Taxonomy, Habitat and Distribution, Morphoanatomical and Physiochemical Properties of Bayog (BambusaMerrilliana (Elmer) Rojo&Roxas Comb. Nov.)

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Abstract - *Bamboo is one of the most important nature's substitutes for the endangered rainforest hardwoods. Pangasinan remains to be the biggest producer of bamboo in the Philippines which is used in building nipa huts, making baskets, bigao, walkers, bookshelves, bangkito and other items. Bayog species of bamboo is the most preferred in the construction of nipa huts because of its strength and thick culms.*

Although, the strength of the stem of the various bamboos was often studied because of their economic use, there are few studies on their morphoanatomical characteristics and physiochemical properties on these plants. The appearances at macro and microlevels direct vital processes in the life cycle of a plant like growth, development, metabolism, photosynthesis, nutrition, and resistance in order to control the vitality or yield of the crop species and to maximize economic benefits. Thus, it is necessary to reveal these properties.

The research aims to know the taxonomy, origin and distribution, and fundamental morphology and anatomy of the B. merrlliana's leaves, adult and young (labong) culms, and roots; inorganic and organic chemicals present (however limited to detection) and physiological properties such as water movement, photosynthate translocation, and water potential of Bayog.

Keywords: *bayog, taxonomy, morphoanatomical properties, physiochemical properties, habitat*

INTRODUCTION

Bamboo known before as the "poor man's timber", now labeled as the "climate change plant", has 64 species and 12 genera in the Philippines [1], [2]. Although it manifests high species diversity, only nine species are commercially used in the Philippines [3].

Furthermore, bamboo is one of the most important nature's substitutes for the endangered rainforest hardwoods. Also, the strength of its culms, their straightness, smoothness, lightness combined with hardness and greater hollowness; the facility and regularity with which they can be split; the different sizes, various lengths and thickness of their joints make them suitable for numerous end products/purposes [4].

Pangasinan particularly San Carlos City remains the biggest producer of bamboo throughout the country [5]. Most residents in the 71 out of 85 villages in this city are engaged in bamboo industry. Bamboos were used in building nipa huts, making baskets, bigao (winnowing tray), anduyan (baby cribs or hammocks), walkers, bookshelves, cabinets, bangkito (stool) and other items [6].

The species Bayog (Bambusamerrilliana (Elmer) Rojo&Roxas comb. nov.) syn. (Dendrocalamusmerrillianus (Elm.) Elm.)is one of the preferred species in the construction of nipa huts because of its strength and thick culms. This native species is used especially in the construction of bahaykubo as foundation or framework of the hut making it sturdy and durable. This species is mostly found in San Carlos City and some parts of Pangasinan such as Bayambang, Malasiqui and Lingayen.

However, because of the increasing popularity of bamboo in local and international market due to the sharp decrease in timber production for furniture and handicrafts, this has severely increased the pressure on bamboo causing serious genetic erosion. Furthermore, because the bamboo shoot, also called labong, used as a local delicacy, the Pangasinan Provincial Environment and Natural Resources (PENRO) is asking the local government unit to regulate the harvesting of these shoots. Thus, an Ex-Situ Conservation called Philippine Bambusetum was established in 1988 by the government [7] which placed emphasis on the conservation of the species especially the native bamboos.

Although, the strength of the stem of the various bamboos was often studied because of their economic use, there are few studies on their morphoanatomical characteristics and physiochemical properties on these plants. The appearances at macro and microlevels direct vital processes in the life cycle of a plant like growth, development, metabolism, photosynthesis, nutrition, and resistance in order to control the vitality or yield of the crop species and to maximize economic benefits. Thus, it is necessary to reveal these properties.

The research aims to know the taxonomy, origin and distribution, and fundamental morphology and anatomy of the B. merrlliana's leaves, adult and young (labong) culms, and roots; inorganic and organic chemicals present (however limited to detection) and physiological properties such as water movement, photosynthate translocation, and water potential of Bayog.

MATERIALS AND METHODS

Taxonomic Classification

The taxonomy of the B. merrilliana (Elmer) Rojo&Roxas comb.nov was obtained from the NCBI Taxonomy Browser Online Program.

Biogeographical Distribution

Its origin and biogeographical distribution in the Philippines were identified based on the Handbook on Erect Bamboo Species Found in the Philippines [8] of Ecosystems Research and Development Bureau, Department of Environment and Natural Resources

Morphoanatomical Observations of the Various Parts of the Bayog

Gross morphological observations were done in the Libsong East, Lingayen, Pangasinan. However, dissection of the various parts was done at the Biology Laboratory of Pangasinan State University-Lingayen Campus. Parts were collected and pressed for the preparation of voucher specimen submitted to the curator of Father Brackman Museum of Natural History at Saint Louis University, Baguio City.

