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Anatomical Study of Pumpkin (*Cucurbita moschata* 'Butternut')

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Abstract

Yellow Pumpkin (*Cucurbita moschata)* is a fruit and vegetable from the Cucurbitaceae family that has striking structural variations both microscopic and macroscopic. The study of the anatomical structure of the Yellow Pumpkin as a whole is still limited, so this study aims to study the anatomical structure of vegetative and generative organs in the *species Cucurbita moschata.* The research method is *free-hand section* for cross-sectional incisions of roots, stems, leaves, and paradermal leaves. Acetolysis method to obtain the morphological structure of flower pollen. This research is descriptive research. The parameters observed were in the form of organ constituent tissues, trichomes and stomata types, tracheal and fiber types, and pollen types. The results of the study showed that the root tissue was made up from the outside in, namely the epidermis, cortex, periticle, and vascular bundles (xylem and phloem). The trunk consists of trichoma-like epidermal tissue, cortex, xylem and phloem, as well as the trachea (spiral, annular and scalariform type) and libriform-type fibers. The leaf structure is composed of the epidermis above the polygonal shape and the lower form of the anticlinal sinuous, the anomocytic stomata type, the amphistomatic stomata distribution, and the leaf trichomes exist that are glandular and non-glandular. Pollen is spherical in shape, echinate-type exine, and is classified as pantoporate-type aperture. The results of this study can be used as basic data in the study of the anatomical structure of plants, especially cucurbitaceae.

Keywords: *Anatomy; Cucurbitaceae; Pumpkin; Morphology*

Abstrak

Labu kuning (*Cucurbita moschata)* merupakan buah sekaligus sayuran yang berasal dari keluarga Cucurbitaceae yang memiliki variasi struktur yang mencolok baik mikroskopis maupun makroskopis. Kajian struktur anatomi labu kuning secara keseluruhan masih terbatas sehingga penelitian ini bertujuan untuk mengkaji struktur anatomi organ vegetatif dan generatif pada spesies *Cucurbita moschata.* Metode penelitian yaitu *free-hand section* untuk sayatan melintang akar, batang, daun, dan paradermal daun. Metode asetolisis untuk mendapatkan struktur morfologi polen bunga. Penelitian ini merupakan penelitian deskriptif. Parameter yang diamati berupa jaringan penyusun organ, tipe trikoma dan stomata, tipe trakea dan serat, serta tipe polen. Hasil penelitian menunjukkan jaringan penyusun akar dari luar ke dalam yaitu epidermis, korteks, perisikel, dan berkas pembuluh (xilem dan floem). Batang terdiri dari jaringan epidermis bertrikoma, korteks, xilem dan floem, serta trakea (tipe spiral, annular, dan scalariform) dan serat tipe libriform. Struktur daun tersusun atas epidermis atas bentuk poligonal dan bawah bentuk Sinuous anticlinal, tipe stomata anomositik, sebaran stomata amfistomatik, dan trikoma daun ada yang berglandular dan non-glandular. Polen berbentuk bulat sferis, eksin tipe echinate, dan tergolong apertur tipe pantoporate. Hasil penelitian ini dapat digunakan sebagai data dasar dalam kajian struktur anatomi tumbuhan, khususnya cucurbitaceae.

Kata Kunci: *Anatomi; Cucurbitaceae; Labu Kuning; Morfologi*

1. INTRODUCTION

The plants are autotrophic organisms consisting of various tissues, and vegetative organs such as roots, stems, and leaves that play a role in the process of photosynthesis, water-nutrient transport, and nutrient absorption (Nurdiana, 2020), as well as organs to adapt and reproduce such as flowers, and fruits (Qian et al., 2025). All of this can be studied in the study of plant anatomy, which studies the microscopic structure of those plant organs. The roots are composed

of a tissue of epidermis, cortex, and a central cylinder whose function is in the absorption of nutrients. The trunk is composed of a tissue of xylem and phloem vessels that play a role in transportation and mechanical support (Hindriana & Handayani, 2023). In the roots and stems, the trachea is contained with tracheal elements with thickened secondary walls that vary including annular, spiral, scalariform, reticulate, and pitted types, which function as a transportation channel for water and minerals from the roots to all parts of the plant organs (Abdi et al., 2019). Leaves consist of epidermal tissue, palisade parenchyma chains, and sponge parenchyma that play a role in gas exchange and photosynthesis processes (Hindriana & Handayani, 2023). All of these parts show a variety of organ constituent tissues. One group of plants that show striking structural variations both macroscopically and microscopically is the pumpkin family or Cucurbitaceae (Abbas et al., 2022). Cucurbitaceae are the world's second-largest fruit and vegetable as a food plant consisting of 115 genera and 965 species, including food crops such as cucumbers (Cucumis), watermelon (Citrullus), and pumpkin (Cucurbita) (Guo et al., 2020; Ma et al., 2022). As one of the members of this plant, *Cucurbita moschata* in particular has potential in terms of nutrition and pharmacology (Enneb et al., 2020). Although it has potential, it is fully necessary in detail to understand the pharmacological properties and physiological adaptations in optimizing the cultivation of *Cucurbita moschata*, including from the anatomical side. Several researchers have studied the anatomy of species from the cucurbitaceae family.

