Leveraging Ethnobotany to Unlock The Green Economy Potential of Flores Through Local Textile Industry

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Abstract. Flores is an island in Wallacea with a rich diversity of more than 150 plant species, some of which are endemic, such as Begonia kelimutuensis and Rhododendron renschianum. Plants have a critical role in ecological functions, such as carbon storage, water and air purification, and mitigation of climate change. They also provide an opportunity to develop a green economy for increasing the livelihoods of local people. Green economy consists of the efficient use of natural resources, low-carbon economic activities, and social inclusion. This paper aims to formulate a green economy strategy for Flores by evaluating the natural capital assets, which include plants and its associated local wisdom, as a recommendation for government authorities, local community, and other stakeholders. There are at least 6 published ethnobotanical research of Flores, particularly in Ruteng Mountains, Manggarai Barat, and Ngada. These studies uncover the rich local wisdom in utilizing plants. We envisage strategic approach to leverage this potential, which involves on the development of utilization of local plants for textile industry. Together, this analysis is targeted for paving the way to unlock Flores socio-economically important plants to improve the life quality of rural communities and beyond.

Keywords: Local Wisdom, Green Economy, Local Culture, Natural Textile Materials

1. Introduction
With more than 150 species of plants growing fruitful in the land of Flores, making the island to be one of Indonesia’s floral biodiversity hotspot. Biodiversity of plants growing in Flores are widespread across the island, one famous area is namely Kelimutu National Park which holds around 100 plant species from 36 families. The plants include Casuarina equisetifolia, Schleichera oleosa, and Alstonis scholaris. Two of Flores’ endemic plants can also be found in Kelimutu National Park as well, which are Begonia kelimutuensis and Rhododendron renschianum [1]. This diversity should be utilized or else it would go...
to waste; thus, a growth of green economy has to be developed. Green economy is defined as an economical field which involve the improvement of human and social well-being and quity, while also preserving the nature by reducing the environmental impact of economic activities [2]. In the development of green economy growth, involvement of locals can be significant since locals have lived alongside the plants for years and understand how to manage it [3]. Developing local plants through ethnobotanical study can help increasing the socioeconomic state of the locals, therefore this study becomes important.

One alternative to utilize ethnobotanical study of local plants is through the local textile industry. Out of many industries in the world, textile industry is one of the most growing industry globally. Like many other industries, the growth of textile industry is fluctuating, but it is one of the most promising and everlasting industry. Not only that, textile industry also involves the human resources in it as well, thus it is affecting the economical dynamics of human resources [4]. Textile industry is known to be accountable for 2% of the Global Gross Domestic Product (GDP) with industry’s value to be as high as US$1,781 trillion by 2010 [5]. World Trade Organization (WTO) announced in their 2018 review that the value of textile export industry globally reached US$296.1 billion, increased by 4.2% from 2016, where it accounts for 6% of world’s export of manufactured goods [6]. It is estimated that global textile industry will increase by 4.7% until 2025 [7]. In Indonesia, textile industry keeps increasing where in 2011, consumption of textile and product of textile reached 4.4kg per capita [8]. The first quartal of 2019 accounts textile industry’s growth in the country by 18.98% than in 2018. It is estimated that this industry will keep growing in the country [9].

There are several materials included in the textile industry, two of the most important materials are fabrics and dye. For long, synthetic materials have been used to replace natural materials for its stability and consistency. Synthetic materials were made to make things easier and materials produced stably. Despite that, synthetic materials tend to leave a quiet huge impact on the environment. Synthetic fibers production requires big energy, are undegradable, and most likely to be shed on every wash [10]. Averagely, jackets that were made out of synthetic fleece fiber shed 1.7 grams of microfibers, and twice as many when they are older, on each wash. These microplastics are entering rivers, lakes, and oceans, which will end up entering the animals living in the water, thus potentially poisoning the food chain [11]. Like synthetic fibers, synthetic dyes are also leaving impacts on the environment. around 10-15% of textile dyes are discharged into the water on every production, which leads to polluted water. Every year, around 200,000 tons of dyes are discharged into water and managed to escape wastewater treatment due to their stability against light, temperatures, water, and soap [12]. Synthetic dyes that entered the water system is very dangerous for the organisms living in it, because often times, they contained formaldehyde, chlorine, lead, and mercury, that are very hazardous [13].

