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Mini Review

A Mini Review on Agarwood Tea Development Towards Alternative Utilization of Agarwood Commodity in Indonesia

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Abstract. Agarwood leaves were classified into an underutilized commodity by traditional agarwood farmers in Indonesia. These agarwood leaves have become disposal waste from pruning activity carried by agarwood traditional farmers. Several studies have revealed beneficial health effects of agarwood leaves from *Aquilaria* genus and *Gyrinops* genus, including antioxidant, antibacterial, anti-hyperglycemic, anti-inflammatory, sedative and laxative activity. Some studies also have reported that agarwood leaves from these genera are a source of herbal drink product called "agarwood tea". The distribution of agarwood species from *Aquilaria* genus and *Gyrinops* genus on several islands in Indonesia has been promising to develop this agarwood tea product in Indonesia. Moreover, agarwood leaves utilization into agarwood tea could give Indonesian agarwood farmers additional income during the waiting period of gubal harvesting as the agarwood cultivation's main commodity. Thus, agarwood leaves processing into herbal tea product is valuable alternatives for prospective utilization of agarwood leaves previously underutilized.

Keyword: agarwood leaves, agarwood tea, Indonesia

Introduction

Tea is one of the most popular beverages in the world (Islam and Jang, 2012). This product becomes one of Indonesia's essential beverage products globally (Nayantakaningtyas *et al*., 2017). In Indonesia's domestic market, there was a various type of tea. Conventional tea made from *Camellia sinensis* species was dominated by black tea and green tea (Nugraha *et al*., 2017). Another type of tea that was not made from *Camellia sinensis* in Indonesia well known as herbal tea (Herlambang *et al*., 2011).

Most herbal tea raw material is the main product that cultivated by the farmer. Raw material diversification is needed to improve the development of herbal tea products in the market. Utilization of underutilized raw material from a particular plant as a new source of herbal tea product could bring new fresh types of herbal tea, leading to a diversification product (Harmayani *et al*., 2019). One of the herbal tea products made from the underutilized organ with good promising development in Indonesia is agarwood tea (Karsiningsih, 2016).

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Traditional agarwood farmer in Indonesia has classified agarwood leaves into waste product (Wangiyana, 2020). These agarwood leaves have been produced as waste from the pruning process on agarwood cultivation technology (Wangiyana and Putri, 2019c & d). Agarwood farmers started to utilize agarwood leaves after they have learned that this commodity could be processed into an herbal drink product called agarwood tea (Wangiyana *et al*., 2019a).

There are several benefits of agarwood leaves processing into agarwood tea products. First, agarwood leaves have been reported for their health beneficial chemical compounds that could become prospective herbal drink medicine (Adam *et al*., 2017). Second, agarwood leaves could be harvested periodically to give agarwood farmers additional income during the waiting period of harvesting resin as the main product of agarwood cultivation (Karsiningsih, 2016). Third, agarwood leaves processing into herbal tea involves simple methods that traditional farmers could learn quickly (Wangiyana *et al*., 2019b). This mini-review mainly discusses the promising of agarwood leaves processing into agarwood tea as an alternative product on agarwood cultivation and the development of this product in Indonesia.

Agarwood leaves characteristics as herbal tea source. Herbal tea is essentially an herbal mixture made from leaves, seed, flower, fruit or roots of various plants. However, herbal tea is not made from tea plants (*Camellia sinensis*) (Ravikumar, 2014). Herbal tea has become a famous global beverage that has been used as traditional medicine (Poswal *et al.*, 2019). Several studies have indicated that routine consumption of herbal tea infusions could benefit certain aspects of health (Etheridge and Derbyshire, 2019).

Agarwood leaves could be one of the prospective sources of herbal tea products. Agarwood leaves contain various chemical constituents related to beneficial pharmacological properties for herbal drinks (Adam *et al*., 2017). Several studies have revealed that agarwood leaves both from the *Aquilaria* genus and *Gyrinops* genus have health beneficial effect. *Aquilaria sinensis, Aquilaria malaccensis, Aquilalria agallocha* and *Aquilaria microcarpa* were the *Aquilaria* genus members that have been reported for their beneficial effects. On the other hand, *Gyrinops versteegii* was the only member of the *Gyrinops* genus that has been reported as a source of natural medicine compound (Wangiyana, 2020) (Table 1).

Health beneficial effects of agarwood leaf could give supporting data for the development of agarwood herbal tea product (Adam *et al*., 2017). Health beneficial effect compounds was an essential quality standard of herbal tea product (Poswal *et al.*, 2019). Health beneficial effect compounds was an essential quality standard of herbal tea product (Srivastava *et al*., 2010), mulberry tea (Killedar and Pawar, 2017), cinnamon tea (Bernardo *et al.*, 2015), chrysanthemum tea (Shahrajabian *et al.*, 2019) and lemon balm tea (Yui *et al.*, 2017).