Previous research has been conducted by Ekeke & Agogbua (2018) which observed the structure of the stem, leaves, and trichomes of *Trichosanthes cucumerina* L. Then, another study by Vieira et al. (2019) focused on the anatomical and histochemical characterization of the leaves of *Luffa cylindrica* (L.) M. Roem. Furthermore, another study by Aqua & Wardhani (2019) observed variations in the anatomical structure of leaf trichomes in the Solanaceae and Cucurbitaceae families. Another study by Almeida et al. (2020) that examined the genetic control of the length of the stem segment (internode) in *Cucurbita moschata*, the results showed that the length of the stem segment is controlled by genetic factors, where before flowering it is influenced by one main gene, while after flowering it is influenced by many genes and the environment. Furthermore, another study conducted by Lee et al. (2021) studied the genetic diversity and population structure of *Cucurbita moschata* which found that there are three main genetic groups based on geographical origin, namely East Asia, South Africa-Asia, and America, where Africa and South Asia exhibit the highest allele variation useful for plant breeding. Recent research by Sadia et al. (2025) specifically examined the pollen morphology of the Cucurbitaceae plant family with light and electron microscopes that found variations in pollen size between species with a diameter of about 20-40 μm, spherical to oval shapes, and reticulate and grooved exin patterns. Although several previous studies have examined the anatomy of vegetative and generative organs in several species of Cucurbitaceae plants, there are still limitations in studies that fully compare the anatomical structure of leaves (including the adaxial and abacillal sides), trichomes, stems, roots, and floral pollen characteristics of *Cucurbita moschata*. Therefore, the focus of this study is to examine the anatomical structure of leaves, stems, roots, and flower pollen of the plant species *Cucurbita moschata*. The results of this study are expected to be able to contribute to future researchers as a basic reference for the anatomy of *Cucurbita moschata* in comparisons between species to complete the Cucurbitaceae plant family database.

2. METHOD

2.1. Research Design

The research was conducted in January-April 2025 at the Biology Laboratory, Faculty of Teacher Training and Education, Sriwijaya University, Indralaya. The preparation is carried out by two methods, namely the free-hand section method for transversal/transverse root incisions, longitudinal and longitudinal sections on the stem to obtain cross-sectional of tissues, fibers and trachea, as well as leaf transverse incisions, upper (adaxial) and lower (abaxial) leaf cuts. Furthermore, the acetolysis method to obtain the anatomical structure of the flower, in this case, especially the morphology of pollen.

2.2. Research Tools and Materials

The sample materials used in this study were the roots, stems, leaves, and flowers of the Yellow Pumpkin (*Cucurbita moschata*) of the Butternut variety, and solution of Formalin Acetic Acid (FAA), glacial acetic acid and sulfuric acid (9:1 ml), safranin 1%. The tools used in this study were razor (Quick Tiger), object glass, coverslip/cover glass, needle, erlenmeyer, pasteur pipette, volumetric pipette, centrifuged, and binocular light microscope (BOECO BM-180).

2.3. Research Procedure

a. Free-Hand Section

The free-hand section method is carried out by making thin transverse incisions on the roots or stems, and paradermal incisions on the leaves, as well as on the adaxial and abaxial surfaces of the leaves using a razor (Quick Tiger). Then, the incision results are placed on the glass of the object given a drop of water, then stained with 1% drops of safranin. Absorb excess water with a tissue and cover the sample with the glass covering the object. After that, it was observed using a binocular light microscope (BOECO BM-180).

