The effort to cultivate natural dyes (Indigofera Sp.) in Timor Region, NTT

Retno Agustarini¹, Yetti Heryati², and Yelin Adalina³

¹²³Forest Research and Development Centre, Bogor – Indonesia

*retno.agustarini@gmail.com

Abstract. The people of NTT, especially the Timor region, have still maintained their customs for generations. The use of natural dyes has also been increased to reduce environmental pollution due to the use of synthetic dyes that have the potential to contain heavy metals. There are more than 30,000 - 40,000 plant species in Indonesia and 150 of them are plants that can produce natural dyes. Indigofera spp. is a kind of natural blue plant. The problem faced in the use of plants as natural dyes is the availability of raw materials. So far, Timorese only harvest Indigofera spp which grows naturally from the environment around the house or in the nearby forest so that it cannot meet the needs on an industrial scale. This study aims to conduct cultivation techniques of 2 species of Indigofera and postharvest techniques to get the optimal blue color. The seeds used are the result of exploration from plants in Bosen, NTT and plant collections available at BPPTH Nursery, Nagrak, Bogor; Indigofera suffruticosa and Indigofera sp. The planting technique uses a completely randomized design (CRD) with 2 factors (2 species, 4 doses of humus). Each treatment combination consists of 3 replications. For postharvest techniques for making indigo paste using completely randomized design (CRD) with 2 levels of lime concentration. I. sufruticosa much better growth by adding humus at a dose of 1500 g/tree shows better branch improvement. For postharvest soaking techniques, it is enough to do 24 hours with the addition of 4% lime concentration.

1. Introduction

Timor Tengah Selatan (TTS) is one of the districts in East Nusa Tenggara (NTT) Province which is rich in cultural heritage. One of them is the cultural heritage of making traditional fabrics called tenun. The weaving activity in TTS is carried out from generation to generation. The weavers in the TTS area are generally women. Based on information from local residents, it is known that almost 90% of women in TTS can weave. Weaving is not only a culture, but is an obligation for women in TTS. The requirement for TTS women to be able to weave is an effort to conserve weaving so that it does not become extinct, on the other hand it can also be a source of income. Woven cloth is a valuable family property.

Since long ago weavers in TTS have known several plants as natural color producers for dyeing woven fabrics, such as jackfruit (Artocarpus heterophyllus.), Mango (Mangifera sp.), Noni (Morinda citrifolia), mahogany (Swietenia macrophylla), turmeric (Curcuma longa), candlenut (Aleurites moluccana), kesumba (Bixa orellana), forest nuts (Phaseolus lunatus), pine (Casuarina sp.), cempaka (Magnolia champaca), tarum (Indigofera spp.) and so on. Parts of the plant used are bark, leaves, roots, pulp, seed coat, rhizome and so on [1]. Unfortunately, the use of plants as natural dyes in the TTS area...
has been replaced by synthetic dyes since the 1970s. According to the TTS community, the change in using natural to synthetic materials is due to ease of use, more efficiency, more affordable prices and better final results. They do not consider the long-term effects of using synthetic dyes, namely the problem of environmental pollution [2].

However, in recent decades, the use of natural dyes has returned to interest because it does not cause side effects to the body [3]. This is due to the increasing movement to return to nature (back to nature), awareness of the dangers of synthetic dyes for the body that can cause cancer and the unique impression of natural dye products [4]. In addition, natural dyes do not cause side effects such as allergies and make them comfortable when used [2]. One type of plant that is often used as a natural dye is tarum (Indigofera spp.). The coloring agent in the form of plant parts, especially Indigofera tinctoria L. is collected from nature directly, both by craftsmen and by people who work as collectors. Until now, no efforts have been made to plant or cultivate these types of plants. This is also a challenge in the development of weaving in the future, especially to ensure the availability of plants that produce natural dyes. This study aims to conduct cultivation techniques of 2 species of Indigofera and postharvest techniques to get the optimal blue color.

2. Material and Methods

2.1. Material

The research was conducted for 4 months from February — May 2018. Research implemented in Bosen Village, Kec. North Mollo, Kab. Timor Tengah Selatan Prov. East Nusa Tenggara. The ingredients are 2 types of Indigofera seeds were used from the BPPTH Nursery, Nagrak, Bogor, namely Indigofera suffruticosa and Indigofera sp and humus. Tool used in the study were planting and measuring equipment. The ingredients for indigo paste processing using indigo leaves and lime. The research location can be seen in Figure 1.