Collection of Leaves, Stems and Roots

The leaves, stems and roots of B. merrilliana (Elmer) Rojo&Roxas comb. nov.were collected from Libsong East, Lingayen, Pangasinan. The plant was initially identified by a native resident and was verified using dichotomous key and online comparison of the bamboo. The leaves of similar sizes and age were gathered from adult bamboo culms and inspected for any presence of disease. Ice floatation of the various parts was done in a medium size ice box and was transported to Natural Science Research Unit (NSRU) of Saint Louis University, Baguio City for the analyses.

Preparation of Bayog Leaves for Ashing

Leaves were washed under running tap water and rinsed with distilled water. These were blot dried using a tissue paper prior to cutting. The cut bayog leaves were then weighed in a metal crucible using the AdventurerTM analytical digital weighing balance with a reading of 5 grams.

The cut leaves in a metal crucible were placed inside the furnace with a temperature reading of 5000C to 6000C. Sample was placed into the furnace until it turned to gray ash. Then, it was cooled then weighed.

Detection of Inorganic Elements in Bayog Leaves

10 mL of distilled water and 5 mL nitric acid were added to the previously weighed leaf ash sample. The ash residue was washed with 10 mL of distilled water until a total of 25 mL filtrate was collected. The ash solution was then subjected to several tests for the detection of calcium, magnesium, chlorine, sulfur, phosphorus and iron [9].

Detection of Organic Molecules in Bayog Leaves

Aqueous leaf extract of bayog was prepared by placing 30g of cut leaves and 300 ml of distilled water

in a blender. The mixture was blended for two minutes until the leaves were thoroughly crushed. The mixture was filtered using cheese cloth. The filtrate was used to test for the presence of carbohydrates using Molisch, Benedict's, Seliwanoff's and Iodine's Tests [10].

Isolation of Chloroplasts from Bayog Leaves

Leaves were obtained from actively growing healthy bamboos. The previously harvested leaves were kept in a cold and dark place for no longer than one night before the isolation of the chloroplasts avoiding high levels of starch accumulation since starch grains can rupture the chloroplast envelope during centrifugation. Then, the leaves were washed under tap water to remove dirt and other debris. Leaves were blot dried using clean cloth and cut into pieces removing the midrib and petioles with about 1 cm square area. 10-15 grams of the de-veined leaf tissue was measured. Then the leaf pieces were placed in a pre-chilled ImariflexMultiblender blender cup containing 50-75 ml of ice-cold 0.05 M sodium-potassium phosphate buffer pH 7.3 (made to 0.4 M sucrose and 0.01 M KCl). These were grinded at high speed for 15 sec. at top speed, paused about 10 seconds then blended again for 10 seconds (1 min max). Then, in a pre-chilled 1000 mL beaker, the leaf homogenate was squeezed through four layers of a pre-chilled cheesecloth into the cold beaker by twisting the top corners of the cloth around each other. This was filtered. The 14 ml of the homogenate was poured into each of two centrifuge tubes and centrifuged at 200g for 5 minutes (1500 x g for 10 minutes max). The supernatant was discarded and the pellet was resuspended in 35 mL sucrose- phosphate buffer. Again, the suspension was centrifuged at 200g for 5 minutes (1500 x g for 10 minutes max) using HeraeusSepatech centrifuge machine. For the second time, the supernatant was discarded again and the pellet was resuspended in 35 mL sucrose- phosphate buffer. The produced solution was known as stock chloroplast solution which was kept at 4 degrees 0C in subdued light.

Half of the stock chloroplast solution was used to visualize the appearance of chloroplast under binocular electric microscope.

Estimation of chlorophyll concentration in Bayog Leaves

4.75 mL 80% acetone was added to 0.25 mL stock chloroplast suspension. The absorbance of the supernatant was measured at 652 nm using the Spectro20D spectrophotometer. 80% acetone solution was used as the reference blank. The dilution factor was multiplied with 100 and divided by the extinction coefficient of 36 to obtain the mass of chlorophyll (in mg) per mL of the chloroplast suspension.

Chromatographic Separation of Plant Pigments

A line was made at1.5 - 2 cm from the bottom edge of the chromatography paper using a pencil. The line was divided into 3 parts for leaves, stems and roots. Each mark was spotted with the corresponding extract using a capillary tube. Spotting was done 3-5 times. The paper was allowed to dry between each application. A developing chamber was prepared by pouring 50 mL solvent into a 1 L beaker. The solvent consisted of a mixture of petroleum ether -n-butyl alcohol- acetone- distilled water (40-2020-20 v/v). The chromatography paper was rolled in a cylinder (staple edges) then placed in the 100o mL-beaker. The paper was made sure that it did not touch the sides of the beaker. Then it was covered with foil and was not moved until the solvent reached a distance of about 1 cm from top edge of the paper. The paper was removed and allowed to dry. Rf values were calculated to identify the plant pigments.