Environmental impact leads to enhancement of market’s awareness, where buyers now tend to choose products that are more environmentally friendly [14]. More and more fashion houses are promoting this trend, where they start to produce more environmentally friendly products [15]. This trend should continue to thrive, so environmental impact left from textile industry can be decreased as much as possible. One way to do this is to do a shift to use natural and degradable materials, such as natural fibers and dyes. Shifting to natural textile materials can involve various sources, one of them is plant to be natural fibers and dyes. This movement can also include the ethnobotanical study that embrace the locals, therefore improving the socioeconomic state of the locals.

In this paper, we accentuate some local plants suited for local textile industry as an alternative to natural-based textile materials, suitable method of the material production, and the underseen value of chosen materials.

2. Methods
Information of natural materials were done with a careful selection of plants that grows abundantly on the land of Flores by analyzing habitat of the selected plants. Then, we selected some plants that shows the ability to be used as natural textile materials; natural fibers and natural colorants that have antimicrobial and UV-protection properties.
3. Result and Discussion

Fabric is an important material in the textile industry, where it will be the “backbone” of a clothing product. Fiber should be strong, long, and flexible enough to be appropriate for a textile material [16]. Textile fibers can be made out of natural or synthetic sources. Natural sources include cotton or jute fibers, while synthetic ones include polyester, nylon, and rayon. Synthetic fibers are usually made out of chemical substances, like aliphatic carbon groups [17]. While in the other hand, textile dyes can also be categorized into their sources, which are from natural sources or synthetic ones. Natural dyes are usually obtained from plants, animals, or minerals, but synthetic dyes are made out of organic substances. Some notable synthetic dyes are mauvine (mauve), rhodamine (red), and methylene blue [18].

In the effort of switching to natural textile materials, we had selected 8 local plant species that has been used and has potential to be used as natural materials in textile industry in Table 1. Some plant species chosen has been used in many areas outside of Flores Island. Providing this data may develop the utilization of the plants.

Table 1. List of local plants used and potentially used as natural materials.

| Plants                     | Vernacular Names                  | Material Types | Additional Properties              |
|----------------------------|-----------------------------------|----------------|------------------------------------|
| Gossypium spp.             | Kapas (Cotton)                    | Fiber          | -                                  |
| Ananas comosus             | Nanas, Nenas (Pineapple)          | Fiber          | -                                  |
| Boehmeria nivea            | Rami (Ramie)                      | Fiber          | Microbes and insect resistant      |
| Punica granatum            | Delima, Gangsalan (Pomegranate)   | Colorant       | Antimicrobial                      |
| Quercus infectoria         | Manjakani (Gall nuts)             | Colorant       | Antimicrobial                      |
| Garcinia dulcis            | Mundu, Apel Jawa                  | Colorant       | UV-protection                      |
| Indigofera tinctoria       | Indigo, Tarum, Nila, Tom          | Colorant       | UV-protection                      |
| Vaccinium varingiaefolium  | Cantigi Ungu, Cantigi Gunung, Manisrejo | Colorant | UV-protection                      |

3.1. Natural fibers

Natural fibers can be defined as fibers that is made out of natural sources, may it be from animals or plants. Environmentally, natural fibers leave so little, if none, environmental impact [19]. This is because when extracted, natural fibers include low energy usage with no land contamination, which synthetic fibers have in reverse [20]. Other than that, natural fibers can be reutilized as carbon source for biomass, where it provides carbohydrates, protein, and minerals. It is also recyclable, non-toxic, biodegradable, and renewable [21].

