BIOEDUSCIENCE
ISSN: 2614-1558
http://journal.uhamka.ac.id/index.php/bioeduscience

Utilization of Natural Dyes of Futus Woven Fabric as an Alternative to Dye Plant Tissue Preparation

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Abstract

Background: Natural plant dyes can replace synthetic dyes to reduce the adverse effects caused. This study aims to determine the types of color-producing plants, the process of using natural dyes as dyes for plant tissue preparations, and the percentage of quality and feasibility of plant tissue preparations. **Methods:** The experiments were carried out to apply natural plant dyes to plant tissue preparations. Data analysis was carried out to calculate the percentage of quality and feasibility of the preparations. **Results:** there were eight plant species from four families, namely Fabaceae, Zingiberaceae, Maliaceae, and Lamiaceae. Processing plant parts into natural dyes iareby soaking, boiling, pounding, grating, and applying to preparations of corn and spinach plants. The use of natural dyes on corn and spinach preparations with a percentage of preparation quality ranging from 33.33% - 75.00% and said to be poor to good, while the percentage of the feasibility of preparations ranged from 67.08% - 87.50% and was said to be feasible to very suitable for use in the observation of plant cells and tissues. **Conclusions:** Natural dyes from *futus* fabrics can replace synthetic dyes in dyeing plant tissue preparations.

Keywords: Futus; Natural dyes; Tissue preparation

Article history
Received: 20 Dec 2021
Accepted: 02 Apr 2022
Published: 30 Apr 2022

Publisher's Note:
BIOEDUSCIENCE stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Citation:
Yolanda Getrudis Naisumu, Emilia Juliyanti Bria, Welli Herlince Kasse (2022). Utilization Of Natural Dyes of Futus Woven Fabric as an Alternative to Plant Tissue Preparation Dyes. *BIOEDUSCIENCE*, 6(1), 96 - 107 Doi: https://doi.org/10.22263/j.bes/618079

Introduction

Preparat is an object-glass containing research samples that are further observed using a microscope (Latifa, 2015). Preparations can be wet or dry in the form of incisions or without incisions. Objects in the preparation to be observed are usually small in size or the form of small pieces (incisions) of a living thing. Based on the objects contained preparations can be divided into two, namely animal preparations and plant preparations.

Plant preparations are observed using a microscope to determine the structure and shape of plant tissue, the process of making and watching preparations under this microscope requires the presence of preparing dyes. Several types of dyes are often used to color plant tissue preparations including safranin (red), fastgreen (green) and methylene blue (blue) (BNN, 2012).

Synthetic dyes are artificial dyes derived from chemicals. The advantages of synthetic dyes are that they have a bright color even though the use of color is slight. Color remains stable against environmental factors such as light and temperature. However, this dye poses a big problem that is very dangerous for human health. Negative effects such as skin allergy and respiratory system disorders (asthma) from synthetic dye powders inhaled can interfere with the respiratory system. In addition to causing health problems,

synthetic dyes are also very difficult to obtain and the price is relatively expensive, especially for areas far from shopping centers such as border areas.

The people of North Central Timor Regency are a diverse community of both tribes, religions, and customs. One of the traditions of this society is to use woven cloth during traditional ceremonies such as parties, thanksgivings, rituals, and in everyday life. The resulting woven fabric is a woven fabric made with a rope technique commonly called futus by the Dawan tribe. One of the stages of making this woven fabric is the dyeing stage. In this stage, the people of eastern Noemuti use plants as dyes and fixators as color binders.

Color substances are sourced from natural dyes that are very potential, namely all parts of the plant and certain organs such as roots, bark, leaves, flowers, fruits, and seeds(Bhuyan & Saikia, 2003). (Dafrita & Sari, 2020) states that purple sweet potatoes can be used as natural dyes for onion root squash preparations. In addition, (Jannah et al., 2019) utilize flamboyant flower filtrate (Delanix regia (Hook.) Raf.) as an alternative dye in the observation of plant tissue preparations. Natural dyes from plants can be used as an alternative dye to prepare plant tissue as a solution to the problem at hand. This research aims to find out the type of color-producing plants, the process of using natural dyes as plant tissue preparation dyes, and the percentage of the quality and feasibility of plant tissue preparations.