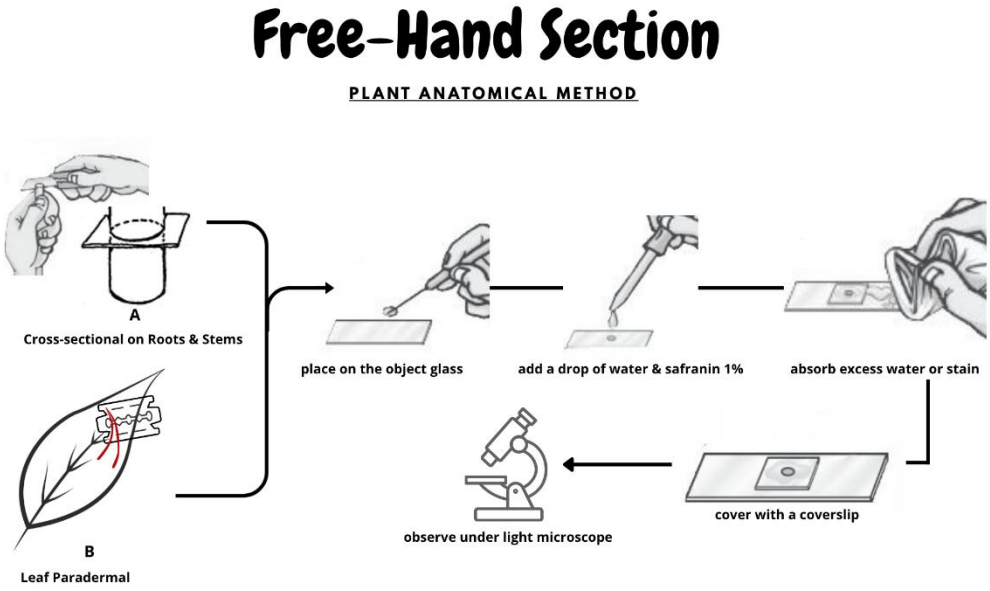

Figure 1. Free-Hand Sectioning Procedure
https://freehand.method/file

b. Acetolysis

The acetolysis method is carried out through several stages. Pollen from blooming Yellow Pumpkin flowers (*Cucurbita moschata*) is fixed with a solution of Formalin Acetic Acid (FAA) for up to 24 hours, then centrifugated at 1000 rpm for up to 15 minutes, then the liquid is discarded and replaced with glacial acetic acid and sulfuric acid in a ratio of 9 ml: 1 ml, and centrifugated again at 1000 rpm for 15 minutes. Furthermore, the liquid is discharged and washed with aqueduct 2-3 times, and each wash is centrifuged at 1000 rpm for up to 15 minutes. Next, the sample was placed on the glass of the object and then observed using a binocular light microscope (BOECO BM-180) (Ermayanti, 2023).

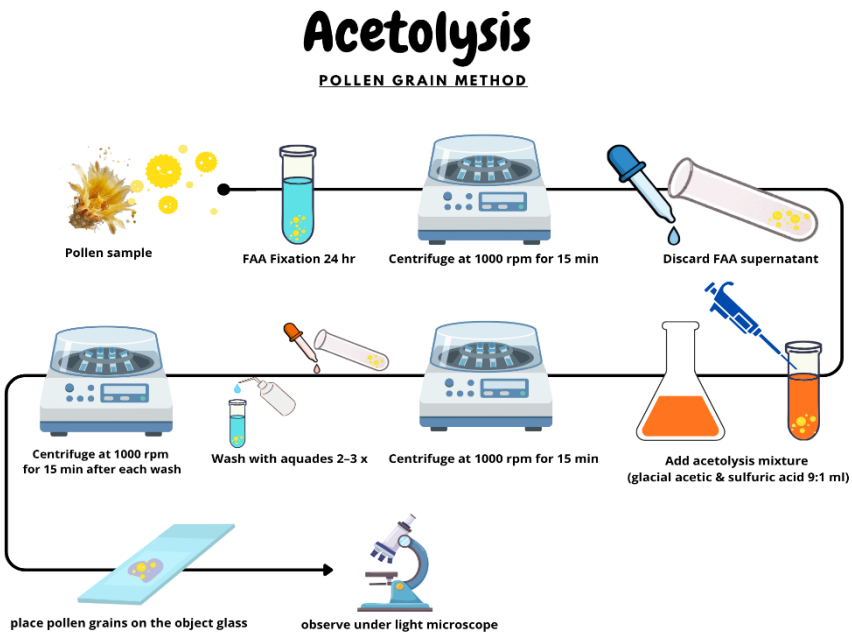

Figure 2. Pollen Acetolysis Procedure
https://Acetolysis.method/file

2.4. Instrument Research

The research instrument used was in the form of observation sheets. This observation sheet serves to record the results of observations of plant anatomical structures. The parameters observed in the root transverse incision are the type of constituent tissue. In the stem the type of constituent tissue, the characteristics of tracheal fibers, and trichomes. Then, in the leaf transverse incision, which is the type of tissue that makes it up, in the paradermal incision, the shape of the epidermis, the type of stomata and the distribution of the stomata, and the type of trichome are observed. The parameters observed included ornamentation type (exine), aperture type and pollen shape. The parameters observed in the pollen include ornamentation type (exine), aperture type and pollen shape.

2.5. Data Analysis

The results of microscopic observations are made in the form of 2D microscopic images and their characteristics are clearly described. This aims to make it easier to understand the characteristics of the anatomical structure of each plant organ (Ermayanti, 2017; Ermayanti et al., 2018; Mukti et al., 2022).

3. RESULT AND DISCUSSION

Based on the results of the research on the anatomical structure of the roots, stems, leaves and flower pollen in the Yellow Pumpkin (*Cucurbita moschata*), the following results were obtained.

3.1. Roots

In the cross-section, the root of *Cucurbita moschata* shows a dicot root with a tissue structure from the outside to the inside consisting of the epidermis, cortex, endodermis, and vascular tissue consisting of phloem and xylem tissue, as well as pith. The epidermis is composed of about one layer of cells, followed by the cortex located in the layer after the epidermal cells and mostly composed of parenchyma with a thickness of about 8-10 layers. The shape of the cells is irregular (Figure 3C). In the endodermal layer that borders the thick cortex, it consists of a layer of cells that circle a central cylinder. The central cylinder of the root consists of a tissue of vessels consisting of xylem and phloem, as well as supporting tissue. According to (Huang et al., 2022;

Laskar et al., 2020) which states that the thick cortex increases the storage capacity of water during periods of drought. The vascular bundle consisting of xylem type facilitates efficient water transfer, while also maintaining mechanical strength.