Though it can be originated from both animals and plants, natural fibers are commonly originated from plants. Plant fibers are usually obtained from the seed, the stems, or the leaves. Most of the commonly used plant fibers used in textile industry includes cotton, jute, hemp, kapok, and sisal [22].

3.1.1. Cotton fiber: Cotton fiber is extracted from the seed epidermal hair of the plant genus Gossypium spp. that contains around 80-90% cellulose, 0.1-5& proteins, and 4-6% hemicelluloses and pectins [23]. Cotton fiber is in the form of flat-rounded tube with a twist every 0.4 mm [24]. It is one of the most commonly used fibers in the textile industry for its low toughness, high elastic recovery, and not allergenic [23]. Amongst the good characteristic, cotton also has its own drawbacks, such as the low microbial resistance and the use of prime arable land to grow the plant [25]. Traditionally, cotton is commonly used as the material of Flores’ traditional clothing, tenun. In Flores, the locals made cotton thread out of Gossypium spp. plant through several steps with some traditional tools. The first step
includes separation of the cotton and seed with Keho, cotton separator, and cleaning the cotton with Rabe, cotton sweeper. It is then continued with the spinning and spindling of the cotton into thread using Ogor and Jata Kapa. The third step is rolling the cotton thread using Kleo and Lain Kapa. The processing of ikat clothing will be continued with cotton coloring and motifs making [26]. The growth of cotton plant in Flores keeps being developed by the locals since the condition of the island fits the growth requirements for cotton plant, though it has been identified as one of the most important plants on the island [27, 28]. Land of Flores Island supports the growth of cotton plants, because cotton needs high exposure of sunshine and dry condition, but with a well-nourished soil. Rain period that happens only about three months a year on Flores island also support the growth of cotton plants, thus developing the growth of cotton plants on Flores island will be a good decision [29, 30].

3.1.2. Pineapple fiber. Pineapple is widely known as a fruit-producing plant where it can grow up to 1.2 meters high producing juicy fruit. The plant takes some time to finally produce fruit, thus cultivation is done vegetatively [31]. Pineapple is cultivated in Flores Island, where it grows well on the coastal area of the island [32]. The plant’s fiber contains 80-81% cellulose, 16-19% hemicellulose, 4.6-12% lignin, and 2-3% pectin [33]. Pineapple fiber is obtained from the leaves of the plant, where usually it yields about 2-3% of 1 ton of pineapple leaves. Extraction of the fiber can be done by scrapping traditionally, scrapping with roller machine, and retting in 0.5% urea or diammonium phosphate. Retting method may result in bigger yield [34]. Pineapple fiber is white, fine, silky, and soft [35]. It has high crystallinity, thus expressing good mechanical properties [23]. Amongst all leaf and bast fibers, pineapple fiber has highest specific strength and specific modulus, all the while remaining soft and silky looking [33]. Since the fiber is naturally colorless, it is rather easy to dye it with colorants and its pH is on the neutral range, which is between 5-6 [36].

![Pineapple fiber](image1.png)

![Colored pineapple fiber](image2.png)

Figure 1. Pineapple fiber [33].