Methods

This research was conducted from January to July 2021 in two locations, namely in futus woven fabric craftsmen (Manikin Village, East Noemuti District, North Central Timor Regency) and at the Biology Laboratory of the University of Timor. This research was carried out with 2 methods, namely the Description and Experiment methods. The description method is carried out by interviewing, observation, and documentation techniques while the experimental method is carried out by applying natural dyes of woven fabrics to plant tissue preparations (*Amaranthus sp*. and *Zea mays* L.). Data is obtained in the form of images and presented in the form of tables.

The quality and feasibility of preparations are analyzed based on several aspects and criteria according to the modifications (Dewi et al., 2017). Determination of the quality score and feasibility of preparation is carried out by two evaluators. A criterion evaluator is a competent person expert in the field of plant micro technical, plant anatomy, and plant structure and development. To determine the quality and feasibility of preparations carried out by measuring the data of observations quantitatively, the quality and feasibility of preparations can be calculated based on the percentage formula (self-modification) namely:

$$Quality = \frac{\Sigma\, all\ repeat\ appraiser\ criteria}{\Sigma\, Maximum\ criteria}\ x\ 100\%$$

$$Feasibility = \frac{\Sigma\, all\ repeat\ appraiser\ criteria}{\Sigma\, Maximum\ criteria}\ x\ 100\%$$

Furthermore, the results of calculating the percentage of quality and feasibility of preparations are then adjusted to the criteria for assessment of quality and feasibility of preparations contained in Table 1 and Table 2 (Wagiyanti & Noor, 2017).

Table 1. Preparation quality assessment criteria

Percentage	Information
81 – 100	Excellent
61 – 80	Good
41 – 60	pretty good
21 – 40	not good enough
0 – 20	not worthy

Table 2. Preparation eligibility assessment criteria

Percentage	Information
81,25 – 100	Very worthy
62,50 – 81,24	proper
43,75 – 62,49	Quite decent
25,00 – 43,74	Less worthy
< 25	not worthy

A preparation is declared quality if it reaches a percentage of > 61% (Wagiyanti & Noor, 2017) and is declared feasible if it reaches a percentage of > 62.5% (Ahmad et al., 2013). If the reviewer provides a value with decent and quality criteria then the coloring of the preparation can be used as a dyeing medium in research activities for cell and tissue observation (Ahmad et al., 2013).

Results

Plants used as natural dyes of futus woven fabric of East Noemuti Subdistrict

The people of East Noemuti Subdistrict use four families and eight species of plants as natural dyes to color the threads used as futus woven fabric (Table 3). These eight species are used as dyes for plant tissue preparations dominated by the fabaceae family.

Table 3. The type of plant used as a natural dye of futus woven fabric.

Local name	Scientific name	Family
Koto/ kratok	*Phaseolus lunatus* L	Fabaceae
Kiu / asam	*Tamarindus indica* L	Fabaceae
Nipe / koro benguk	*Mucuna pruriens* (L)DC	Fabaceae
Taum /tarum	*Indigofera tinctoria* L	Fabaceae
Mek-meko/ mangsian	*Phyllathus reticulatus* Poir	Fabaceae
Huki / kunyit	*Curcuma domestica* L	Zingiberaceae
Maoni /mahoni	*Swietenia Mahagoni* L	Maliaceae
Jatse / jati	*Tectona grandis* L.f	Lamiaceae

Plant organs used in the process of dyeing futus woven fabric

The plant parts used as natural dyes of futus woven fabric by the people of TTU Regency are leaves, bark, rhizomes and seeds (Table 4), while plant parts in the form of roots, flowers and plant fruits were not used as natural dyes in this study.

Plant organs are commonly used as natural dye making materials because in plant organs there are various pigments so that they can be used as natural dyes. This result is also expressed by (Ate et al., 2020), which states that the parts of the plant used as natural dyes are leaves, bark, rhizomes and roots.

