recently, study of traditional knowledge often focuses on the role of demographic factors, such as age, gender, educational level, profession, and live duration in an area because these factors can form traditional knowledge (Ayantunde *et al.*, 2008, Cruz *et al.*, 2013).

Ethnobotany researches have been conducted on a group of plants such as all of plants species used in an area (Luizza *et al.*, 2013), and medicinal plants (Kewessa *et al.* 2015). The ethnobotany researches also have been carried out on a plant species, such as cassava (Ellen & Soselisa, 2012), sanseviera (Takawira - Nyenya *et al.*, 2014), rattan, and bamboo (Honfo *et al.*, 2015). During this time, the ethnobotany study on the identity plant of regency in Indonesia has never been published.

The study was aimed to describe the traditional knowledge of local people in Rembang Regency, specially about: 1) the existence and status, 2) the economic value and utilization, 3) the types of organs utilized, and 4) the breeding technique; and the perceptions of conservation of wood apple. The result was useful to provide a basis of government policy of Rembang Regency in order to develop an efficient strategy of management and conservation of wood apple as plant identity.

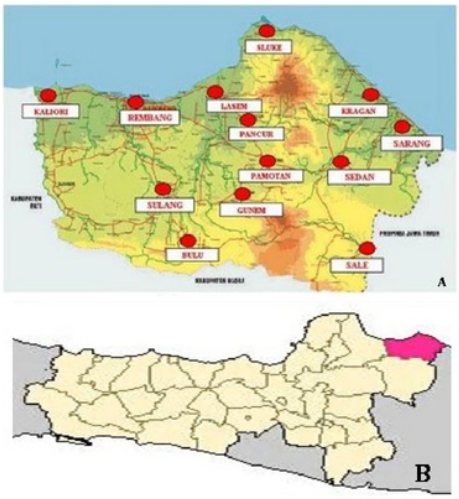

Figure 1. Rembang Regency. A. The 14 sub-districts of Rembang. B. Location of Rembang Regency is on the north coast of Java Island, in the border between the Central of Java and East of Java.

METHODS

The study was carried out in Rembang Regency in August to October 2017. The regency covers an area of 101,408 ha. Most of the area (46.39%) is lowland in the northern part (0-25 m above sea level), while in the south it is relatively higher between 100-500 m above sea level. It has a tropical climate type, with an average of rainfall is 502.36 mm/year, and daily temperature ranged from 23°C to 33°C. The soil type is about 45% Mediterranean soil, 32% grumusol, 10% alluvial, and the rest are andosol and regosol. The area encompasses 14 sub-districts (Figure 1), of which 13 of them are rural and another one is urban. The population is estimated to reach 621,134 with a density between 259 – 1.519 inhabitants per km^2. The population consists of 309,564 men and 311,570 women. Farming is the main occupation (44.70%) (Statistics of Rembang Regency, 2016).

An ethnobotanical survey was conducted in 10 sub-districts selected by purposive sampling. The samples consist of 5 sub-districts located on the coast and 5 sub-districts in the inland. From each sub-district, as many as 102 respondents were selected by stratified proportional random technique depend on their gender and age (Table

Table 1. Gender and age proportion of sample

Sub-district	Location	Men			Women			Total number
		Youth < 30	Adult 30 – 55	Old > 55	Youth < 30	Adult 30 – 55	Old > 55	
Bulu	Coast	2	3	1	1	3	1	11
Pamotan	Coast	3	2	2	1	2	2	12
Gunem	Coast	1	3	1	3	2	1	11
Pancur	Coast	1	4	0	2	4	0	11
Sulang	Coast	2	2	1	2	3	0	10
Sluke	Inland	0	2	2	2	4	2	12
Sarang	Inland	2	1	1	3	3	1	11
Rembang	Inland	1	3	1	1	3	1	10
Kaliori	Inland	2	1	0	2	1	1	7
Lasem	Inland	2	2	1	1	1	0	7
Sub-total		16	23	10	18	26	9	102
Total number			49			53		

1). It is stated that a minimum number required for a qualitative interview study to be published can be between 20 to 30 persons.

The focuses of this research were the traditional knowledge about 1) the existence and status, 2) the economic value and utilization, 3) the types of organs utilized, and 4) breeding technique; and the community perceptions about conservation of wood apple. Data were collected by questionnaire, interview, and observation methods. Questionnaires and interviews was individually conducted used a semi-structured questionnaire.