Maintaining quality of agarwood tea product. Maintaining quality products is the next challenge for agarwood tea development. Standardization of the product was one of the essential things in the quality control of herbal products. Good standardization of the herbal product could carry an assurance of quality, efficacy, safety, and reproducibility (Kunle *et al*., 2012). There were three factors on the standardization of agarwood tea to ensure a good quality product. These three factors are raw material, processing method, and finishing product (Fig. 1).

Agarwood leaves as the raw material of agarwood tea and has an essential role in the quality product. Not all of the agarwood species from the Thymeleaceae family could be processed into agarwood tea. Agarwood tea commonly was made from agarwood leaves of the *Aquilaria* genus (Adam *et al*., 2017) and *Gyrinops* genus (Samsuri and Fitriani, 2013). Agarwood leaves condition also has affected the quality of agarwood tea. Several leaves condition that could affect agarwood tea

Table 1. Health beneficial effect of agarwood leaves

Health beneficial effect	Agarwood species	Reference
Antioxidant activity	*Aquilaria sinensis*	(Duan *et al.*, 2015)
	Aquilaria malaccensis	(Batubara *et al.*, 2020)
	Aquilaria sinensis	(Dahham *et al.*, 2015)
	Gyrinops versteegii	(Prihantini and Rizqiani, 2019; Parwata *et al*., 2018)
Antibacterial activity	*Aquilaria sinensis*	(Kamonwannasit *et al.*, 2013)
	Aquilaria agallocha	(Dash *et al*., 2008)
	Aquilaria microcarpa	(Sari *et al*., 2017)
	Gyrinops versteegii	(Wangiyana *et al*., 2020)
Antidiabetic activity	*Aquilaria malaccensis*	(Zulkifle, 2018)
Antihyperglycemic activity	*Aquilaria sinensis*	(Pranakhon *et al*., 2011)
Aphrodisiac properties	*Aquilaria malaccensis*	(Che Musa *et al*., 2019)
Anti-inflammatory activity	*Aquilaria malaccensis*	(Eissa *et al*., 2018)
Anticancer potency	*Aquilaria malaccensis*	(Millaty *et al.*, 2020)
~~Laxative activity~~	~~*Aquilaria sinensis*~~	~~(Hara *et al*., 2008)~~
Hepatoprotective potency	*Aquilaria agallocha*	(Alam *et al*., 2017)
Anti-arthritic activity	*Aquilaria agallocha*	(Rahman *et al*., 2016)
Anti-tumor potency	*Aquilaria sinensis*	(Wang *et al.*, 2008)
Anti-nociceptive activity	*Aquilaria sinensis*	(Zhou *et al.*, 2008)
Anti-metastasis and cytotoxic potency	*Gyrinops versteegii*	(Septia and Wijayanti, 2019)
Sunscreen potency	*Gyrinops versteegii*	(Wahyuningrum *et al*., 2018)
Sedative and relaxing effect	*Aquilaria malaccensis*	(Kamaluddin *et al.*, 2017)

product including the maturity of leaves (Wangiyana *et al.*, 2018), the position of leaves on agarwood tree (Adrianar *et al*., 2015), shape and size of leaves (Simatupang *et al.*, 2015) and source of leaves whether from induction tree or non-induction tree (Nasution *et al*., 2015).

The processing method of agarwood leaves into agarwood tea had an essential role in the quality product. The processing method should have a standard protocol for the reproducible batch to batch product (Kunle *et al*., 2012). There were three standard protocols for agarwood leave processing: sterilization, drying, and chopping (Wangiyana and Putri, 2020). Oxidation was an additional option on the processing method. This protocol affected the type of agarwood tea as well as the different taste of the tea (Wangiyana *et al.*, 2018).

A suitable finishing product protocol should follow the standardization of raw material and processing methods. The packaging was the most crucial part of finishing herbal products (Masand *et al*., 2017). Packaging of agarwood tea depends on the final product, whether it is a tea bag or a brewed tea product. Commonly, agarwood tea was sold in the form of teabag products (Karsiningsih, 2016). Teabag product has a longer shelf life than brewed tea product. standardization of teabag product is much easier than standardization of brewed tea product since many factors have affected the brewing process (Wangiyana and Putri, 2019c).