Table 4. Plant organs used and the color produced

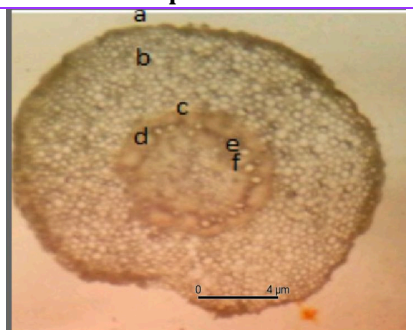
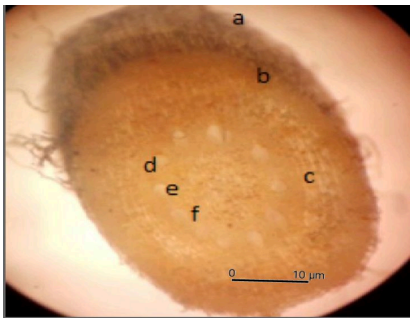
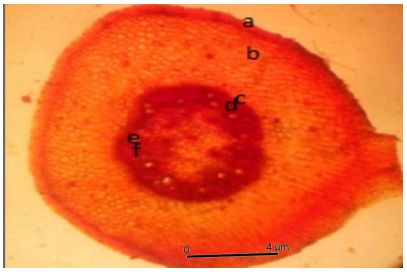
Scientific name	Parts used	Resulting colors
Phaseolus lunatus L	Leaf	Green

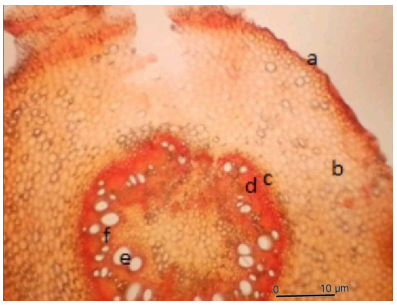
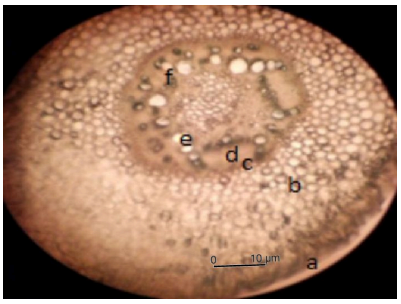
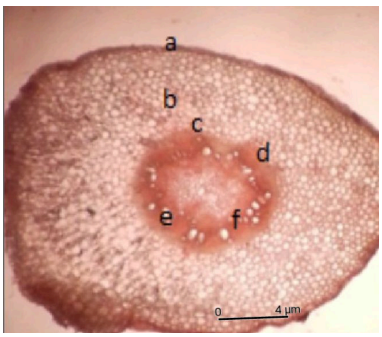
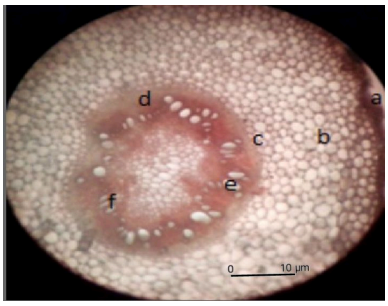
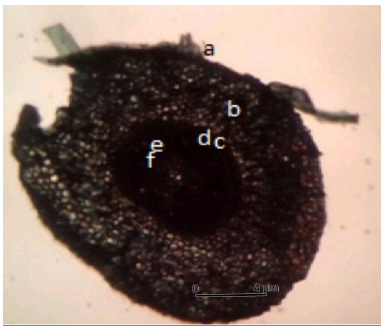
Tamarindus indica L	Leaf	Green
Curcuma domestica L	Rhizome	Yellow, red, maroon red
Indigofera tinctoria L	Leaf	Blue and black
Phyllathus reciculatus Poir	Leaf	Blue and black
*Mucuna pruriens (*L) DC	Seed	Blue and black
Swietenia Mahagoni L	Stem skin	Red
Tectona grandis L.f.	Leaf	Purple

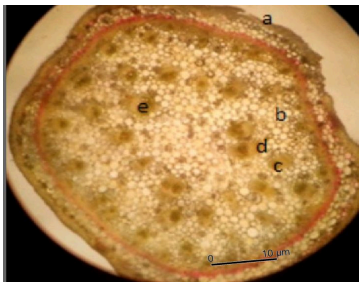
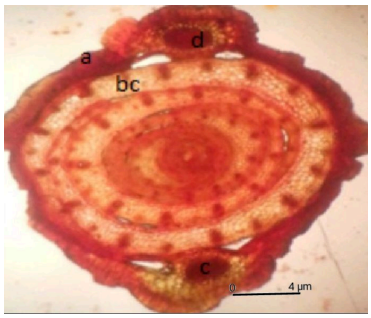
Application of natural dyes on spinach and corn garden