Figure 3B shows the undeveloped vascular tissue for the dicot root because the root taken is a young root. Phloem is indicated by areas of cells that appear small, squeezed, slightly darker in color, and interspersed with xyle. According to McCubbin & Braun (2021), phloem is greatly influenced by the structure and function of the characteristics of the cell wall, especially the filter element as the main route of photosynthate transportation, where the filter cell wall undergoes modifications, such as thinning and perforation for the efficiency of the flow of solutes. Whereas in xylem the cell looks like a round hole with a larger diameter, the walls thicken, forming arms that surround it penetrating in the direction of the center. The supporting tissue consists of a layer of periscille tissue located next to the endodermis (Figure 3C). The pith tissue ocated in the center/center of the root, consists of many fairly large parenchyma cells as shown in Figure 3B. The function of perisicles is to strengthen the root vessels (Lynch et al., 2021).

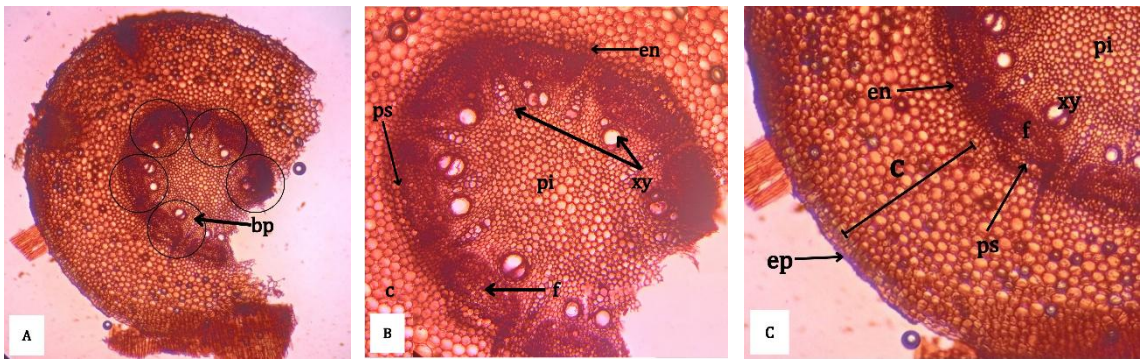

Figure 3. Anatomical Structure of the Roots of the Yellow Pumpkin (*Cucurbita moschata*). A, B, C. Visible Transverse Incision of the Main Structure of the Root Successively Magnification 40x and 100x; (EP) Epidermis; (en) Endodermis; (tr) Trichoma; (ps) Pericles; (c) The cortex; (sk) Sklerenkim; (pi) pith; (f) Phloem; (xy) Xylem

3.2. Stem

In the cross-section, the *Cucurbita moschata* stem are composed of epidermal tissue with trichomes on the outside, and on the inside in the form of the cortex (colenchyma, chlorenchyma, and parenchymal tissue), vascular tissue in the form of xylem and phloem which is arranged to form a bicollateral type, and there is pith tissue in the middle consisting of large-celled parenchymal tissue (Figures 4B and 4D). While Figures 4B and 4C show the epidermis of the stem composed of a layer of cells with thin walls and covered by the cuticle. The secondary cortex contains a lot of dark cholenchyma tissue because it has thickened corners (angular type), and next to it there is chlorenchyma that looks red-orange with thin walls. In Figure 4D, a bicollateral type of rod tissue can be seen where the xylem is located in the middle between the outer phloem and the inner phloem. Sclerenchyma is found around the tissue of vessels. In xyllems, the cell holes that appear larger and wider are called metaxilems, and the smaller, narrower ones are the protoxyles. Likewise, the outer phloem appears to be pointing out of the stem and the inner phloem appears to be pointing inwards facing the pith.

Figures 4E and 4F show the longitudinal cross-section of the trunk found with a type of secondary wall thickening, namely, ring type (Annular), spiral type (Helical), and ladder type (Scalariform). According to Huang et al. (2022) and Laskar et al. (2020), the trachea or vessel elements that are radially connected and large in diameter, serve as a facilitator of flow and minerals for rapid plant growth. In addition, there are also libriform-type fibers (Figure 4G). Trichomes on the stem are found in epidermal cells which are dominated by non-glandular types, multicellular needles of about 3-4 cells. In addition, there is also a type of glandular, namely Capitate.