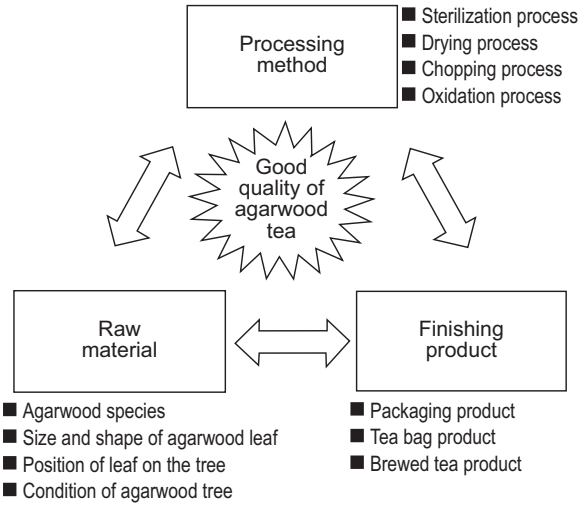

Fig. 1. Factor affecting quality of agarwood tea (Wangiyana and Putri, 2020; Adrianar *et al*., 2015; Simatupang *et al.*, 2015)

Agarwood tea development on Indonesia. Agarwood tea products are mainly manufactured in China, Malaysia and Indonesia. This herbal tea is well known as "Chenxiang Tea" in China and has been reported to its toxicology assessment of safety (Wu *et al.*, 2007). Agarwood tea has recently emerged as a contemporary herbal drink in Malaysia (Adam *et al*., 2017). Agarwood tea in Indonesia is well known as "teh gaharu" and was first reported on a research paper in 2013 (Samsuri and Fitriani, 2013). Since then, agarwood tea products in Indonesia has been developed rapidly as a new type of herbal tea with good economic feasibility (Karsiningsih, 2016).

The development of agarwood tea in Indonesia has been done in several regions, where agarwood tea production has been reported. These regions are well distributed in Indonesia's islands, including Sumatra, Bangka, Java, Kalimantan, Sulawesi, Bali and Lombok (Fig. 2). Agarwood tea development in these regions could be divided into two schemes: research and development and home industry.

Research and development scheme for agarwood development has been conducted mainly on Sumatra Island, Bangka Island, and Lombok Island. This scheme put research and scientific method to improve the quality of agarwood products. The improvement of agarwood tea products was conducted in many aspects (Table 2).

Research and development of agarwood tea on Sumatera Island and Bangka Island have used agarwood leaves from *Aquilaria mallacensis* species. Sumatra Island and

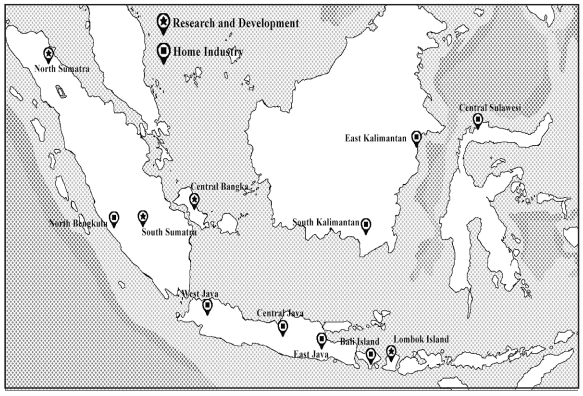

Fig. 2. Distribution of agarwood tea utilization region in Indonesia (Batubara *et al.*, 2020; Wangiyana and Samiun, 2018; Kamaluddin *et al.*, 2017; Karsiningsih, 2016)

Table 2. Improvement aspect of research and development scheme on agarwood tea development product

Improvement aspect	Region	Reference
Raw material selection	North Sumatra	(Adrianar *et al*., 2015; Simatupang *et al.*, 2015)
Leaves processing method	North Sumatra	(Nasution *et al*., 2015)
	Lombok Island	(Wangiyana *et al*., 2019a; Samsuri and Fitriani, 2013)
Phytochemical screening	North Sumatra	(Batubara *et al*., 2018)
	Lombok Island	(Wangiyana *et al.*, 2018)
Additional ingredient formulation	Lombok Island	(Wangiyana *et al.*, 2019)
Safety and medical assessment	North Sumatra	(Surjanto *et al*., 2019; Batubara *et al.*, 2017)
	South Sumatra	(Kamaluddin *et al.*, 2017)
Marketing product strategy	Central Bangka	(Karsiningsih, 2016)
	North Sumatra	(Ginting *et al*., 2016)

Bangka Island were a natural habitat of *A. mallacensis* species (Roemantyo and Partomihardjo, 2010). Improvement of the agarwood tea product was conducted in many aspects. These improvements based on research were covered every stage of agarwood tea development form raw material selection to marketing product strategy (Karsiningsih, 2016; Adrianar *et al*., 2015).