![Figure 1. Research location](image)

2.2. Methods

This research will take place in 2 stages, namely planting and post-harvesting to be processed into dye (indigo paste). The planting technique uses a completely randomized design (CRD) with 2 factors (2 species, 4 doses of humus). Each treatment combination consists of 6 replications. The first factor is the type of indigofera used, namely A1: Indigofera suffruticosa, A2: Indigofera sp. the second factor was the 4 doses of humus given, namely B0: Control, B1: 500 g, B2: 1000 g, B3: 1500 g.
Indigofera leaf harvesting is done in the afternoon at 16.00. Due to the limited availability of Indigofera leaves. The design of this study was based on a Randomized Block Design with factors including: Factor 1 (duration of immersion) namely L1: 24 hours, L2: 48 hours. And factor 2 are Lime concentration (K), namely K1: 2%, K 2: 4%. The number of treatments that were tried were 2 x 2 = 4 treatment combinations. Each treatment combination required as many as 300 grams of Indigofera leaves. Each treatment combination was repeated 3 times. So that the number of leaves needed is 4 x 3 x 0.3 kg = 3.6 kg.

2.3. Work Procedure
For the plantation, each treatment combination consisted of 6 replications, in each test consisting of 9 Indigofera seedlings planted in an area of 1 m². For the making of indigo paste that is Weighed as much as 300 grams of Indigofera leaves, put in a bucket then added 3 liters of clean water (1 ingredient: 10 water) until the leaves were submerged in water. To avoid the leaves floating, the leaves are pressed with stones or boards. The leaves are soaked for 1 day and 2 days. During the immersion process the fermentation occurs so the liquid turns green. Then the leaves are removed and the liquid is filtered. Indigo leaf liquid / solution added with lime with 2% and 4% concentrations in each treatment. Furthermore, the process of mixing / shaking for 1 hour or until the liquid does not foam anymore. The solution is left for 24 hours, then the solution is filtered. Indigo paste obtained was analyzed at the Center for Forest Product Research and Development which consisted of the quality of the dye, pH and extract yield.

3. Result and Discussion
3.1. About Indigofera, weaving, and natural dyes
Tarum belongs to the Indigofera clan, a member of the Leguminosae (Fabaceae) tribe, a child of the Papilionideae tribe. Indigofera species grow at an altitude of 0 - 2,200 m above sea level, can grow in hot and humid climates with rainfall of 600 - 3,000 mm / year and are tolerant of dry seasons and are well adapted to drought, but production continues to decline during the dry season [5;6]. Indigofera spp. grows well in full light conditions, but is quite tolerant of shade [6]. In natural conditions, tarum types can be found in open places with full sun [7]. There are 18 types of tarum scattered in Indonesia with a distribution area on various islands, namely: Java, Sumatra, Kalimantan, Sulawesi, Maluku, Madura, Sumba, Flores, Timor, Alor, Sawu, Rote, Wetar, and Bangka [8].

Most of the types of tarum spread in Java, there are 17 species. The distribution of tarum species in East Nusa Tenggara ranges from 11 species, with the highest number on Flores Island (9 species), Timor Island (7 species) and Sumba Island (6 species). The types of tarum in Timor Island are I. colutea, I. galegoides, I. linefolia, I. suffruticosa subsp. suffruticosa, I. tinctoria, I. trifoliata subsp. trifoliata, and I. trita subsp. trita. Of the various types of tarum on the island of Timor, the ones commonly used as raw material for natural dyes are I. tinctoria and I. suffruticosa [8]. The two types of Indigofera have different local names, namely beautiful tom or early tom for type I. suffruticosa and tom java for type I. tinctoria [9]. However, in the TTS area, the two types are called taum. In the international world, natural blue dye of the type I. suffruticosa is known as anil indigo, while I. tinctoria is known as indian indigo. The characteristics of the two types of tarum can be seen in Table 1 and Figure 2.

| No. | Species name | Habitus | Stacking Fruit | Forms and Build Leaves | Place to Grow | Habitat Height (m assl) |
|-----|--------------|---------|----------------|------------------------|--------------|-------------------------|
| 1   | I. suffruticosa subsp. Suffruticosa | Shrubs, 240 cm | Base, curved, 15 - 30x2 mm | Compound 7 - 15, jorong- ovate breech | Roadside, gardens, beaches | 0-1800 |
| 2   | I. tinctoria | Shrubs, 100 cm | Straight, sometimes curved at the | Compound, 7-13, | Grass field, open land | 0-800 |
The use of tarum as a blue color for weaving or batik is an effort to preserve tarum plants as a wealth of Indonesia's tropical regions and a legacy for future generations [8]. Even this tarum or indigo is known as "The King of Dyes", the king of dyes, the oldest natural dye known to people [10]. Furthermore, [10] states that indigo dye gives blue color (wedel) to traditional batik, its quality is a reliable natural dye due to its superior color resistance to light, chlorine washing, rubbing, sweat and others. Unlike other places, the use of tarum leaves in TTS Regency does not only produce blue but also black color. This color arises when in use mix tarum leaves with mud. In contrast to other dyes whose application is only through the boiling and dyeing processes, tarum requires a longer process. Color pigments caused by tarum are grouped into fatty dyes because they are re-generated in the fibers through a reduction process. So that for use it needs to be processed first into a paste which is made through the indoxyl oxidation process in an alkaline atmosphere [10].