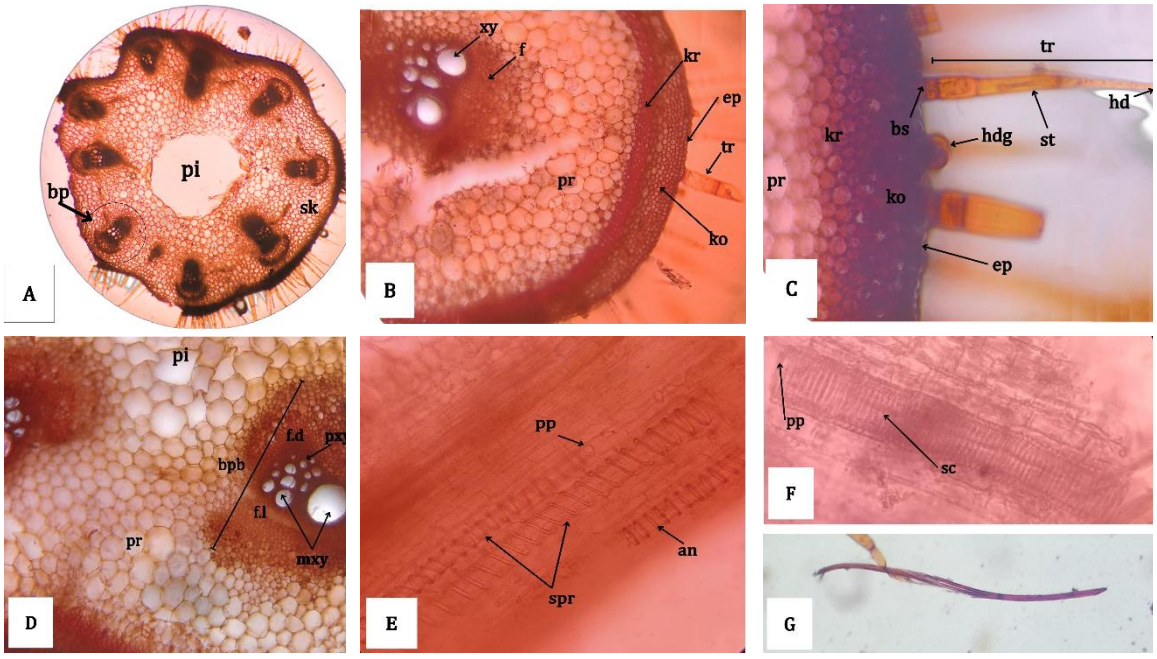

Figure 4. Anatomical Structure of the Stem of the Yellow Pumpkin (*Cucurbita moschata*). A, B, D. Transverse Cross-Section Magnification 10x, 100x; c. Non-glandular trichonous structure of 400x magnification rod; E, F. Trachea Successively Magnification 400x and 1000x; G. 1000x Magnification Fiber; (ep) epidermis; (e.g.) upper epidermis; (ep.b) lower epidermis; (tr) trichoma; (ko) chollencyma; (pr) parenchyma; (sk) sklerenkim; (pi) pith; (fl) outer phloem; (f.d) deep phloem; (xy) xylem; (mxy) metaxilem; (pxy) protoxylem ; (pp) perforation holes; (an) annular type trachea; (spr) spiral trachea; (sc) scalariform type trachea; (st) stalk cells; (hd) non-glandular head ; (hdg) glandular head; (bs) basal cells; (bp) vessel bundles; (bpb) bicollateral vessel

3.3. Leaf

In Figures 5A and 5B, the transverse surface of the leaves of *Cucurbita moschata* is composed of several main tissues, including epidermal tissue, then mesophyll tissue (parenchyma palisade, and sponge), as well as bundles of vessels (xylem and phloem) in the midrib/bone zone of the leaves, there are also parenchyma and collenchyma (Figures 5G and 5H). On the adaxial (top) surface of the leaves, the epidermal cells are polygonal, tightly arranged, and the cell walls are neither too thin nor thick. While on the abaxial (bottom) surface of the leaf, the epidermal cells are winding, tightly arranged and locking or sinuous anticlinal. In line with research (Aqua & Wardhani, 2019) which explains the mechanism of the formation of anticlinal epidermal indentations of the leaf epidermis where this indentation occurs due to the coordination of the arrangement between anticline microtubules, with the thickening of the cell wall, as well as the deposition of microfibriles in the direction of the microtubules resulting in a notched shape on both layers of epidermal cells.

Epidermal cells undergo modification in the form of stomata that are spread on both sides of both adaxial and abaxial leaves called amphystomatic, but many are scattered in the abacsial/underside of the leaf while in the adaxial / upper part is little. For the type of stoma, both sides are anomocytic, surrounded by 4-5 neighboring cells that are not much different from other epidermal cells and kidney-shaped guard cells (Mety Aulia et al., 2023) Both are related where the epidermis functions to protect external disturbances, and play a role in gas exchange in the leaves (Anu et al., 2017). In addition, in Figure 5I, there are trichomes on both sides of the leaf consisting of capitate-type glandular trichomes, and non-glandular multicellular needle-type trichomes, consisting of 3-4 trichome cells (Figure 5J), both of which play a role in adaptation to dry environments (Talebi & Ghorbanpour, 2023).