Research and Development of agarwood tea on Lombok Island have used agarwood leaves from *Gyrinops versteegii* species. This agarwood species was an endemic species from Lombok Island and Nusa Tenggara (Mulyaningsih and Yamada, 2008). Improvement research of *Gyrinops versteegii* agarwood tea was focused on leaf processing methods (Wangiyana *et al.*, 2018). Additional ingredient formulation for agarwood tea was also conducted for improvement (Wangiyana *et al.*, 2019b).

The home industry scheme for agarwood tea development was more straightforward than the research and development scheme for agarwood tea development. Several regions in Indonesia are the center of agarwood tea home industrial products with different product brands. Those product brands are Teh Gaharu Royal Original (west Java), Teh Gaharu Nogosari (central Java), Teh Tubruk Gaharu (east Java), Teh Gaharu Sekatup (east Kalimantan), Teh Gaharu Masindo (south Kalimantan), Teh Gaharu GHAZARD FREEDOM (central Sulawesi), Teh Gaharu Sanchita (Bali Island). These brands have been registered on several Indonesian E-commerce websites (tokopedia.com; bukalapak.com; shopee.com; blibli.com; lazada.co.id). Many agarwood tea brand products indicate that the agarwood tea product was quite famous among Indonesian people as one of the herbal medicinal products. However, this home industry product needs more innovation for product development. This product development should have applied science and technology approaching method to make better its quality (Pelkonen *et al*., 2014).

Agarwood tea has been classified into traditional herbal medicine beverage products on the Indonesian market share. Traditional herbal medicine in Indonesia is well known as "jamu." Jamu product needs a scientific method approaching its development (Sumarni *et al*., 2019). Moreover, it is essential to enforce product certification and legal protection of traditional herbal products in the modern food industry era. This enforcement will improve the development of agarwood tea products in Indonesia as a standard herbal medicine beverage (Purwaningsih *et al*., 2016).

Agarwood tea development challenge in Indonesia. The main challenge of agarwood tea development in Indonesia was the standardization of the product. Agarwood tea products in Indonesia were mainly made from two agarwood species producer: *Aqiularia malaccensis* and *Gyrinops versteegii*. However, most home industry centers of agarwood tea in Indonesia have never described their product's agarwood species source. Most of them just state that their product was made from agarwood leaves. In fact, agarwood tea made from *Aquilaria* was different from agarwood tea made from *Gyrinops* based on phytochemical analysis (Batubara *et al.*, 2020; Wangiyana *et al.*, 2019a, b, c & d).

Agarwood leaves both from *Aquilaria* and *Gyrinops* commonly contain flavonoids, terpenoids, and tannins, which are classified into antioxidant activity compounds. However, Agarwood leaves from *Aquilaria malaccensis* contain saponins compounds (Surjanto *et al.*, 2019). This compound could not be found on *Gyrinops versteegii* leaves (Mega and Swastini, 2012). Saponins are the foaming agent in the beverage industry that responsible for the bitter taste of the product. Thus,

Table 3. Various tannin concentration of agarwood tea product

Location	Region	Agarwood species	Tannin concentration	Reference
Laru	North Sumatera	*A. malaccensis*	5.62%	(Batubara *et al.*, 2020)
Hutanbolon	North Sumatera	*A. malaccensis*	3.08%	
Langkat	North Sumatera	*A. malaccensis*	2.34%	(Adrianar *et al*., 2015)
Sigiring – giring	North Sumatera	*A. malaccensis*	7.94%	(Surjanto *et al.*, 2019)
S.Kalangan II	North Sumatera	*A. mallacensis*	8.71%	
Langko	Lombok Island	*G. versteegii*	7.70%	(Wangiyana *et al.*, 2018)
Duman	Lombok Island	*G. versteegii*	5.28%	(Wangiyana *et al.*, 2019a, b, c, & d)

agarwood tea made from *A. malaccensis* and agarwood tea made from *G. versteegii* should have slightly different flavour on the bitterness (Moghimipour and Handali, 2015).

Phytochemical standardization of agarwood tea products could have adapted the standardization of conventional tea products that have been settled. Tannin is one of the essential compounds that has been approved as conventional tea's quality product standardization (Yadav *et al.*, 2020). Conventional tea has various tannin concentrations depend on its type. Black tea has the highest tannin concentration among conventional tea with 13.36%, followed by Oolong tea with 8.66% and green tea with 2.65% (Khasnabis *et al*., 2015).

Agarwood tea's tannin concentration depends on agarwood species as the agarwood species' raw material and habitat location (Table 3). However, there are no specific agarwood tea types based on tannin concentration as standard, just like conventional tea. This classification based on tannin concentration standard will lead to the fast development of agarwood tea as a new type of herbal tea (Wangiyana *et al.*, 2019).