Figure 2. Colored pineapple fiber [36].
3.1.3. Ramie fiber. Ramie fiber is extracted from the stem of *Boehmeria nivea* plant. It is considered one of the strongest natural fibers where its strength increases as it gets wet [23]. The ultimate fibers of ramie have similar shapes to cotton fibers, where they are flattened and have occasional twists, but they are way longer than cotton, ranging from 39-600 mm in length. Ramie fiber contains 72-97% cellulose, 3-27% hemicellulose, and 0-1% lignin [37]. Ramie fiber exhibits unique and remarkable for its silky white appearance that does not change under sunlight exposure and does not shrink. Other than its nice appearance and characteristics, ramie fiber also has high resistance towards bacteria, fungus, and even insects [38]. This fiber is also similar with linen fiber, where it has high absorbance ability, making it comfortable to be used even in warm season [39]. Ramie fiber needs to be processed specifically to get its texture comfortable and useable, because if not, it will have coarse texture. This characteristic is one factor why ramie fiber is rarely used in textile industry, but this problem can be overcome with advanced processing or blending the fiber with other fibers, such as cotton fiber [40]. *B. nivea* plant can grow in the warm and tropical area, with planting period starting from May to September and can be harvested up to two until three times a year, and sometimes even six times a year when land condition supports it. Harvesting can be done until the plant is six years old [33]. Though ramie plant needs sufficient water to grow, irrigational system can be done to grow ramie plant in dry lands, such as Flores. Irrigational system for ramie plant in dry area shows a great result of ramie growth [41]. In 2009, it is said that cultivation of ramie plant in East Nusa Tenggara should be started and developed, due to its high demand. The locals showed some supports on the idea, since the cultivation of ramie plant is rather easy, and with the high demand, it can be advantageous for the locals [42]. Ramie fiber can be produced through three main stages, which are: 1) decortication to remove the bark of ramie plants, 2) scraping of the outer bark, parenchyma, gums, and pectin, and 3) washing of the fiber. After those three steps, ramie fiber should be degummed to produce spinnable fiber [35].

![Figure 3. Ramie fiber [40].](image)

3.2. Natural colorants
Natural colorant, or natural dye, is a colorant or pigmented substance that is derived from plants, animals, or minerals [43]. Natural colorants can be classified based on their base color, chemical structure, source, and method of application [44]. Most of natural colorants are known to exhibit soft, lustrous, and luminescent color. They are renewable and biodegradable, they utilize small to zero carbon waste, and they can be utilized as fertilizer. Natural colorant is also known to enhance within age, where the more they got exposed by sunlight or the older they got, the better the color they emit [45]. Using natural colorant in textile industry can help reduce the exposure of harmful chemical substances to both textile workers and cloth wearer for its non-toxic nature [46]. Plant-derived natural colorant can be obtained from the root, bark, leaf, flowers, fruits, or seed of a plant source [43]. Though natural colorant hues are
only categorized into red, yellow, blue, green and black, combinations of each pigments can be done, thus creating unique pigment to the fabrics made [47].

For natural colorant to be able to be readily used, it has to go through four main steps, which are extraction, pigment isolation, dyeing, and dye fixing [48]. The processing of natural colorant needs to be done carefully and sometimes, the extraction of natural colorant pigment needs the assistance of chemical substances since not every pigment can be extracted in water [49]. Extraction of natural colorant utilizes polar solvent for polar pigment. Extraction can also be done with hot water extraction with no addition of any organic solvent or chemical substances then continued to be fixed with mordanting agents. Extraction with water is a one-bath dyeing method to ease the handling, reduce low reproducibility risk, and for time efficiency [46]. Pigment extracted can also be enhanced with microwave radiation treatment to loosen the cell wall of the plant, where it can improve the color and its fastness [49].

There are several aspects that can be observed on the quality of a textile dye, some of it are color strength that is measured by CIELAB color space value with spectrophotometer and colorfastness [50]. CIELAB color space is a measurement of color that was developed by International Commission on Illumination (CIE) that measures color with three values, L*, a*, and b*. The L* value shows color lightness that ranges from 0 for darkest black color and 100 for brightest white, while a* value shows color coordinate of red/green, where +a* represents red and -a* represents green. B* value shows color coordinate of yellow/blue, with +b* shows yellow value and -b* shows blue value [51]. This method shows colors’ reflectance, sorption and scattering coefficient [50]. Colorfastness in textile industry refers to the ability of the colorant to resist fading or running which ranges in the value of one to eight, where the higher value indicates the better fastness [52]. This aspect can be observed against different substances, such as soap, detergent, bleach, acidic solution, or even heat [53].