Measurement of Water Potential

Chardakov method was used to measure the water potential present in the leaves. Eight test tubes were filled with sucrose solution (2 tubes/bottles per concentration of 25%, 50%, 75% and 100%). In each concentration 1 whole leaf of bamboo was fully immersed into the test tubes. The remaining 4 test tubes bottles containing same volume of sucrose served as control. Then the mouths of the four test tubes were covered with aluminum foil. This was done overnight. On the next day, the leaves were removed from the test tubes. Few drops of methylene blue was added enough to color the solution lightly. Then, using a medicine dropper, a drop of the colored solution was transferred carefully to the corresponding control test tubes. Observation was done immediately after dropping the colored solution to the controlled test tubes.

Observation and Measurement of Uptake and Movement of Water in Plants

Two young leafy bamboo shoots were obtained. Leaves in one of the shoots were removed; the other shoots had intact leaves. Bases of the shoots were cut under water and were immersed in separate beakers containing 2 mL of 0.1% eosin. After 10 minutes of immersing, the shoots were removed from the tubes and cut longitudinally. The length (cm) stained by the dye in each shoot was measured. Thin free hand cross sections of the shoots midway between the bases and the highest point reached by the stain were prepared. These were observed under the microscope.

The second way of observing the movement of water in plants was through weighing method. Two small plotted bamboo plants were secured and enclosed with a plastic bag up to the plant's stem base in order to seal all evaporative surfaces. The leaf area of the bamboo was determined by laying the pot on its side in such a way that one can trace the outline of the leaves on a sheet of paper. A uniform kind of paper was used in the tracing. After tracing all the leaves, the tracings were cut up and determined its total weight. Using the same kind of paper10 x 10 cm square cut out was made and its weight was determined.

Translocation of Photosynthates in Leaves

A starved bayog plant was obtained (dark grown for 5-7 days) plant. A section of the leaf was cut and tested for the presence of starch by adding 3-5 drops of Tincture of Iodine Solution to the depigmented leaves. Two leaves were selected and labeled A and B. One leaf was covered with carbon paper and was placed in the light for 48 hours. The depigmentation was done by boiling the leaf in water to kill the protoplasm. It was boiled in 95% ethyl alcohol over a water bath to extract the chlorophyll. Then it was washed with warm water. The leaves were spread in a petri dish with 4 to 5 drops of dilute iodine solution and color change was observed.

RESULTS AND DISCUSSIONS

Taxonomic Classification

Taxonomy ID: 4581
Genbank common name: **bamboos**
Inherited blast name: **monocots**
Rank: genus
Genetic code: Translation table 1 (Standard)
Mitochondrial genetic code: Translation table 1 (Standard)
Other names:
synonym: **Bambusa Schreb.**

Lineage (full)
cellular organisms; Eukaryota; Viridiplantae; Streptophyta; Streptophytina; Embryophyta; Tracheophyta; Euphyllophyta; Spermatophyta; Magnoliophyta; Mesangiospermae; Liliopsida; Petrosaviidae; commelinids; Poales; Poaceae; BOP clade; Bambusoideae; Bambusodae; Bambuseae; Bambusinae

Common/Vernacular names: Bayog (Ibanag, Iloko, Sambali, Tagalog), Bayugin (Tagalog), Botong (Bisaya, Bicol); Butong (Panay, Bisaya); Kawayanbayog (Pangasinan

Origin and Biogeographical Distribution

Bayog is endemic to the Philippines. It can be found in Luzon (Ilocos Sur, Abra, Nueva Ecija, Rizal, Laguna, Zambales, Pangasinanand Bulacan), Visayas (Leyte, Cebu, Bohol) and in Mindanao (Lanao)

Morphoanatomical Features of *Bayog* (*Bambusamerrilliana* (Elmer) Rojo&Roxas

Figure 1. B. merrilliana in its natural habitat located Libsong East, Lingayen, Pangasinan

Figure 2. B. merrilliana leaves. A-Young leaves; B. Mature leaves

Figure 2. Young shoot of B. merrilliana. A-Young shoot or labong of Bayog; B- Apex of the shoot showing sheathing; C-Longitudinal section of labong; D-Closer image of sectioned labong. 1-Young culm sheath; 2-lumen; 3-node; 4- internode; 5- apical meristem 6- culm auricles

Figure 3.Adult culms of B. merrilliana. 1-node; 2-internode; 3 leaf sheath; 4-branch; 5-aerial roots

Figure 4. Cross section of B. merrilliana adult culm. A. Thick walled hollow culm. B. Solid culm; 1-Lumen ; 2-Bud

Figure 5.Longitudinal section B. merrilliana adult culm. 1-Lumen; 2 Node; 3-Internode; 4-branch growing from the node

Bamboos are giant grasses, thus they belong to the Graminae or PoaceaeFamil;y of flowering plants, but they differ from the smaller grasses in many ways. They have woody culms, well developed branching, specialized culm sheaths, leaf bases narrowed into thin petioles, and cyclical flowering.