Conclusion

The utilization of agarwood leaves into herbal tea product was an excellent alternative utilization of agarwood commodities. Processing agarwood leaves into herbal tea product has given additional income for traditional agarwood farmers during the waiting period of agarwood resin production. Agarwood tea products were developed in several islands in Indonesia, including Sumatra, Bangka, Java, Bali, Lombok, Kalimantan and Sulawesi. The development of this product was mainly conducted based on a research and development scheme. This herbal tea also was developed in the form of home industry products with several brands that have been registered on the Indonesian E-commerce website. Phytochemical standardization, based on tannin concentration, is essential for the further development of agarwood tea products.

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References

Adam, A.Z., Lee, S.Y., Mohamed, R. 2017. Pharmacological properties of agarwood tea derived from *Aquilaria* (Thymelaeaceae) leaves: An emerging contemporary herbal drink. *Journal of Herbal Medicine*, **10:** 37-44.

Adrianar, N., Batubara, R., Julianti, E. 2015. Value of consumers preference towards to agarwood tea leaves (*Aquilaria malaccensis* Lamk) based on the location of leaves in the trunk. *Peronema Forestry Science Journal*, **4:** 12-16.

Alam, J., Mujahid, M., Rahman, M.A. 2017. Hepatoprotective potential of ethanolic extract of *Aquilaria agallocha* leaves against paracetamol induced hepatotoxicity in SD rats. *Journal of Traditional and Complementari Medicine*, **7:** 9-13.

Batubara, R., Surjanto, Shiombing, T.M., Ginting, H. 2016. The safety of tea agarwood (*Aquilaria malaccensis*) from tree induction through test of toxicity subchronic Oral 90 Days. *Biofarmasi Journal of Natural Product Biochemistry*, **14:** 69-76.

Batubara, R., Surjanto, Hanum, T.I., Handika, A., Affandi, O. 2020. The screening of phytochemical and antioxidant activity of agarwood leaves

(*Aquilaria malaccensis*) from two sites in north Sumatra, Indonesia. *Biodiversitas*, **21:** 1588-1596.

Batubara, R., Hanum, T.I., Surjanto. 2018. Phytochemical and tannin content in two species of agarwood leaves from Mandailing Natal Regency north Sumatera province. In: *AIP Conference Proceedings*, *The 3rd International Seminar on Chemistry: Green Chemistry and its Role for Sustainability*, pp. 1-5, Surabaya, Indonesia.

Bernardo, M.A., Silva, M.L., Santos, E., Moncada, M.M., Brito, J., Proenca, L., Singh, J., de Mesquita, M.F. 2015. Effect of Cinnamon tea on postprandial glucose concentration. *Journal of Diabetes Research*, **2015:** 1-6.

Che Musa, N.H., Mohd Zain, H.H., Ibrahim, H. 2019. Aphrodisiac properties of *Aquilaria malaccensis* leaves aqueous extract in ICR mice. *Journal of Research in Pharmacy*, **23:** 130-140.

Dahham, S.S., Tabana, Y.M., Iqbal, M.A., Ahmed, M.B.K., Ezzat, M.O., Majid, A.S.A., Majid, A.M.S.A. 2015. The anticancer, antioxidant and antimicrobial properties of the sesquiterpene β-caryophyllene from the essential oil of *Aquilaria crassna*. *Molecules*, **20:** 11808-11829.

Dash, M., Patra, J.K., Panda, P.P. 2008. Phytochemical and antimicrobial screening of extracts of *Aquilaria agallocha* Roxb. *African Journal of Biotechnology*, **7:** 3531-3534.

Duan, Z., Li, W., Dou, Z., Xie, H., He, A., Shi, M. 2015. Extraction and antioxidant activity of flavonoids from *Aquilaria sinensis* (Lour) Gilg leaves. *Journal of Food Science*, **36:** 45-50.

Eissa, M., Hashim, Y.Z.H., Zainurin, N.A.A. 2018. *Aquilaria malaccensis* leaf as an alternative source of anti-inflammatory compounds. *International Journal on Advance Science Engineering Information Technology*, **8:** 1625-1632.

Etheridge, C.J., Derbyshire, E. 2019. Herbal infusion and health a review of findings from human studies mechanisms and future research direction. *Nutrition & Food Science*, **50:** 969-985.

Ginting, R.B., Batubara, R., Ginting, H. 2016. Tingkat Kesukaan Masyarakat Terhadap Teh Daun gaharu (*Aquilaria mallacensis* Lamk.) Dibandingkan Teh Lain yang Beredar Di Pasaran. *Peronema Forestry Science Journal*, **4:** 214-217.