Dye fixing of a colorant is done with the help of a substance called mordant. This substance helps pigment to bind within the cellulosic fibers, that mostly do not have enough binding affinity towards natural colorant [54]. Dye mordanting can utilize either metallic mordants or biomordant. Metallic mordants include alum, chrome, tin, copper, and iron mordants, while biomordant can be obtained from plant organs in the form of tannins [44]. Metallic mordants are considered as toxic for human and can pollute the environment, while the biomordant one is safer for the environment and is biodegradable [55]. Though tannin is considered as safe, but it is most suitable with only brown and black pigment dye as dulling mordant [56, 57]. One of the safest metallic mordant option happens to be alum mordant. It is a brightening mordant with chemical formula as KAl(SO\textsubscript{4})\textsubscript{2}.12H\textsubscript{2}O [58]. Mordanting can be done two ways, either pre-mordanted or meta-mordanted. Pre-mordanted method is where alum mordant is boiled and poured 10% of the fabric’s weight, then dyed with the chosen colorant. Meta-mordanting is where mordant is added into the colorant liquor altogether, so fixing and coloring process of the fabric is done simultaneously [59].

Natural colorants have been in used as textile colorant since ages ago, until it is replaced with synthetic dyes, but it reemerges nowadays as the mindset of the market has changed into a more sustainable and eco-friendly products [60]. As a country of thousands of cultures and biodiversity, natural colorant is not a strange thing. It has been done since years ago, especially in the island of Flores. In making ikat clothing, Flores people usually used indigofera for blue pigment, root of noni fruit for red pigment, turmeric or bark of jackfruit and mango tree for yellow pigment, cacao leaves for brown pigment, and several plant leaves for green pigment [61]. Flores people likes using natural colorant, because they can plant the plants themselves, thus they do not have to buy synthetic colorants. Besides, it is safer for them to use natural colorants than the synthetic ones. It is also known that the ikat clothing with natural colorant will keep its color even after the exposure of heat, it even got better after some time [62]. Some natural colorant can also add several qualities to the fabrics, such as antimicrobial and UV-protection properties [47].

3.2.1. Antimicrobial colorant. Textile fabrics are very fragile against microorganisms such as bacteria since it contains cellulose, sugar, and other minerals that supports the growth of such microorganism
Fabrics also provide large surface area, nutrients, and sufficient temperature for bacterial growth. Bacterial growth may lead to deterioration of fabric’s quality to allergic responses. Therefore, the need for improved fabrics with quality such as antimicrobial property is direly needed [64]. Plants often produced secondary metabolites as a defense mechanism. It can be produced actively on several parts of the plants, may it be roots, bark, leaves, or fruit. This secondary metabolite exhibits many different abilities, one important ability is the antimicrobial ability [65].

Pomegranate (Punica granatum) is a 1-5 meters shrub that produces big red fruit all year long. This plant is originated in Middle East and grows perfectly in mild-temperate to subtropical land, but due to its natural ability on adaptation, pomegranate plant can grow in warm tropical area [66]. This plant needs long sun exposure and grow optimally on tropical land with long summer [67]. Ideally, pomegranate will grow optimally on a warm and dry land, though they can also grow on fertile and moist land [68]. Pomegranate, or Delima in Bahasa, distributed widely in Indonesia, including Flores island [69]. Pomegranate is one of the many natural dyes that is commonly used, where the rind exhibits yellow to brown pigment and the fruit with its seed exhibits red pigment. While utilized as natural colorant, pomegranate also exhibits antimicrobial properties due to its large amount of tannins [70]. Natural colorant of pomegranate is known to have effective antimicrobial activity against E. coli, S. lutea, K. pneumoniae, B subtilis, E. faecalis, P. vulgaris, S. cerevisiae and Methicillin resistant S. aureus (MRSA) [71]. Other than having antimicrobial ability, pomegranate dye shows high deodorizing ability by 99% [72]. Pomegranate dye also have good dye fastness against washing, light, rubbing, and perspiration, meaning that this natural colorant can be feasible for textile industry [73].