3.2. Requirement for growing Indigofera

Naturally, the two types of tarum grow well in areas with an average rainfall of 700 - 4200 mm / year for I. tinctoria and 700 - 4000 mm / year for species I. suffruticosa [11]. Based on its characteristics, tarum grows naturally at an altitude of 0 - 1800 m above sea level for species I. suffruticosa and 0 - 800 m above sea level for species I. tinctoria [8]. Therefore, I. suffruticosa species can be planted in all areas of TTS Regency, while I. tinctoria species should be planted in areas with an altitude below 800 m above sea level.

Based on the information on where the two types of tarum grow (Table 1), tarum is very suitable to be cultivated in the TTS Regency area which has an extreme climate, where during the dry season the area will experience drought. It is recommended that the location for planting tarum is close to a water source. However, the character of this tarum is a type of plant that does not like to be stagnant water. Therefore, the land for planting tarum must have good drainage, so that during the rainy season with high rainfall, the location of tarum plants is not flooded ([12]. tarum type I. suffruticosa will grow well in areas with full sun or partial shade, but does not tolerate full shade (USDA-NRCS, 2013). Like type I. suffruticosa, tarum type I. tinctoria will produce the best growth in open conditions and get full sun [11, 13].
3.3. Plantation of Indigofera

Tarum used for dye is a type of tarum that likes the open, because in open conditions the tarum will get full sun. In their research, [13] concluded that tarum planted in the open resulted in better growth and number of leaves compared to tarum planted in moderate and heavy shade. Likewise, with the research of [11] which compared planting tarum in the open and under 35-year-old coconut trees. The vegetative growth of tarums planted in the open produces superior growth compared to those under the shade of coconut trees. Therefore, it is better if the land that is prepared for planting tarum is open land that will receive lots of sunlight. The cropping pattern used is adjusted to the availability of land. Tarum can be planted at a spacing of 50 cm x 50 cm, 75 cm x 75 cm or 1 m x 1 m. For open land, the land is cleared of plants that will interfere with tarum growth, then cultivate the land so that the soil becomes loose. The size of the planting hole for planting tarum seeds is just one hoe or with a size of 20 cm x 20 cm x 20 cm.

If there is limited land, such as in TTS, tarum can be intercropped with other crops such as maize because generally open land in TTS is used by the community to plant corn. Tarum can be planted after planting corn. The type of tarum suitable for intercropping with corn is the type I. suffruticosa. Type I. suffruticosa is a type of tarum that can reach 240 cm in height. When the corn plant has not been harvested, tarum growth is somewhat stunted. However, after the corn is harvested, which is when it is 3 months old, the land will open, so that it will provide room for tarum to grow optimally in full sun. For less fertile land, the planting hole is given a basic fertilizer in the form of manure, because manure contains a lot of macro nutrients (nitrogen, phosphorus, potassium, calcium, sulfur) and micro (iron, zinc, boron, cobalt, and molybdenum). In addition, manure can improve soil structure and granulation, increase water retention and will improve soil permeability [14].

Unfortunately, at the time of observation, 1 type of plant, namely Indigofera spp, did not grow well. so that what can be observed and can be processed into indigo paste is I. suffruticosa. After 4 months of maintenance, there was no significant difference in the dose of fertilizer given to the parameters of height, diameter and branches of the plant. Information related to treatment of I. suffruticosa growth parameters can be seen in table 2. However, looking at its growth, it is suggested that I. suffruticosa grow much better by adding humus at a dose of 1500 g / tree. This dose also creates more branches, so that the yield of indigo leaves as the main target for harvesting will be higher.

### Table 2. The effect of humus dosis on growth of I. suffruticosa

| Treatment | Height | Diameter | Branch |
|-----------|--------|----------|--------|
| PO        | 42,17  | 4,12     | 9,96   |
| PI        | 49,04  | 4,11     | 11,04  |
| PII       | 42,30  | 3,63     | 11,51  |
| PIII      | 51,08  | 4,26     | 11,75  |