Hara, H., Ise, Y., Morimoto, N., Shimazawa, M., Ichihashi, K., Ohyama, M., Iinuma, M. 2008. Laxative effect of Agarwood leaves and its mechanism. *Bioscience, Biotechnology and Biochemistry*, **72:** 335-345.

Harmayani, E., Anal, A.K., Wichienchot, S., Bhat, R., Gardjito, M., Santoso, U., Siripongvutikorn, S., Puripaatanavong, J., Payyappallimana, U. 2019. Healthy food traditions of Asia: Exploratory case studies from Indonesia, Thailand, Malaysia, and Nepal. *Journal of Ethnic Foods*, **6:** 1-18.

Herlambang, E.S., Hubeis, M., Palupi, N.S. 2011. Study on consumer behavior marketing strategy of herbal tea in the city of Bogor. *Manajemen IKM*, **6:** 85-93.

Islam, M.M., Jang, H.H. 2012. Perceived quality and attitude toward tea and coffee by consumers. *International Journal of Business Research and Management*, **3:** 100-112.

Kamaluddin, M.T., Yuliarni, Agustin, Y., Parisa, N., Hidayat, R., Wahyuni, T., Yuliana, C., Perryanis. 2017. Efek Sedativa dan Kebugaran Teh Celup Daun Gaharu (*Aquilaria malaccensis* L). *Jurnal Jamu Indonesia*, **2:** 114-119.

Kamonwannasit, S., Nantapong, N., Kumkrai, P., Luecha, P., Kupittayanant, S., Chudapongse, N. 2013. Antibacterial activity of *Aquilaria crassna* leaf extract against *Staphylococcus epidermidis* by disruption of cell wall. *Annals of Clinical Microbiology and Antimicrobials*, **12:** 1-7.

Karsiningsih, E. 2016. Analisis Kelayakan Finansial dan Strategi Pengembangan Teh Gaharu di Kabupaten Bangka Tengah (Studi Kasus: Teh Gaharu "Aqilla" Gapoktan Alam Jaya Lestari). *AGRARIS: Journal of Agribusiness and Rural Development Research*, **2:** 143-151.

Khasnabis, J., Rai, C., Roy, A. 2015. Determination of tannin content by titrimetric method from different types of tea. *Journal of Chemical and Pharmaceutical Research*, **7:** 238-241.

Killedar, S.G., Pawar, A.V. 2017. Preparation of herbal tea from mulberry leaves. *Journal of Medicinal Plants Studies*, **5:** 325-328.

Kunle, O.F., Egharevba, H.O., Ahmadu, P.O. 2012. Standardization of herbal medicines - A review. *International Journal of Biodiversity and Conservation*, **4:** 101-112.

Masand, S., Madan, S., Balian, S.K. 2017. Modern concept of storage and packaging of raw herbs used in Ayurveda. *International Journal of Research in Ayurveda and Pharmacy*, **5:** 242-245.

Mega, I., Swastini, D. 2012. Screening fitokimia dan aktivitas antiradikal bebas ekstrak metanol daun gaharu (*Gyrinops versteegii*). *Jurnal Kimia*, **4:** 187-

192.

Millaty, I.N.K., Wijayanti, N., Hidayati, L., Nuringtyas, T.R. 2020. Identification of anticancer compounds in leaves extracts of agarwood (*Aquilaria malaccensis* (Lamk.)), In: *IOP Conference Series: Earth and Environmental Science*, **457** (012036)**:** 1-8

Moghimipour, E., Handali, S. 2015. Saponin: properties, methods of evaluation and applications. *Annual Research & Review in Biology*, **5:** 207-220.

Mulyaningsih, T., Yamada, I. 2008. Notes on some species of agarwood in Nusa Tenggara, Celebes and west Papua. In: *Natural Resource Management and Socio-economic Transformation Under Decentralization in Indonesia: Toward Sulawesi Area Studies*, pp. 365-372, CSEAS Kyoto University, Kyoto, Japan.

Nasution, P.A., Batubara, R., Surjanto. 2015. Level of antioxidants power and society interest of aloes tea (*Aquilaria malaccensis* Lamk) based on induction and non-induction tree. *Peronema Forestry Science Journal*, **4:** 10-21.

Nayantakaningtyas, J.S., Daryanto, A., Saptono, I.T. 2017. Competitiveness of Indonesian tea in International market. *Indonesian Journal of Business and Entrepreneurship*, **3:** 14-23.

Nugraha, A., Sumarwan, U., Simanjuntak, M. 2017. Determinant factors of preferences and consumtion behaviour of black and green tea. *Jurnal Manajemen dan Agribisnis*, **14:** 198-208.