Bayog is a clumping bamboo with erect and sturdy culms more or less 20m tall, 8-12cm in diameter and has walls up to 4cm thick. The nodes are solitary, the nodal line and nodal ridge are present with aerial roots especially at the lower nodes. Internodes are green and smooth; the lower ones are up to 30cm long, moderately hollow and sometimes almost solid at the base. Culm sheaths are 20cm long, 25cm wide, narrowed upward to truncate, the outer surface is strongly ribbed, shortly pubescent with brown to black hairs while the inner surface is weakly ribbed, shiny and glabrous. The auricle is 2mm high, has margins and fringed with brown hairs; the blades are 4.55cm long, base is 2cm wide, narrowed upward to acute tip, inner and outer surfaces are pubescent, margin is folded. Branches are usually one at each node, sturdy and about 2m long. Leaves are as many as 12 to a branchlet; blades are linear-lanceolate to oblong-lanceolate, 13-26cm long, 1.5-3.3cm wide, glabrous or sparsely puberulent; the base is obtuse to rounded, the margins are weakly scabrous and the tip acuminate; petiole is short and glabrous; sheaths are longer than the internodes and glabrous; the auricles are not distinct; and the ligule is 1mm and glabrous.

Inorganic elements present in Bayog leaves

Table 1 shows that the inorganic elements calcium, magnesium, chlorine, sulfur and iron are present in the leaf ash of B. merrilliana. It was contented that the selection of bamboo species for various applications is not only related to physical and mechanical properties but also its chemical composition because it determines the properties of the plant.

Furthermore, these minerals are necessary as structural components in macromolecules, as cofactors in enzymatic reactions, as osmotic solutes needed to maintain proper water potential, or as ionized species to provide charge balance in cellular compartments. These minerals are divided into main categories such macronutrients and micronutrients. The macronutrients include nitrogen (N), potassium (K), calcium (Ca), magnesium (Mg), phosphorus (P) and sulfur (S) which are generally found in plants at concentrations greater than 0.1% of dry tissue weight. On the other hand, micronutrients include iron (Fe), zinc (Zn), manganese (Mn), copper (Cu), boron (B), chlorine (Cl), molybdenum (Mo) and nickel (Ni) are found at concentrations less than 0.01% of dry tissue weight [13].

Specifically, calcium is needed by the plant for membrane integrity, functions as ‘second messenger” to coordinate plant’s responses in many environmental stimuli and reversibly with calmodulin which activates many enzymes. Also, magnesium is needed as part of chlorophyll, enzyme activator and protein synthesis. Chlorine is needed to activate photosynthetic elements and in maintenance of water balance. On the other hand, sulfur becomes part of the coenzyme A and the amino acids cysteine and methionine. Phosphorus forms parts of nucleic acids, Adenosine triphosphates and phospholipid membranes. Lastly, iron is required for synthesis of chlorphyll, becomes component of cytochromes and

ferrodoxin and cofactor of peroxidase and some other enzymes (Moore, Clark & Stern, 1995).

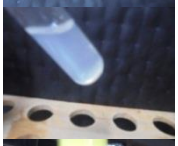
Additionally, mineral deficiencies limit the biosynthesis or expression of key components of energy capture and/or metabolism eventually affecting plant growth. Deficiencies of N, Fe or Mg reduce chlorophyll synthesis and thus photosynthetic capacity, and result in chlorosis, or yellowing, of leaves. On the other hand, the lack of P, K or S impact metabolites or enzymes involved in photosynthesis and respiration leading to inadequacies in the transfer of light energy to chemical bonds, or in the export of sugars from chloroplasts, and can result in the development of necrotic lesions on leaves.

Since plant growth and metabolism is affected by mineral deficiency, their most significant outcome in the case of agronomically important crop plants is a reduction in harvest yields, or in some cases, total loss of the crop. Also, the moderate nutrient deficiencies can reduce the general health of the plant, inhibiting its ability to withstand environmental or biotic stresses. Thus, all the essential minerals required by plants are essential for the health of humans and other animals, plant mineral deficiencies can reduce the nutritional content and quality of our harvested food supply [13].

Thus, the well-known strength and durability of the B. merrilliana culm is indirectly affected by the inorganic elements present in its leaves. Since biosynthesis of important molecules necessary for the growth and development of culms are dependent on photosynthesis which happens in the leaves.

However, it is suggested that the B. merrilliana culm should have been tested at its various nodes and internodes of its different ages for the presence and relative quantity of these organic substances to establish the relationship between strength and durability with that of level of the node and age.

Table 1. Inorganic elements present in Bayog leaves

Detection of Inorganic Elements	Observations		Remarks
1. Calcium	Presence of white precipitate		Calcium is present
2. Magnesium	Presence of white precipitate		Magnesium is present
3. Chlorine	Presence of grayish precipitate		Chlorine is present
4. Sulfur	Presence of white precipitate		Sulfur is present
5. Phosphorus	Presence of yellow precipitate		Phosphorus is present
6. Iron	Reddish discoloration		Iron is present

Organic Molecules Present in Bayog Leaves

Table 2 indicates the presence of carbohydrates and reducing sugars. However, aldose, ketose and starch were not detected using the Seliwanoff's and Iodine's tests respectively.