3.4. Post harvesting and making of indigo paste

The process of making indigo paste can be seen in Figure 3. The results of the processing of indigo paste making can be seen in table 3. The observations showed that the yield of extracts was 36 to 44%. The addition of lime with a concentration of 2% produces a blue paste color, while the addition of lime with a concentration of 4% produces a bluish green indigo paste. This shows that the lime added to the excess tarum solution at a concentration of 4% so as to produce a bluish green paste. The yield of extraction with a concentration of lime addition of 4% is higher than that of lime concentration of 2%, both in the 24 hour and 48-hour immersion treatment. This is because lime is added to the solution also more. Immersion for 48 hours did not show the weight of the paste increased significantly. Therefore, the duration of indigofera leaf immersion is sufficient for 24 hours.
4. Conclusion
Indigofera is a natural dye that must be used by the community. This species began to decrease in existence in nature due to continuous exploitation. Cultivation effort is a must. One of the indigo species, i. Sufruticosa, has been developed. To get the growth of i. Sufruticosa, especially the growth of branches, the addition of 1500 grams of humus per tree is needed. For postharvest soaking techniques, it is enough to do 24 hours with the addition of 4% lime concentration.

Acknowledgment
We thank co-workers (Endang Estiningsih) for their assistance in laboratory and nursery in Bogor. Thank you for their dedication during carrying out the research activities that require patience and a high routine.
References

[1] Heryati Y, Agustarini R, & Karlina E 2016. Potensi Pemanfaatan Beberapa Tumbuhan Sebagai Sumber Bahan Baku Zat Pewarna Alami Pada Batik Dan Tenun. Membangun Hasil Hutan Yang Tersisa. Forda Press. Hal: 115 – 128

[2] Alamsyah A 2018. Kerajinan Batik dan Pewarnaan Alami. Endogami: Jurnal Ilmiah Kajian Antropologi, 1(2), 136-148. https://doi.org/10.14710/endogami.1.2.136-148

[3] Kwartiningsih, E., Setyawardhani, D. A., Wiyatno, A. & Triyono, A. (2009). Zat warna alami tekstil dari kulit buah manggis. Jurnal Ekuilibrium Vol. 8. No. 1. Januari 2009, hlm. 41-45. Dalam https://Eprints.Uns.Ac.Id/700/1/Zat_Warna_Alam_Tekstil_Dari_Kulit_Buah_Manggis.Pdf.

[4] Pringgenies, D., E. Supriyantini, R. Azizah, & R. Hartati. (2013). Aplikasi pewarnaan bahan alam mangrove untuk bahan batik sebagai diversifikasi usaha di Desa Binaan Kabupaten Semarang. Jurnal Info LPPM Edisi XV, Nomor 1, Februari 2013, hlm. 7. Dalam https://Ejournal2.Undip.Ac.Id/Index.Php/Info/Article/View/1282/968

[5] Herdiawan dan Krisnan. (2014). Produktivitas dan pemanfaatan tanaman leguminosa pohon Indigofera zollingeriana pada lahan kering. Wartazoa 24 (2): 75-82.

[6] Ginting dan Simon P. (2012). Kualitas Nutrisi dan Pemanfatan Genus Indigofera Sebagai Pakan Ternak Ruminansia. Loka Penelitian Kambing Potong. Sumatra Utara

[7] Ariyanti M dan Asbur Y. (2018). Tanaman tarum (Indigofera tinctoria Linn) sebagai penghasil zat pewarna. Jurnal Hutan Pulae-Pulae Kecil 2 (1): 109-122. DOI:10.30598/jhpk.2018.2.1.109.

[8] Muzazzinah. (2016). Etnobotani Indigofera di Indonesia. Bioedukasi Vol. 9, No. 2: 7 – 13.

[9] Muzzayinah. (2014). Indigofera: “Kini dan Nanti”. Bioedukasi Vol. 7, No. 2: 23 -26

[10] Nugroho, Adi; Setiawan, TA; Rusdianto, Hidayat, R & Susilo D. (2019). Simplifikasi aplikasi pewarna indigo. Kajen Volume 3. No, 2, Oktober 2019: 147-157

[11] Sarada, S & Reghunath, B.R. (2013). Evaluation of Indigofera tinctoria L. for yield and glycoside content under open and shaded conditions. Germany: Lambert Academic Publishing. 207 p

[12] Heryati, Y. (2015). Mengenal Tarum (Indigofera tinctoria L.) Sebagai Tanaman Serbaguna. Mitra Hutan Tanaman Vol. 10 No. 1.

[13] Kurniaty, R., Heryati, Y. dan Agustarini, R. (2016). Pertumbuhan tanaman tarum (Indigofera tinctoria L.) pada kondisi tempat tumbuh yang berbeda. Prosiding Seminar Nasional Perhutanan Sosial Tahun 2016. Lambung Mangkurat University Press

[14] Yuliana, Rahmadani, E. & Permanasari, I. (2017). Aplikasi pupuk kandang sapi dan ayam terhadap pertumbuhan dan hasil tanaman jahe (Zingiber officinale rosc.) di media gambut. Jurnal Agroteknologi Vol 5 No.2, Februari 2015: 37-42 37.