Traditional knowledge of the respondents on wood apple was measured using the Reported Use Value (RUV) i.e. the total number of plants uses reported by respondents. The RUV then was compared to the Theoretical Use Value (TUV) to determine the increase of efforts required. To identify the most used wood apple part, Organ Use Value (OUV) was calculated. OUV was defined as the ratio of the total number of an organ utilization (RU_{org}) to the total number of reported utilization (RU_{total}) for the all of organs (Gomez-Beloz, 2002).

$OUV = (RU_{org} \times 100) / RU_{total}$

RESULTS AND DISCUSSION

The respondents have various educational levels and occupations; under/post graduate and government employees were the least compared to the others. Most respondents have lived in Rembang for more than 5 years (Table 2).

Interview and questionnaire results revealed that all of respondents were familiar with wood apple figure, but only 79.50% of them understood its status as an identity plant of Rembang Regency (Table 3). Most of the respondents noticed the trees grow in the yard (Figure 3A) and roadside, and 5.88% of them confirmed some wood apple trees grew at plantation in Rembang. However, the observations in this study did not find the plantation. More than half of the respondents told that so far they found less than 5 wood apple trees (Table 3). It proved that the existence of wood apple is really limited.

Wood apple was known to have economic value, especially its fruit. However, according to more than half of respondents, the economic value was relatively low. All respondents understood the benefits of wood apple. Most of them had ever consumed the fruit, generally 1-3 times per month (Table 4) because they did not like the taste or they felt hard to found the fruit at a certain time. Most respondents used wood apple as food/beverage and firewood. A small proportion of them used it as building construction materials, medicine, animal feed, reforestation and ornamental plants (Figure 2).

The wood apple organs used were stems for house construction, young leaves for fodder (Fig 3B), ripe fruit (Figure 3C, 3D) for drinks, and whole plants as ornamental plants and reforestation. These utilizations were still very limited compared to benefits based on research results for each organ. Based on some researches in many regions and countries; the root, unripe fruit and

Table 2. Distribution of research samples based on educational level, occupation and live duration in Rembang

Sub district	Educational level*				Occupation**					Live duration in Rembang		Total number
	A	B	C	D	A	B	C	D	E	< 5	> 5	
Bulu	3	2	3	3	1	6	1	0	3	3	8	11
Pamotan	3	4	3	2	1	3	4	2	2	6	6	12
Gunem	3	3	5	0	0	5	2	1	3	7	4	11
Pancur	4	1	6	0	0	4	3	1	2	5	6	11
Sulang	2	2	5	1	0	4	3	2	0	1	9	10
Sluke	5	3	2	2	2	3	2	2	1	0	12	12
Sarang	7	3	1	0	3	1	1	0	6	0	11	11
Rembang	4	1	2	3	1	4	3	1	3	2	8	10
Kaliori	2	3	2	0	1	4	0	1	3	1	6	7
Lasem	3	3	1	0	1	3	0	1	2	4	3	7
Total	36	25	30	11	10	37	19	11	25	29	73	102

* A: elementary school; B: yunior high school; C: senior high school; D: under/post graduate; ** A: government employees; B: private employees; C: farmer; D: trader: E: others

Table 3. Community knowledge about the existence of wood apple

Knowledge aspects	Respondent number	Percentage	Explanation
The wood apple figure			
Yes	102	100.00	
No	0	0.00	
The status as identity plants			
Yes	81	79.50	
No	21	20.50	
The location of planting			
The yard	63	61.76	There are some respondents who know that wood apple grows in two or more places
Road side	46	45.09	
Plantation	6	5.88	
Number of plants ever seen			
< 5 trees	54	52.94	
5 – 10 trees	24	23.52	
11 – 20 trees	10	9.80	
21 – 30 trees	2	1.96	
> 30 trees	12	11.76	

bark actually have some potencies to be used for various purposes (Pradhan *et al.*, 2012; Patel & Pandey, 2014; Buvanaratchagan & Dhandapani, 2016; Banupriya & Vijayakumar, 2016), but the people of Rembang Regency did not use them at all. The stem, ripe fruit, and young leaf have also many utilities that have not been widely exploited by people of Rembang. It was calculated that there was 70.28% mean of ER or untapped potency; or in other words as much as only 29,72% of potency that had been used. Among the organs used, the fruit had 50% of OUV; it was the greatest and the most widely used by the community (Table 5).