Parwata, A., Manuaba, P., Yasa, S. 2018. The potency of flavonoid compounds in water extract *Gyrinops versteegii* leaves as natural antioxidants sources. *Biomedical and Pharmacology Journal*, **11:** 1501-1511.

Pelkonen, O., Xu, Q., Fan, T.P. 2014. Why is research on herbal medicinal products important and how can we improve its quality?. *Journal of Traditional and Complementary Medicine*, **4:** 1-7.

Poswal, F.S., Rusell, G., Mackonochie, M., MacLennan, E., Adukuwu, E.C., Rolfe, V. 2019. Herbal teas and their health benefits: a scoping review. *Plant Food for Human Nutrition*, **74:** 266-276.

Pranakhon, R., Pannangpetch, P., Aromdee, C. 2011. Antihyperglycemic activity of agarwood leaf extracts in STZ-induced diabetic rats and glucose uptake enhancement activity in rat adipocytes rats and glucose uptake enhancement activity in rat adipocytes. *Songklanakarin Journal of Science and Technology*, **33:** 405-410.

Prihantini, A.I., Rizqiani, K.D. 2019. Various antioxidant assays of agarwood extracts (*Gyrinops versteegii*) from west Lombok, West Nusa Tenggara, Indonesia. *Asian Journal of Agriculture*, **3:** 1-5.

Purwaningsih, E., Huda, N., Ulfah, A.R. 2016. Product certification and legal protection to enhance Indonesian traditional herbal productions. *Mimbar Hukum*, **27:** 566-578.

Rahman, H., Eswaraiah, M.C., Dutta, A.M. 2016. Anti-arthritic activity of leaves oil of *Aquilaria agallocha*. *Saudi Journal of Life Science*, **1:** 34-43.

Ravikumar, C. 2014. Review on herbal teas. *Journal of Pharmaceutical Sciences and Research*, **6:** 236-238.

Roemantyo, Partomihardjo, T. 2010. Natural distribution prediction analyses of Agarwood genera of *Aquilaria* and *Gyrinops* in Indonesia. *Berita Biologi*, **10:** 189-198.

Samsuri, T., Fitriani, H. 2013. Pembuatan Teh dari Daun Gaharu Jenis *Gyrinops versteegii*. *Jurnal Ilmiah Biologi Bioscientist*, **1:** 137-144.

Sari, R., Muhani, M., Fajriaty, I. 2017. Uji aktivitas antibakteri ekstrak etanol daun gaharu (*Aquilaria microcarpa* Baill.) Terhadap Bakteri *Staphylococcus aureus* dan *Proteus mirabilis*. *Pharmaceutical Science and Research*, **4:** 143-154.

Septia, Y., Wijayanti, N. 2019. Antimetastasis Ekstrak Kloroform Daun Gaharu *Gyrinops versteegii* (Gilg.) Domke terhadap Cell Line Kanker Payudara T47D. *Undergraduate Thesis*, Universitas Gadjah Mada, Yogyakarta, Indonesia.

Shahrajabian, M.H., Sun, W., Zandi, P., Cheng, Q. 2019. A review of Chrysanthemum the eastern queen in traditional Chinese medicine with healing power in modern pharmaceutical science. *Applied Ecology and Environmental Research*, **17:** 13355-13369.

Simatupang, J., Batubara, R., Julianti, E. 2015. Consumers acceptance and antioxidant of the Agarwood (*Aquilaria malaccensis* Lamk.) leaves tea based on the shape and size of leaves. *Peronema Forestry Science Journal*, **4:** 1-11.

Srivastava, J.K., Shankar, E., Gupta, S. 2010. Chamomile: A herbal medicine of the past with bright future. *Molecular Medicine Report*, **3:** 895-901.

Sumarni, W., Sudarmin, S., Sumarti, S.S. 2019. The scientification of jamu: a study of Indonesian's traditional medicine. *Journal of Physics: Conference Series*, **1321:** 1-7.

Surjanto, S., Batubara, R., Hanum, T.I., Pulungan, W.

2019. Phytochemical and antioxidant activity of gaharu leaf tea (*Aquilaria malaccensis* Lamk) as raw material of tea from middle Tapanuli regency, north Sumatera Province. In: *IOP Conference Series: Earth and Environmental Science*, *International Conference on Agriculture, Environment and Food Security*, pp. 1-6, Medan, Indonesia.

Surjanto, S., Batubara, R., Rangkuti, D.S. 2019. Safety test of agarwood leaves tea (*Aquilaria malaccencis* lamk.) through skin sensitization test on Albino Rabbit. *Open Access Macedonian Journal of Medical Sciences*, **7:** 3896-3899.