Carbohydrates, specifically monosaccharides are dehydrated in the presence of concentrated sulphuric acid to form an aldehyde known as furfural (pentoses) or hydroxymethyl furfural (hexoses) derivatives. However, Molisch's is a general test for carbohydrates which means it will not distinguish carbohydrates as aldose or ketose, or reducing or non-reducing sugar. Since the leaf is the site of photosynthesis, aside from the fact that it contains the complex carbohydrate cellulose, it is expected that carbohydrate is found in this plant organ.

Benedict's test identifies reducing sugars (monosaccharide's and some disaccharides), which have free ketone or aldehyde functional groups. Positive results involves color change upon boiling into green means there would be 0.1 to 0.5 percent sugar in solution; changes color to yellow, then 0.5 to 1 percent sugar is present; changes to orange means that 1 to 1.5 percent sugar is present; changes to red means 1.5 to 2.0 percent sugar is present and changes to brick red means that more than 2 percent sugar is present in solution (Aryal, 2015). Thus, in the result for the presence of reducing sugar, it indicated that there was the presence of approximately 0.1 to 0.5 percent reducing sugars in the ash solution.

Seliwanoff's test differentiates between ketoses and aldoses. Ketoses react more quickly than aldoses and thus the reaction time is a means of separation or detection. Ketoses react within 1 minute of heating while aldoses will require several minutes. The test is based on the fact that, when heated, ketoses are more rapidly dehydrated than aldoses. Based on the actual results, ketose or aldose is absent or not detected in leaf sample since there was no change in the color. It is a fact that plants produce sucrose in their leaves, from glucose made during photosynthesis. The leaf cells then export the sucrose to the plant sap through which the sucrose is transported to the other parts of the plant [14]. Thus, it is expected that it should generate positive result; however, it yielded a false negative result which may be due to non-dehydration of the reagent to the carbohydrate present.

Further, negative result was obtained for the presence of starch using the iodine's test. Starch should be present in the leaf sample since this is one of the converted carbohydrates produced from photosynthesis. The reason for the false negative results in the experiment because the leaf was not decolorized by boiling and adding ethanol. The process should have removed the chlorophyll present in the leaf that would masks the color change of the iodine [15].

Table 2. Organic molecules present in Bayog leaves

Tests	Observations		Remarks
1.Molisch's Test	Presence of purple ring at the junction		Carbohydrate is present
2. Benedict's Test	Green color of the solution; no brick red precipitate		Reducing monosaccharide is present
3. Seliwanoff's Test	Yellow color of solution; no change in color to orange or red		Non detection of aldose or ketose in the sample
4. Iodine's Test	Brown color of the solution; no change in color to violet or blue		Non detection of starch in the sample

The carbohydrate content of bamboo plays an important role in its durability and service life. Durability of bamboo against mold, fungal and borers attack is strongly associated with the chemical composition [16]. However, since the leaves were the plant organ tested for the qualitative tests for the presence of carbohydrates and not the culms of bamboos, it would have an indirect impact on the physical properties of the culm since photosynthesis mainly happens in these areas. Products of photosynthesis which will be eventually converted to several products in different pathways will be transported to other bamboo parts.

Chloroplast in Bayog Leaves

Figure 2 shows the chloroplasts containing the green pigment chlorophyll. The shape observed under 1000x magnification was ovoid to spherical. Chloroplasts are functional units of photosynthesis. These are the organelles which contains a green pigment called chlorophyll, which absorbs light energy for photosynthesis. Chloroplast varies in shape. They are spheroid or ovoid or discoid in higher plants. Furthermore, the size of the plastids varies from species to species; however, the size remains constant for a given cell type. In higher plants, it is 4-5 microns in length and 1-3 microns in thickness. Also, generally chloroplasts of plants growing in shady places are larger in size.The number of chloroplasts varies from plant to plant, but it remains constant for a given plant. In higher plants there are 20 to 40 chloroplasts per cell or up to 1000 chloroplasts.

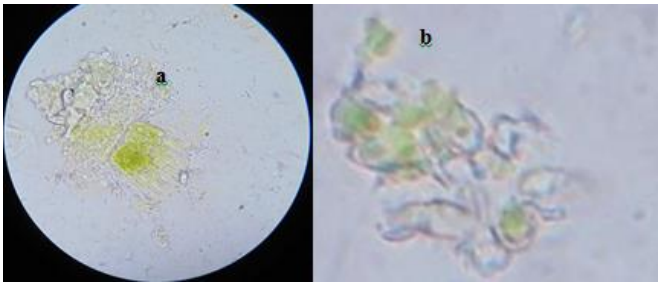


Figure 2. A. Chloroplast of *B. merrilliana* leaves at 1000x; a: mesophyll cell; b: ovoid chloroplasts

Estimation of chlorophyll concentration in Bayog leaves

Table 3 shows that the average absorbance of the stock chloroplast suspension from Bayog leaves was 0.066 with the equivalent weight of 0.183 mg/ml of the chloroplast stock solution.