Table 4. Aspects of community knowledge of economic value and utilization of wood apple

Knowledge aspects	Number	Percentage
The economical value		
Know	98	96.07
Do not know	4	3.93
The organs sold		
Fruit	95	93.14
Stem	3	2.94
Do not know	4	3.92
The relative selling point		
High	17	16.67
Medium	11	10.78
Low	60	58.83
Do not know	4	3.92
The benefits		
Know	102	100.00
Do not know	0	0
Experience in utilize		
Yes	82	80.39
No	20	19.61
Frequency of utilize		
ver use	20	19.61
1 - 3 times per month	65	63.72
4 - 6 times per month	4	3.92
7 - 9 times per month	4	3.92
10 - 12 times per month	6	5.89
More than 12 times per month	3	2.94

The majority of respondents (74.51%) aware some techniques of wood apple reproduction, such as seed germinating, stem cutting and grafting (Table 6). Consequently, there are no plantations of wood apple from seedlings raised in nurseries. Moreover, about of half of respondents have never tried to plant wood apple. They commented that wood apple is a demanding species, and its seed germination and growth is very slow.

The low population of wood apple was responded by most respondents that this species needs to be preserved. According to them, the most important conservation effort was increasing the plantation and giving information about the various uses. In addition, it should also be done by making regulations, counseling, banning logging, and land preparation. On the contrary, a small percentage of respondents stated that the wood apple did not need to be conserved because of cheap price, less benefit, little usefulness, and low growth; and frequently the falling fruits cause roof damage (Table 6).

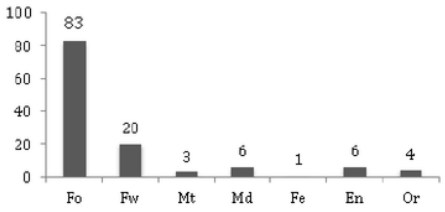

Figure 2. Number of respondents who mentioned types of wood apple usage. Fo: food; Fw: firewood; Mt: materials; Md: medicine; Fe: feed; En: environment/reforestation; Or: ornamental plant

The results above indicated that the main cause of the low wood apple population in Rem-

Table 5. The use of wood apple organs and effort increase needed of the usage

Organ	Factual usage	Number of factual usage	Theoretical usage*	Number of theoretical usage	Efforts increase needed (%)
Root	-	0	used against snakebite	1	100
Stem	Construction	1	Fuel	6	84
			adulterant of gum		
			artists' watercolors, ink, dyes and varnish		
			agricultural implements		
			Construction		
Young leaf	Fodder	1	Fodder	4	75
			intestinal troubles of children		
			dysentery and diarrhea in children		
			used against snakebite		
Ripe fruit	eaten raw	4	eaten raw	6	33
	drunk as a beverage		drunk as a beverage		
	making syrup		frozen as an ice cream		
	medicine		making jelly and jam		
			poulticed onto bites and stings of venomous insects		
Unripe fruit	-	0	liver and cardiac tonic	2	100
			treatment for hiccough, sore throat		
Bark	-	0	used against snakebite	2	50
			applied on venomous wounds.		
Whole plant	Ornamental	2	roadside tree	2	0
	Green plant		Boundary or barrier		
				Mean	63,14

* Pradhan *et al.* (2012), Patel & Pandey (2014), Buvanaratchagan & Dhandapani (2016); Banupriya & Vijayakumar (2016)

bang Regency was not due to the incompatibility of environmental factors for wood apple growth. Wood apple was found in almost all of the observed sub-districts, although the density varied. According to Orwa (2009), this species comes from India and its surroundings. Its origin area is dry and it can grow well at altitudes of up to 450 m with mean annual rainfall of 800-1,200 mm and mean annual temperature of 20-29°C on various soil types. The Rembang region meets the needs of the microclimate because Rembang has a tropical climate type with an average of rainfall is 502.36 mm/year, and daily temperature ranged from 23° C to 33° C. The Rembang region is mostly located on the beach (0-25 m above sea level) and inland (100-500 m above sea level) (Statistics of Rembang Regency, 2016).