Wahyuningrum, M., Sari, R.K., Rafi, M. 2018. Antioxidant activity and sunscreen of *Gyrinops versteegii* leaf extract. *Jurnal Ilmu Teknologi Kayu Tropis*, **16:** 141-149.

Wang, H., Zhou, M., Lu, J., Yu, B. 2008. Antitumor constituent from leaves of *Aquilaria sinensis* (Lour) Gilg'. *Linchan Huazue Yu Gongye*, **28:** 1-5.

Wangiyana, I.G.A.S. 2020. Medicinal effect review of agarwood leaves from *Aquilaria* and *Gyrinops* genera. *Jurnal Silva Samalas*, **3:** 36-43.

Wangiyana, I.G.A.S., Akram, Isbulloh, F. 2020. Comparison of antibacterial activities of agarwood (*Gyrinops versteegii*) resin and leaf crude extract. *Jurnal Bioteknologi & Biosains Indonesia*, **7:** 28-36.

Wangiyana, I.G.A.S., Putri, D.S. 2020. *Modul Pembuatan Teh Gyrinops Teh Gaharu Asli Pulau Lombok*. University Nusa Tenggara Barat, Mataram, Indonesia.

Wangiyana, I.G.A.S., Putri, D.S., Triandini, I.G.A.A.H. 2019a. Pelatihan pengolahan daun gaharu menjadi teh herbal untuk istri petani anggota kelompok tani desa Duman. *Logista Jurnal Ilmiah Pengabdian Kepada Masyarakat*, **3:** 82-89.

Wangiyana, I.G.A.S., Sawaludin, Nizar, W.Y., Wangiyana, W. 2019b. Tannin concentrations of Gyrinops tea with different leaf processing methods and addition of herbal medicine ingredients Tannin concentrations of Gyrinops tea with different leaf processing methods and addition of herbal medicine ingredients. In: *AIP Conference Proceedings*, *2nd International Conference on Bioscience, Biotechnology, and Biometrics*, pp. 1-7, Lombok, Indonesia.

Wangiyana, I.G.A.S., Putri, D.S. 2019c. 'Teh Gyrinops: Produk Inovatif dari Istri Petani Desa Duman Kecamatan Lingsar Kabupaten Lombok Barat. In: *Prosiding PEPADU*, *Seminar Nasional Pengabdian Kepada Masyarakat*, pp. 388-396, Lombok, Indonesia.

Wangiyana, I.G.A.S., Putri, D.S. 2019d. Aplikasi Zat Pengatur Tumbuh dan Kegiatan Pruning Dalam Optimalisasi Budidaya Gaharu Di Desa Duman Kecamatan Lingsar Lombok Barat. *Lumbung Inovasi*, **4:** 1-7.

Wangiyana, I.G.A.S., Samiun. 2018. Characteristic of Agarwood tea from *Gyrinops versteegii* fresh and dry leaves. *Jurnal Sangkareang Mataram*, **4:** 41-44.

Wangiyana, I.G.A.S., Triandini, I.G.A.A.H., Putradi, D., Wangiyana, W. 2018. Tannin concentration of Gyrinops tea from leaves of Juvenile and mature Agarwood trees *Gyrinops versteegii* Gilg (Domke) with different processing methods. *Journal of Chemical and Pharmaceutical Research*, **10:** 113-119.

Wu, A., Zheng, D., Huang, Y., Wang, Z., Zhang, X. 2007. Toxicology assesment of safety of Chenxiang tea in Hainan. *China Tropical Medicine*, **7:** 1226-1227.

Yadav, K.C., Parajuli, A., Khatri, B.B., Shiwakoti, L.D. 2020. Phytochemicals and quality of green and black teas from different clones of tea plant. *Journal of Food Quality*, **2020:** 1-13. doi: 10.1155/2020/8874271.

Yui, S., Fujiwara, S., Harada, K., Motoike-Hamura, M. 2017. Beneficial effects of lemon balm leaf extract on *in vitro* Glycation of proteins, arterial stiffness, and skin elasticity in healthy adults. *Journal of Nutritional Science Vitaminology*, **63:** 59-68.

Zhou, M., Wang, H., Soulangjiba, Kou, J., Yu, B. 2008. Antinociceptive and anti-inflammatory activities of *Aquilaria sinensis* (Lour.) Gilg. leaves extract. *Journal of Ethnopharmacology*, **117:** 345-350.

Zulkifle, N.L.B. 2018. *Antidiabetic Activity of Aquilaria malaccensis (Agarwood) Leaves Extracts*. Master Thesis, Universiti Malaysia Pahang, Malaysia.