![Figure 4. Pomegranate rind [73].](image)

Gall nuts (Quercus infectoria) is a semi-evergreen tree with height of 1-4 meters, found in warm area. In Indonesia, the plant is known as Manjakani, and is known to be distributed widely in the country [66]. The extract of the plant is known to have medicinal benefits, where it can be used in several digestive problems and leukorrhea [74]. While being medicinally beneficial, gall nuts is also useful in the textile industry as a natural colorant that exhibits brownish color. Due to its chemical substances, it has antimicrobial activity. Gall nuts is known to be able to inhibits the growth of P. aeruginosa, B. subtilis, P. vulgaris, E. coli, and K. pneumoniae [75]. The antimicrobial ability of gall nuts against E. coli and P. vulgaris is shown to be very effective, where it can reduce the colony by 97.4% and 99.5% respectively. As a colorant, gall nut also shows good wash fastness, meaning that using gall nuts as antimicrobial colorant will be suitable [76]. The water extract of gall nuts contains phenols, flavonoids, tannins, saponins, alkaloids, and carbohydrates. These components may support gall nuts’ antimicrobial ability [77]. Gall nuts dye is extracted by drying the whole plant, then grounding it until it turns into fine particles. Grounded plants then dissolved in boiling water to be filtrated. Dyes will be obtained by centrifugation [71].
3.2.2. UV-protection colorant. UV radiation is categorized into three ranges, UV-A (315-400 nm), UV-B (290-315 nm), and UV-C (100-290 nm) which will be absorbed by the ozone layer directly, while UV-A and UV-B exposure will reach the surface of the Earth. Exposure of UV-A and UV-B can cause serious skin problem, tissue oxidative damage or even skin cancer [78]. Textile product is one thing that can protect the wearer from harmful UV ray exposure, where its protection depends on several factors. Dye is one of the factors that can protect the wearer against the exposure of UV radiation where it provides UV light transmission blockage. Dyes’ ability to protect wearer against UV exposure increases as the concentration does [79]. Textile dyes commonly have absorption band that extends in the UV spectral region; thus, it absorbs the UV light and increases the UV-Protective Factor (UPF) [80]. UPF is measured by the ratio of skin getting reddened with protection and without it. It is categorized into three range; good, very good, and excellent, where good category has UPF range of 15-24, very good ranges in 25-39, and excellent ranges in 40-50 and 50+ [81].

Gall nuts (Quercus infectoria) has other ability than only antimicrobial. It is known that gall nuts also exhibit UV-protective ability. With only 12% of gall nuts dye, it can provide UPF value of 65.8, where it can be categorized into excellent protection [82]. Gall nuts has UV-protective ability due to its main constituent, tannin, which constructed in gall nuts by 50-70% [83]. Tannin is the fourth most abundant compounds present in plant after cellulose, hemicellulose, and lignin. It is known that tannin can absorb UV radiation with good efficiency and provide good protection against UV radiation [84].

Mundu (Garcinia dulcis) is a tropical fruit tree that may grow up to 10-13 meters and is widely distributed in Indonesia. This plant is known to have several beneficial properties, such as antioxidant, anti-inflammatory, antiviral, and anticancer properties [66]. As a colorant, the bark of mundu plant is the part used. Mundu dye without any mordant shows UPF value of 15.6, while mordanted with 5% alum its UPF value increased significantly to 78.8, which categorized into an excellent UV-protection [85]. The bark of mundu also exhibits antibacterial and antimalarial properties. Mundu dye is extracted with the drying of mundu bark, grounding, boiling of the bark with distilled water for one hour, and filtration to remove bark residue [86].