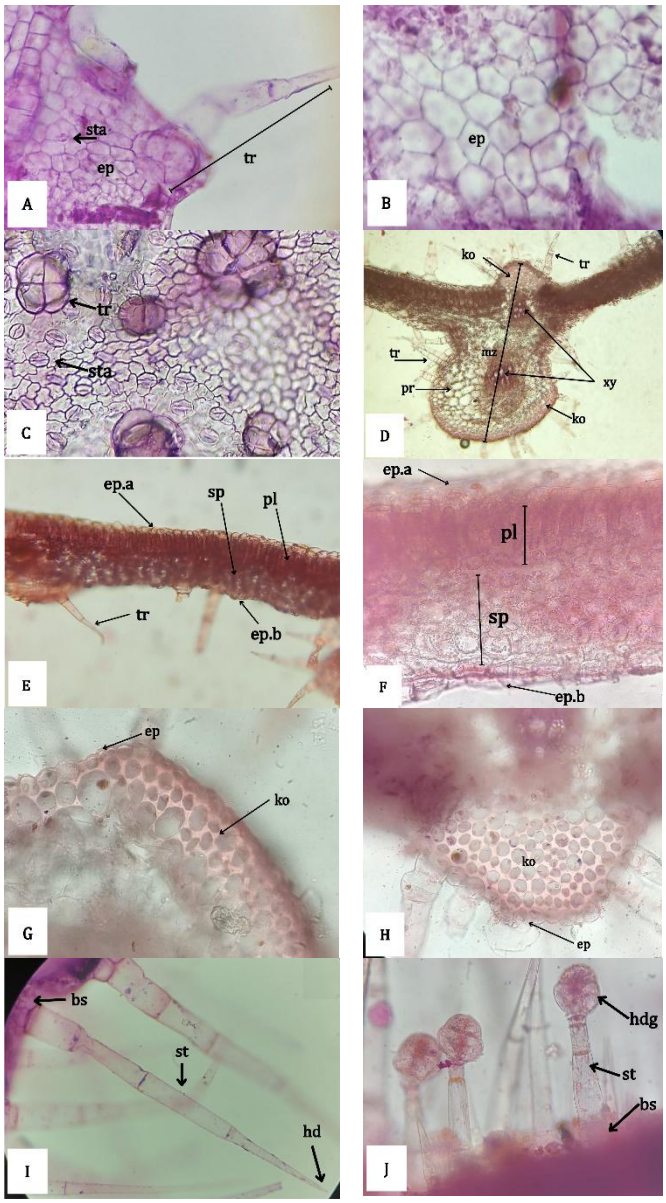

Figure 5. Anatomical Structure of Leaves of Yellow Pumpkin (*Cucurbita moschata*)
A, B. Adexial Magnification 100x; C. Abaxial Magnification 400x; D, E. 400x magnification transverse incision; F. Mesophil Leaf Enlargement 1000x; G, H. Leaf Bone Tissue/Midrib; I. 400x Magnification Non-Glandular Trichomes; J. Glandular trichomes 400x magnification;
(ep) epidermis; (e.g.) upper epidermis; (epb) lower epidermis; (standing) stomata;
(tr) trichoma; (ko) chollencyma; (mz) midrib zone; (pr) parenchyma; (f) phloem; (xy) xylem;
(pl) palisade tissue; (sp) sponge tissue; (st) stalk cells; (hd) non-glandular head; (hdg) glandular head;
(bs)basal cells.

3.4. Flower

In the flowers of *Cucurbita moschata* that are observed are part of pollen. In Figure 6B, it can be seen that the pollen structure is spherical (spheroidal), with exine or echinate-type outer wall filled with a pointed, slightly blunt spine/spine that is evenly distributed, and is classified as pantoporate pollen (aperture or pore > 3). The inside of the pollen contains intin on the inside after the exine layer, then the cytoplasm fills almost the entire inner surface of the pollen. This is in contrast to the study by Olubukola & Titilayo (2022) which examined the types of apertures (porate, colpate, colporate) and seven combinations of apertures (monoporate, monocolpate, bicolporate, triporate, tricolporate, tetraporate, tetracolporate) where the results showed that the tricolporate type is most commonly found in cucurbitaceae. In taxonomy pollen functions as a

differentiator between species, in ecology it functions as pollination related to aperture type as well as pollen size.

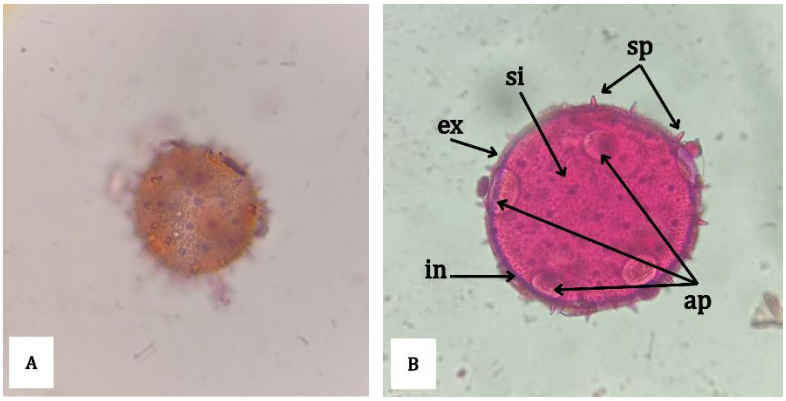

Figure 6. Anatomical Structure of Yellow Pumpkin Plant Flower Pollen (*Cucurbita moschata*)
A. Visible Pollen Magnification 400x; B. 1000x magnification pollen structure; (ex) eksin; (in) intin; (si) cytoplasm; (ap) aperture; (sp) spine