Table 3. Absorbance of the stock chloroplast suspension and the equivalent milligram per mL of chlorophyll

Trial	Absorbance of the supernatant at 652 nm	Milligram of chlorophyll per mL of chloroplast solution
Trial 1	0.069	0.192 mg/ml
Trial 2	0.070	0.194 mg/ml
Trial 3	0.059	0.164 mg/ml
Average	0.066	0.183 mg/ml

Chlorophyll (Ch) is a key biochemical component in the molecular apparatus that is responsible for photosynthesis. It is significant to know the chlorophyll content in characterizing the productive potential of various crops like bamboo since the entire biomass productivity depends ultimately on the photosynthetic efficiency of the leaf. But the bamboo leaf and its chlorophylls a and b and their ratio, carbohydrates and starch were inversely proportional with age [17]. Based on the appearance of brought leaves, most of them were mature and had brown tips which could be one of the factors to the very low average chlorophyll content. The amount of chlorophyll present leaf affects the size and the thickness and strength of the Bayog culms since it is directly proportional to its photosynthetic activities.

Pigments present in the various parts of Bayog

Pigments present in leaves were chlorophyll b and xanthophyll 2 as revealed through the paper chromatography. On the other hand, stem and roots have xanthophyll 2 only. Although the main photosynthetic pigment used is chlorophyll a in higher plants, there was no mark left by chlorophyll a in the chromatographic paper which could be due the inadvertent movement of the set-up. Furthermore, it could be due to less concentrated solution produced from crushing of a small number of parts chosen with small size thus less pigments were extracted from the grinding of the different parts. Chlorophyll a functions as the primary donor in the Reaction center of Photosystem II (PS II) , and is the closely related pigment acting as primary donor of photosystem I (PS I).On the other hand, the majority of Chl b is found in the antenna complexes of PS II; in the Light Harvesting Complex (LHC) II, it forms to nearly 50% of the chlorophylls [18].

Table 4.Rf Values and Pigments present from chromatographic separation of pigments

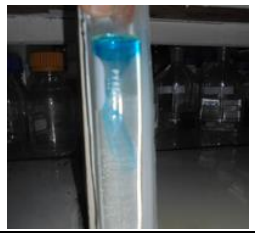
Part	Rf Value	Pigment Present
Leaves	0.375	Chlorophyll b
	0.1	Xanthophyll 2
Stem	0.1	Xanthophyll 2
Roots	0.1	Xanthophyll 2

Similarly, xanthophyll pigments have critical structural and functional roles in the photosynthetic light-harvesting complexes of algae and vascular plants. In almost all photosynthetic eukaryotes, the majority of xanthophylls are bound with chlorophyll (Chl) molecules to proteins of integral membrane, light-harvesting complexes. The LHCs absorb and transfer excitation energy to the photosynthetic reaction centers to drive electron transport; these reactions convert light energy into chemical energy that is used to fix atmospheric CO_2 into sugars. Thus, it can function as accessory light-harvesting pigments, as structural entities within the LHC, and as molecules required for the protection of photosynthetic organisms from the potentially toxic effects of light [19].

Measurement of Water Potential in Bayog Leaves

Using Chardakov Method in the determination of the water potential, Table 5 reveals that the solution where leaf was immersed in the 25% sugar solution had diffuse dispersion in the control solution indicating that water potential of the bathing solution is equal to that of the plant cells. On the other hand, the solutions where leaves were immersed in 50%, 75% and 100% solution had moved upwards in the control solution indicating that the drop is lighter and that the leaf solution was less concentrated-meaning that water from the tissue passed out of the cells and into solution.

Table 5. Water Potential of Bayog Leaves at Different Solution Concentrations

Solution	Observations		Remarks
25% Sucrose Solution		Uniform dispersion (diffused) of the methylene blue solution in the 25% sucrose control solution	No change in the water potential of either tissue or solution
50% Sucrose Solution		Methylene blue solution moved upwards in the 50% sucrose solution which indicated that the test solution	The water potential of the tissue is higher than the water potential of the solution
75% Sucrose Solution		Methylene blue solution moved upwards in the 75% sucrose solution which indicated that the test solution	The water potential of the tissue is higher than the water potential of the solution
100% Sucrose Solution		Methylene blue solution moved upwards in the 100% sucrose solution which indicated that the test solution	The water potential of the tissue is higher than the water potential of the solution

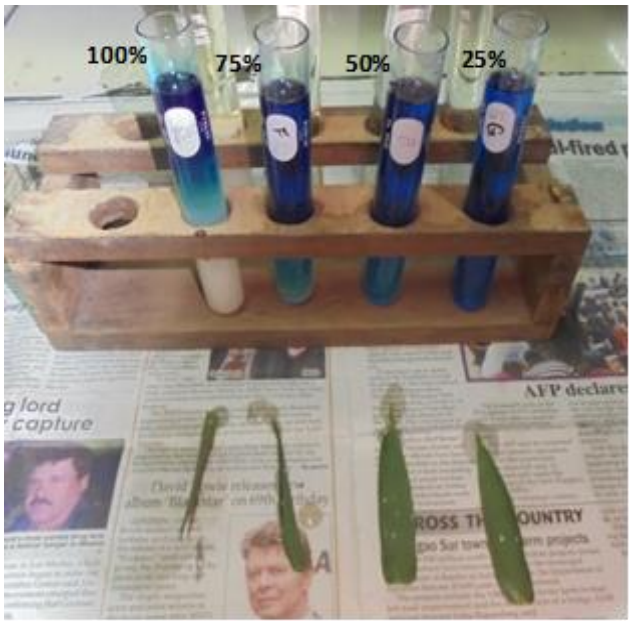


Figure 3. The morphology of leaves after immersion to the various concentrations of sucrose solutions