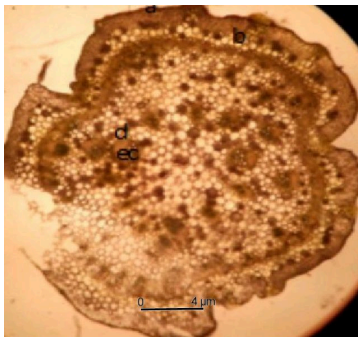
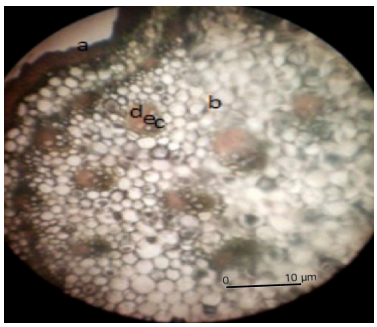
The application of natural dyes to the preparation of spinach and corn plant tissue varies greatly (Table 5). From the results of the photos obtained, the most prominent variation is the many color substances absorbed by the tissues, causing the presence or absence of visible color equality. The results of natural dye application in plant tissue preparations can be used if they meet the criteria from the quality and feasibility aspects of plant tissue preparations.

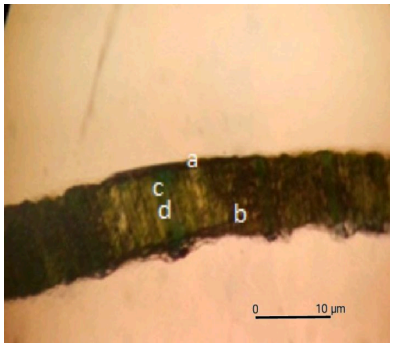
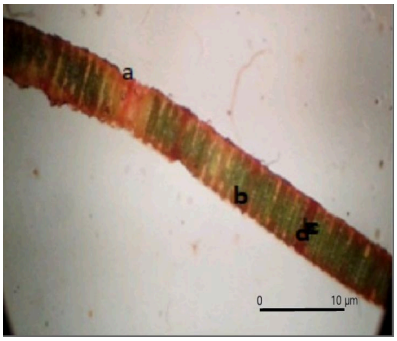
Table 5. Application of natural dyes on plant tissue preparations

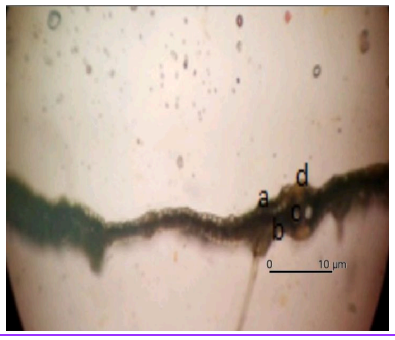
No	Color type	Preparations	information
1	Preparations across corn roots (Green)		a. epidermis b. cortex c. endodermis d. perisikel e. xylem f. phloem
2	Preparations transverse corn roots (Yellow)		a. epidermis b. cortex c. endodermis d. perisikel e. xylem f. phloem
3	Red corn root transverse preparations (turmeric)		a. epidermis b. cortex c. endodermis d. perisikel e. xylem f. phloem

4	Preparations transverse corn roots (Red maron)		a. epidermis b. cortex c. endodermis d. perisikel e. xylem f. phloem
5	Preparations across corn roots (Blue)		a. epidermis b. cortex c. endodermis d. perisikel e. xylem f. phloem
6	Preparations across corn roots (Purple)		a. epidermis b. cortex c. endodermis d. perisikel e. xylem f. phloem
7	Preparations across corn roots (Red (mahogany))		a. epidermis b. cortex c. endodermis d. perisikel e. xylem f. phloem
8	Preparations across corn roots (black)		a. epidermis b. cortex c. endodermis d. perisikel e. xylem f. phloem

9	Preparations across corn stalks (green)		a. Epidermis b. Basic network c. Xilem d. folem
10	Preparations across spinach stems (yellow)		a. Epidermis b. Cortex c. Xylem d. Phloem e. Kambium
11	Preparations across corn stalks (red)		a. Epidermis b. Basic network c. Xilem d. folem
12	Preparations across spinach stems (maron red)		a. Epidermis b. Cortex c. Xylem d. Phloem e. Kambium
13	Preparations cross spinach stems (black)		a. Epidermis b. Cortex c. Xylem d. Phloem e. Kambium