4. CONCLUSION

Based on the results of observations of the anatomical structure of the Yellow Pumpkin plant (*Cucurbita moschata*), it shows that the constituent tissue on the roots from the outside to the inside consists of the epidermis, cortex (parenchyma), endodermis, pericicle, and vascular bundles (xylem and phloem). The trunk also consists of epidermal tissue with capitate type glandular trichomes and multicellular needle-type non-glandular trichomes. In addition, there are cortex (collenchyma, chlorenchyma, and parenchymal tissue), vascular tissue (xylem and phloem), as well as trachea (spiral, annular, and scalariform types) and libriform-type fibers. The leaf structure is composed of the polygonal upper epidermis and the inferior anticlinal sinuous epidermis, the anomocytic type amphistomatic stomata, and the capitate-type glandular leaf trichomes and non-gandular multicellular needle-type 3-4 cells. Pollen is spherical in shape, echinate-type exine, and is classified as pantoporate-type aperture.

To obtain more accurate data on the anatomy of the cucurbitaceae family, it is recommended to conduct a study of the anatomy of other plants in the cucurbitaceae family, such as cucumbers and cantaloupe, by measuring the density and type of stomata, determining the type of thriphome, the ratio of the palisade spongeus, and the thickness of the cuticle which highlights key anatomical characteristics to support environmental durability and efficiency in the photosynthesis process.

5. ACKNOWLEDGMENT

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6. REFERENCES

Abbas, N., Zafar, M., Ahmad, M., Althobaiti, A. T., Ramadan, M. F., Makhkamov, T., Gafforov, Y., Khaydarov, K., Kabir, M., Sultana, S., Majeed, S., & Batool, T. (2022). Tendril Anatomy: A Tool for Correct Identification Among Cucurbitaceous Taxa. *Plants*, *11*(23). https://doi.org/10.3390/plants11233273

Abdi, R. I., Sartika Ami, M., Wulandari, A., Wahab, K. A., & Jombang, H. (2019). Media 3 Dimensi Materi Polinasi dan Fertilisasi Tumbuhan Berbiji. *Journal of Education and Management Studies*, *2*(1).

Almeida, C. F., Gomes, R. S., Machado Junior, R., Oliveira, R. L., Laurindo, R. D. F., Chagas, R. R., & da Silva, D. J. H. (2020). Genetic Control of Internode Length in Winter Squash (*Cucurbita moschata*). *Genetics and Molecular Research*, *19*(3), 1–15. https://doi.org/10.4238/gmr18660

Anu, O., Rampe, H. L., & Pelealu, J. J. (2017). Struktur Sel Epidermis dan Stomata Daun Beberapa Tumbuhan Suku Euphorbiaceae. *Jurnal MIPA UNSRAT Online*, *6(1)*, 69–73.

Aqua, H., & Wardhani, K. (2019). Studi Anatomi Trikoma Daun pada Famili Solanaceae dan Cucurbitaceae. *Edumedia: Jurnal Keguruan Dan Ilmu Pendidikan*, *3(2)*, 78–81.

Ekeke, C., & Agogbua, J. U. (2018). Morphological and Anatomical Studies on *Trichosanthes Cucumerina* L. (Cucurbitaceae). *International Journal of Plant & Soil Science*, *25*(6), 1–8. https://doi.org/10.9734/ijpss/2018/44982

Enneb, S., Drine, S., Bagues, M., Triki, T., Boussora, F., Guasmi, F., Nagaz, K., & Ferchichi, A. (2020). Phytochemical Profiles and Nutritional Composition of Squash (*Cucurbita moschata* D.) from Tunisia. *South African Journal of Botany*, *130*, 165–171. https://doi.org/10.1016/j.sajb.2019.12.011

Ermayanti. (2017). Analisis Kemampuan Representasi Gambar 3D Mahasiswa Calon Guru Biologi pada Mata Kuliah Anatomi Tumbuhan. *Prosiding Seminar Nasional Pendidikan IPA 2017; STEM Untuk Pembelajaran SAINS Abad 21*, 603–609.

Ermayanti. (2023). *Panduan Praktikum Mikroteknik Tumbuhan* (Tidak dipublikasikan). Program Studi Pendidikan Biologi-FKIP UNSRI.