The process of diffusion of water intake may occur because of differences in the concentration of the concentration in a plant cell is lower than the concentrations that are outside of plant cells. Plant cells can undergo a major loss of water if the water potential outside the cell is lower than the water potential in the cell. Lack of water in the plant tissue may interfere with the activity of physiological and morphological plant causing atrophy [20]. Thus, it was also observed that the leaves removed from 50%, 75% and 100% sucrose solution underwent leaf rolling as compared to the leaf immersed in 25% solution which had similar morphology before and after immersion. However, leaf that was immersed in 100% sucrose solution had the most change in leaf morphology. The change in the leaf morphology indicated that there was a massive movement of water from the cells of Bayog leaves to the surrounding solution while the former had zero net movement of water thus it had similar size and shape.

Water potential in plants is important because of its influence on growth and development. Increase or decrease in the amount of water inside the cells will affect all the metabolic process of the plant as a result of cell's plasmolysis.

Uptake and Movement of Water in Bayog Using Ascent in Stem

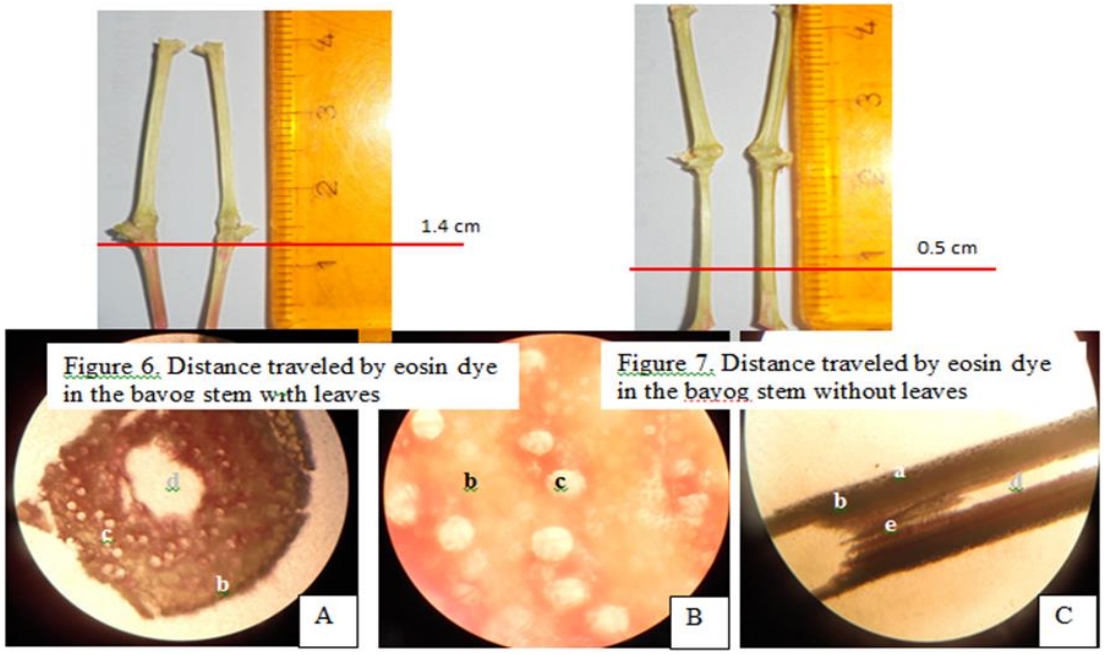


Figure 8. A. Cross section of bamboo stem with leaves at 40x; B cross section at 4000x; C. Longitudinal section of bamboo stem at 40x. a- epidemis; b-cortex; c:xylem; d: lumen; e: diaphragm/internode