14	Preparations cross spinach stems (blue)		a. Epidermis b. Cortex c. Xylem d. Phloem e. Kambium
15	Preparations cross the stems of spinach (red)		a. Epidermis b. Cortex c. Xylem d. Phloem e. Kambium
16	Preparations across corn stalks (purple)		a. Epidermis b. Basic network c. Xilem d. folem
17	Preparations transverse spinach leaves (green)		a. Epidermis b. Carrier file c. Stomata
18	Preparations across spinach leaves (yellow)		a. Epidermis b. Carrier file **c.** Stomata

19	Banyam leaf preparation (red)		a. Epidermis b. Carrier file **c.** Stomata
20	Spinach leaves (maron red)		a. Epidermis b. Carrier file **c.** Stomata
21	Preparations transverse spinach leaves (Black)		a. Epidermis b. Carrier file **c.** Stomata
22	Preparations transverse corn leaves (blue)		a. Epidermis b. Stomata c. Xylem **d.** phloem
23	Preparations across corn leaves (red)		a. Epidermis b. Stomata c. Xylem **d.** phloem

24	Preparations across corn leaves (purple)		a. Epidermis b. Stomata c. Xylem **d.** phloem

Preparation quality

The percentage of preparation quality (Table 6) has a range from 33.33% to 75.00%. Quality preparations based on color substances are found in preparations with red color substances from the bark of mahogany stems with a percentage of ≥ 65%. Poorly quality preparations are seen in preparations with blue substances where the percentage is ≤ 59.17%. Red spinach root plant (*Allium ascolonicum* L.) as a medium to learn plant tissue with a percentage of 80% that includes "excellent" cryptia. Based on the plant organs used, the quality preparation is corn root preparation. This is evidenced by the percentage of 87.5% is said to be good / quality compared to other organs.

Table 6. Percentage of preparation quality

Color/organ	spinach root (%)	corn root (%)	spinach stems (%)	corn stalks (%)	spinach leaves (%)	corn leaves (%)
green	49,17	73,33	62,50	70,83	44,17	43,33
Yellow	77,67	63,00	68,33	73,33	58,33	52,50
red (turmeric)	48,33	63,33	56,67	60,00	69,17	67,50
maroon red	44,12	62,50	68,33	64,17	66,67	60,83
Black	50,00	63,33	61,67	63,33	36,67	46,67
Blue	53,33	59,17	50,00	45,00	38,33	33,33
red (mahogany)	68,33	66,67	75,00	65,00	66,67	66,67
Purple	70,83	64,17	60,00	70,83	45,83	45,00

Feasibility of preparation

From the results of this study obtained the percentage of feasibility of preparation with a range of 51.25% to 87.50% (Table 7). The color yellow, red (turmeric), maroon red, red (mahogany) in spinach and corn preparations has a percentage varying from 67.08-87.50% and is said to be feasible until very feasible. Leaf organs both spinach and corn have the feasibility of preparing quite decent with green, black, blue, and purple dyes. (Ahmad et al., 2013) using boyfriend leaf filtrate (Lawsonia inermis) obtained a percentage value of 81.25%-100% which is a viable criterion and very worthy of obtained from the transverse preparation of malela stems, striped stems, vernonia stems and bandotan stems.

Table 7. Percentage of preparat eligibility

Color/organ	spinach root (%)	corn root (%)	spinach stems (%)	corn stalks (%)	spinach leaves (%)	corn leaves (%)
green	71,25	77,92	75,85	74,17	58,78	51,25
Yellow	84,17	87,50	80,42	87,08	73,75	70,42
red (turmeric)	82,08	81,67	78,33	83,75	67,08	65,00
maroon red	82,92	79,58	77,92	80,83	68,33	67,92

black	75,00	80,83	82,92	80,83	52,92	64,68
blue	67,50	82,08	74,58	70,83	59,17	62,08
red (mahogany)	72,92	76,25	72,08	79,17	68,33	67,08
purple	80,00	85,42	79,17	82,08	62,08	58,75

Discussion

The results of research on natural dyes of ikat woven fabrics were also found by (Muflihati et al., 2019) which explained that Ensaid Village is long sintang regency of West Kalimantan Province, Dayak Iban People use natural dyes to color traditionally woven threads and woven fabrics that produce yellow and bluish black colors. In addition, (Sutara, 2016) also suggested that teak plants (*T. grandis* L.f), tilapia or tarum (*L. tinctoria*, L) is used as a natural dye in weaving companies in Blahbatuh District of Gianyar Regency.