Indigo (Indigofera tinctoria), or widely known as Nila or Tarum in Indonesia, is a shrub that can grow up to 2 meters tall and produce beans with small pods. Its growth is rather slow, and it is considered as soil-improving groundcover, where its presence can hold off erosion and prevent drought [87]. The ability of indigo as a UV-protection colorant shows UPF value of 33-34 when treated with no mordant. This result shows that indigo’s UV-protection property is categorized as very good [88]. When indigo dye is treated with alum as mordant, 2% of indigo shows UPF value of 43.1, whereas 4 and 5% concentration of the dye shows UPF value of more than 50. This shows that indigo, when mordanted with alum, shows the best UV-protective property. This result can be supported with the color indigo.
produced, blue to dark blue, where darker colors have higher UV absorption that covers UV spectral region [89]. Extraction process of indigo dye involves fermentation of indigo leaves for 24-48 hours then aqueous phase and residue of the leaves are separated through filtration [90]. In the application, indigo dye should be used in soluble form to bind in with the fiber and it needs to be aerated to get oxidized so that it can generate blue color on the fabric [91]. The longer the aeration, the higher indigo concentration is. This is because when aerated, pigmen will be precipitated in the fiber, thus creating permanent blue color [92]. 

*I. tinctoria* plant has been cultivated in many places in Indonesia, Flores Island included, since 19th century [93].

Cantigi ungu (*Vaccinium varingiaefolium*) is an endemic Indonesian shrub that can grow up to 10 meters tall in rich hummus area. It is distributed widely and mainly in Java, but it also grows in many places in Indonesia, Flores Island included. This plant has sweet fruits that varies in size, where its diameter ranges in between 5-12 mm [94]. In Flores, cantigi ungu dominates the vegetation in Tiga Warna Lake, Kelimutu National Park with 127 plants in 2003 [95]. Fruit of cantigi ungu is very rich in anthocyanin, known as the producer of red pigment [96]. Though fruit of cantigiu ungu dye has not been used as textile colorant, knowing that they have anthocyanin makes it really potential for it to be utilized as textile colorant of the color red [97]. Extraction of the pigment can be done with grounding the fruit of cantigi ungu, then dissolved in cold polar solution, either with alcohol or water. Organic solvents like methanol or ethanol can help stabilizing anthocyanin, while rupturing the cell membranes [98]. Due to the anthocyanin cantigi ungu contains, it is possible that cantigi ungu dye will have UV-protection property, because anthocyanin dye is known to have UPF that ranges between 21-40, making it classified into a good to excellent UV-protective dye category [99].

3.3. Policy Recommendation

With the abundant presence of the source of natural fibers and colorants in Flores Island, it would be good if the locals, NGOs, governors, and stakeholders are planning to enhance the effectivity of the plants’ cultivation. In the same time, it is important for the local weavers to be acknowledged, convinced, and recommended to make a switch to natural source from synthetic materials. Indonesia Ministry Agriculture, Indonesian Agency for Agricultural Research and Development can help the development of some plant species where their research include the cultivation of ramie, pineapple, and cotton. Meanwhile, to improve locals’ knowledge on agricultural practice, Agricultural Extension and Human Resource Development Agency (BPPSDMP), can assist the improvement of it by their programs which directed to create professional, independent, and competitive human resources and to improve the welfare of local farmers.

4. Conclusions

A total of 8 plant species are identified as potential natural fiber and colorant source. Regarding to the plants’ properties as potential natural materials in textile industry, cultivation of pineapple (*A. comosus*), ramie (*B. nivea*), pomegranate (*P. granatum*), mundu (*G. dulcis*), and gall nuts (*Q. infectoria*) in Flores Island should be developed to enhance the diversity of traditional textile industry in Flores Island. Cantigi ungu (*V. varingiaefolium*) that has been abundant in Flores should be cultivated more and utilized as textile colorant considering its ability to conduct UV-protection due to its chemical compositions. These plants species would be a valuable material for the development of local textile industry that will support the sustainable socioeconomic improvement of people in Flores island. The cultivation of these plants, therefore, needs to be leveraged and prioritized by local people and government authorities alike.

Acknowledgement

The completed review would not be possible without the supports from RISTEKDIKTI-NERC Newton Fund Wallacea Program for the funding of this research and publication.

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