Ermayanti, Susanti, R., & Anwar, Y. (2018). Profile of Biology Prospective Teachers Representation on Plant Anatomy Learning. *Journal of Physics: Conference Series*, *1006*, 012043. https://doi.org/10.1088/1742-6596/1006/1/012043

Guo, J., Xu, W., Hu, Y., Huang, J., Zhao, Y., Zhang, L., Huang, C. H., & Ma, H. (2020). Phylotranscriptomics in Cucurbitaceae Reveal Multiple Whole-Genome Duplications and Key Morphological and Molecular Innovations. *Molecular Plant*, *13*(8), 1117–1133. https://doi.org/10.1016/j.molp.2020.05.011

Hindriana, A. F., & Handayani. (2023). *Anatomi Tumbuhan*. PT. Literasi Nusantara Abadi Grup.

Huang, Y., Ottley, H., Yep, Y., Wilson, S., Griffiths, D., O'sullivan, N., Han, Y., & Hempel, J. (2022). Studies on Tracheary Element of Several Native Cycad Species in Australia and Two American Plants. *American Journal of Plant Sciences*, *13*(01), 147–174. https://doi.org/10.4236/ajps.2022.131010

Laskar, S., Ghoshal, U., & Sen, K. (2020). Vessel Elements of Two Thelypteroid Ferns-Part I. *Botanical Studies*, *61*(1). https://doi.org/10.1186/s40529-020-0281-y

Lee, H. Y., Jang, S., Yu, C. R., Kang, B. C., Chin, J. H., & Song, K. (2021). Population Structure and Genetic Diversity of *Cucurbita moschata* Based on Genome-Wide High-Quality SNPS. *Plants*, *10*(1), 1–10. https://doi.org/10.3390/plants10010056

Lynch, J. P., Strock, C. F., Schneider, H. M., Sidhu, J. S., Ajmera, I., Galindo-Castañeda, T., Klein, S. P., & Hanlon, M. T. (2021). Root Anatomy and Soil Resource Capture. *Plant and Soil*, *466*(1–2), 21–63. https://doi.org/10.1007/s11104-021-05010-y

Ma, L., Wang, Q., Zheng, Y., Guo, J., Yuan, S., Fu, A., Bai, C., Zhao, X., Zheng, S., Wen, C., Guo, S., Gao, L., Grierson, D., Zuo, J., & Xu, Y. (2022). Cucurbitaceae Genome Evolution, Gene Function, and Molecular Breeding. *Horticulture Research*, *9*. https://doi.org/10.1093/hr/uhab057

McCubbin, T. J., & Braun, D. M. (2021). Phloem Anatomy and Function as Shaped by the Cell Wall. *Journal of Plant Physiology*, *266*, 153526. https://doi.org/10.1016/J.JPLPH.2021.153526

Mety Aulia, O., Amintarti, S., & Rezeki, A. (2023). Tipe-Tipe Stomata Tumbuhan Myrtaceae di Lingkungan Kampus FKIP ULM Sebagai Booklet Bahan Ajar Pendamping Mata Kuliah Anatomi Tumbuhan. *Bioedukasi: Jurnal Pendidikan Biologi Universitas Muhammadiyah Metro*, *14(2)*, 231–237.

Mukti, S. P., Ermayanti, E., & Susanti, R. (2022). Representasi 3D Jaringan Epidermis dan Stomata Daun Beberapa Jenis Tumbuhan Suku Apocynaceae serta Sumbangannya pada Pembelajaran Biologi SMA. *BIOEDUSAINS: Jurnal Pendidikan Biologi Dan Sains*, *5*(1), 170–181. https://doi.org/10.31539/bioedusains.v5i1.3732

Nurdiana. (2020). *Taksonomi Tumbuhan Tinggi* (R. Sucilestari, Ed.). Sanabil.

Olubukola, A., & Titilayo, O. (2022). Palynology of Some Species in the Family Cucurbitaceae from Nigeria. *International Journal of Advanced Research*, *10*(05), 1199–1207. https://doi.org/10.21474/IJAR01/14836

Qian, D., Wang, M., Niu, Y., Yang, Y., & Xiang, Y. (2025). Sexual Reproduction in Plants Under High Temperature and Drought Stress. *Cell Reports*, *44*(3), 115390. https://doi.org/https://doi.org/10.1016/j.celrep.2025.115390

Sadia, H., Malik, K., Qureshi, R., Mehmood, K., Khan, K., Hassan, A., Ahmad, S., Shah, H., Gul, H., Alkahtani, J., Almunqedhi, B., Iqbal, R., & Ameen, M. (2025). Pollen Morphology of Cucurbitaceae Using Microscopic Techniques for Accurate Taxa Identification. *Genetic Resources and Crop Evolution*, 1–24. https://doi.org/10.1007/s10722-025-02344-9

Talebi, S. M., & Ghorbanpour, M. (2023). Trichomes Plasticity of Plants in Response to Environmental Stresses. *Plant Stress Mitigators: Types, Techniques and Functions*, 495–504. https://doi.org/10.1016/B978-0-323-89871-3.00015-X

Vieira, L. E. B., Damasceno Sá, R., & Randau, K. P. (2019). Anatomical and Histochemical Characterization of Leaves of *Luffa cylindrica* (L.) M. Roem. *Pharmacognosy Journal*, *11*(3), 511–514. https://doi.org/10.5530/pj.2019.11.81