Plants produce color due to the presence of pigments in plants that give rise to different colors. Plant pigment groups can take the form of chlorophyll, carotenoids, anthocyanins and tannins. In this study, each plant organ found to produce a distinctive color after extraction included the kratok plant leaf organ (*P. lunatus* L) and the acid plant (T. indica L) produced a green color due to chlorophyll pigments, the turmeric rhizome organ (*C. domestica* L) produced yellow and red colors due to the presence of caroteneoite pigments, mahogany stem skin organs *(S. Mahagoni* L), tarum plant leaf organs (*L. tinctoria* L) and mangsian leaf organs (*P. reticulatus* Poir) produce a blue color due to the presence of anthocyanin pigments, teak plant leaf organs (*T. grandis* L.f) contains tannins so that they produce a purple color.

The process of processing plants to get dyes carried out by the people of East Noemuti Subdistrict is still very traditional inherited from ancestors and continued until now by means of materials pounded, shredded, soaked and cooked until they produce color and applied to threads so that the threads change color according to the color applied, this statement is supported by (Ate et al., 2020) is the process of processing natural dye plants in Harona Kalla Village is a very simple processing process and is still relatively traditional. This process is also carried out by (Santa et al., 2015) includes boiling and mashing parts of organs used as natural dyes.

The percentage of quality preparations in this study is in line with the results of research from (Dafrita & Sari, 2020) which uses senduduk and purple yam as a coloring for onion root squash preparations. The percentage of quality preparation obtained was 53.33% - 83.33% while in this study it was 33.33% - 75%. In addition, the intensity of color absorption is more dominant in transport networks while the results of the (Apriani, 2016) which used brown rice and tea (*Camellia sinensis*) as alternative dyes for wet preparations of plant tissue, the intensity of absorption of color substances is higher in sclerenchyma tissue compared to other tissues.

The color absorption of each tissue at the root is no different on the stem. Intensive tissue absorbs color that is the tissue of the epidermis, the transport file. The transport file consists of xylem and phloem, where the constituent elements of xylem are tracheal elements, trachea (vessels), trakeids, xylem fibers, xylem parenchyma, while phloem consists of tapis elements, accompaniment cells (neighboring cells), phloem fibers, phloem parenchyma, albumin cells (Kusumaningrum, 2017). From the drawing of the preparation, it shows that the colored part of the xylem is the trachea (protoxilem). (INDASARI, 2013) in his research revealed that the tracheal element that is still in the form of protoxilem has the ability to absorb colors more intensively. This is because this element rarely undergoes lignification. In addition, the plants used in this study are also still relatively young (aged 1-2 weeks).

For the eligibility criteria for preparing spinach and corn with yellow, red (turmeric), red (mahogany skin) and maron red, it can be seen that all organs can be well colored, namely epidermal tissue, cortex, parenchyma, snare file and in each preparation does not have air bubbles, good preparation position, preparation identity is present and complete and the absorption rate is high. Therefore, the use of natural dyes as an alternative to preparant dyes is quality and worthy of use in the observation of plant cells and tissues. (Nurwanti et al., 2013) using filtrate of young teak leaves can be absorbed and color the tissues of the epidermis, parenchyma, phloem, xylem and slerenkim on the stem preparations of *Pluchea indica*. In glycine max root preparations, this dye can be absorbed and color the tissues of the epidermis, phloem and xylem.

Conclusions

There are eight types of plants used as natural dyes for futus woven fabrics by the people of East Noemuti District, North Central Timor Regency, consisting of kratok (*Phaseolus lunatus* L), tamarind (*Tamarindus indica* L), tarum (*Indigofera tinctoria*, L), koro benguk (*Mucuna pruriens*). L.Dc), mahogany (*Swietenia mahagoni* L), mangosteen (*Phyllathus reciculatus* Poir), teak (*Tectona grandis*, L.f), turmeric (*Curcuma domestica* L). The application of natural dyes on plant tissue preparations consists of extraction and staining stages. The use of natural dyes in corn and spinach preparations with a percentage of the quality of the preparations ranging from 61% to 77.67% is included in the criteria for these preparations to be of quality to be used, while the percentage of the feasibility of the preparations ranging from 62.5% to 87.50% is included in the criteria for use. in the observation of plant cells and tissues.

Declaration statement

The authors reported no potential conflict of interest.

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