The main cause of the low wood apple population was due to the anthropogenic activities, i.e. lack of understanding of the benefits

Table 6. The frequency and value of use of wood apple organs

Organs	Respon-dents number	Percent-age (%)	Usage based on respondent opinion	OUV
Root	0	0	-	0
Stem	23	22.55	Construction	12.50
Young leaf	1	0.09	fodder	12.50
Flower	0	0	-	0
Fruit	83	81.37	eaten raw drunk as a beverage making syrup medicinal	50.00
Bark	6	5.88	medicine	12.50
Whole plant	10	9.80	ornamental tree reforestation	25.00

Table 7. Community knowledge on breeding technique and preservation of wood apple

Aspects of knowledge	Number of respondents	Percentage
Wood apple breeding		
Understand	76	74.51
Do not understand	26	25.49
Known breeding technique		
Seed	70	68.62
Cuttings	9	8.82
Grafting	1	0.98
Do not understand	26	25.48
Breeding experience		
Have experience	52	50.98
Do not have experience	50	49.02
Perception of the preservation		
Needed	83	81.37
Not needed	19	18.63
Preservation technique		
increase usage	24	23.53
increase planting	44	43.14
making local regulations	2	1.96
create identity	12	11.76
others: counseling, provision of superior seeds, ban on logging, land preparation	1	0.98
No needed	19	18.63

and attention to cultivation. The understanding of the benefits and cultivation of a plant species is a part of local knowledge. Traditional knowledge can be said as uniqueness in a community culture in the form of original knowledge, local knowledge and traditional values. Such knowledge covers agriculture, food supply, nature protection, and health. The inheritance system is done orally, using the expression of words in ceremonies, rituals, and customs (Cruz *et al.*, 2013). The

Figure 4. The morphology of wood apple. A. A tree grown at the yard at Sluke. B. The young leaves and flower. C. The pieces of ripe fruit shows brown fruit flesh. D. Fruits on the tree.

traditional knowledge of plants can be realized in the pattern of utilization of plants and traditional agriculture. Local people develop their traditional knowledge in a practical way in which they live. The phenomenon of traditional knowledge can be used as a conservation step (Luizza *et al.*, 2013).

When designing sustainable strategies for management of species stands with implications for local people, the knowledge and use value of the people should be taken into consideration (Cruz *et al.* 2013). Accordingly, the people must be involved in the enhancement of the wood apple population. This involvement will be easier when the people understand the benefits of wood apple. The survey revealed that the majority of respondents understood the economic value of wood apple but the value was considered low. It was caused by the only use of the fruit, otherwise the other organs were almost never used. Consequently, it is necessary to educate community in order to disseminate the potential benefits.

Our results did not reveal a significant trade of wood apple product. This is due to the fact that the cultivation was not carried out on a large scale. Base on this finding, wood apple population should be increased through cultivation of the species in agroforestry systems and preserve on protected areas where they grow. This is the time for propagation of wood apple by planting through seeds germination in the nursery. Muna & Rahayu (2015) suggested that new approaches should be explored, such as mycorrhiza application and compost in planting holes dug several months before planting. This practice has an advantage of creating a favorable microclimate, allowing the roots to survive during the dry season.

This study documented ethnobotanical local knowledge of wood apple. It is hoped that its results will form a basic knowledge for in-depth studies on this species. Future studies on the conservation should focus on the sustainability of utility methods. Biological studies need to be conducted on the medicinal use to generate information that wood apple could be used in future as drug development. The possibilities to improve plant quality through breeding are also need to be done.

CONCLUSION

The results showed that all of respondents knew the figure of wood apple, but only 79.50% of them understood its status as plant identity.

Most of respondents (96%) stated that the fruit has low economic value. There are 80.39% respondents that have utilized ripe fruit as ingredients of beverages and stems as firewood. This utilization was only equal to 29.72% compared to the potential usability based on the research results. The most important outcome was the finding that some respondents thought if conservation efforts should be undertaken, while the others stated that it is unnecessary due to falling fruit frequently cause roof damage and the plants' less economic profit. It was concluded that the traditional knowledge about the existence, economic value, and breeding technique were good; and on the contrary, the knowledge about the usability was bad.

Based on the results, it is suggested to educate local people about the importance of woody apple conservation, as well as to inform and train the various uses.

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