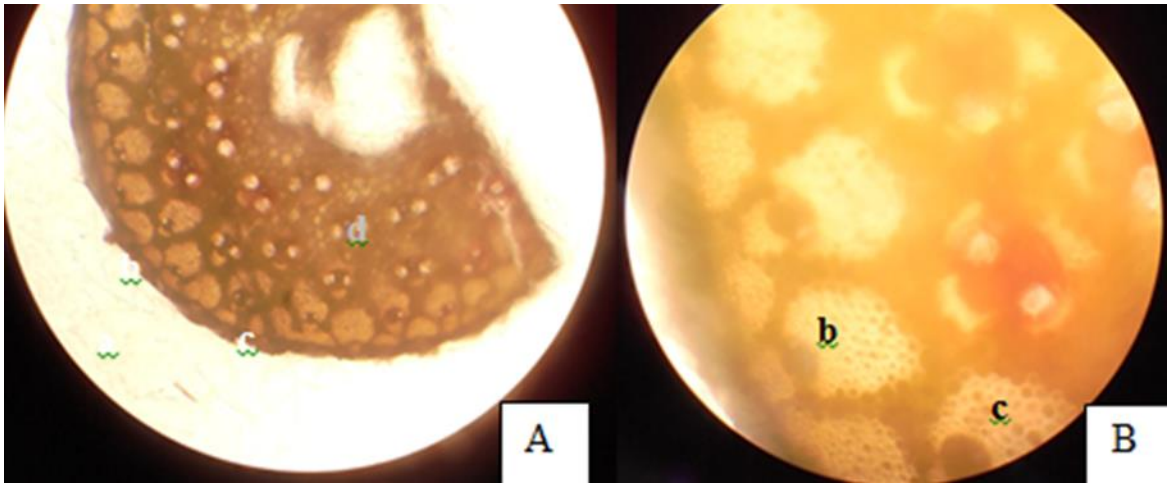


Figure 9. A. Cross section of bamboo stem without leaves at 40x; B cross section at 400x. a- epidemis; b-cortex; c: xylem; d: lumen; e: diaphragm

Figures 6 and 7 indicate the ascent of water in the stems with and without leaves travelling in a distance of 1.4 cm and 0.5 cm respectively. The stem with leaves has a higher distance traveled from the base as compared to the former. This implies that leaves play an important role in the movement of water upward.

The main driver of water movement in the xylem is transpiration which is possible which happens when there is the loss of water from the plant through evaporation at the leaf surface. The cohesion-tension theory explains how water moves up through the xylem wherein inside the leaf at the cellular level, water on the surface of mesophyll cells saturates the cellulose microfibrils of the primary cell wall. The wet cell wall is exposed now to the internal air space and the water on the surface of the cells evaporates into the air spaces leading to the decrease in the thin film on the surface of the mesophyll cells. The decrease creates a greater tension on the water in the mesophyll cells, thereby increasing the pull on the water in the xylem vessels with leaves [11]. Thus, longer distance travelled by water was observed with the leaves.

Moreover, the cross section of the stem revealed that water (with eosin dye) travelled through the xylem (c). Comparing figures 8 and 9, more xylem were stained by eosin dye in the stem with leaves as compared to stem without leaves. This implies that the movement of water upward did not involve most of the xylem vessels for the stem without leaves.

Uptake and Movement of Water in Bayog Using Weighing Method

Table 6.Transpiration rate of Bayog leaves exposed to light and under shade

Plant Sample	Weight (g)			Total Surface area of leaves (cm^2)	Transpiration rate per leaf area ($g/hr./cm^2$)
	Initial	Final	Difference		
Bayog exposed to light	0.3 g	0.1 g	0.2 g	60 cm^2	0.00028 $g/hr./cm^2$
Bayog under shade	0.2 g	0.1 g	0.1 g	40 cm^2	0.00021 $g/hr./cm^2$

Bayog leaves exposed to light had a higher transpiration rate of 0.0028 g/hr./cm2 as compared to bayog leaves under shade which had 0.00021 g/hr/cm2 implying that leaves under greater light intensity has faster transpiration rate.

According to Moore et al. [12], the environmental factors affecting transpiration in plants include light, relative humidity, temperature, availability of water, and wind. In general, plants transpire fastest under the following climatic conditions: (a) bright day, (b) dry air, (c) moist soil, (d) warm temperature, and (e) windy day. Light has a controlling effect on the opening of the stoma through which water primarily escapes in gaseous state. In general, transpiration rate is high during daytime, particularly when light is bright, than during night time. The stomata are typically open during daytime, allowing the entry of CO2 and the exit of O2. However, the opening of the

stomata likewise enables the escape of water as water vapor in the process of stomatal transpiration. Thus, transpiration is both beneficial and detrimental since this is needed in the upward movement of water; however it could lead to dehydration of the plant.

Translocation of Photosynthates in Leaves

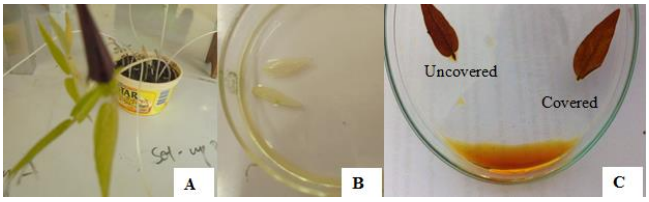


Figure 10. A. Set-up showing appearance of initially starved leaves and exposed to sunlight. B. Iodine's Test for starved leaves C. Iodine's Test for the uncovered and covered leaves after exposing to sunlight.

Figure 10 shows the color of the leaves after exposing to sunlight. Iodine's test reveals that uncovered leaves had more color intensity based on the intensity of the color brown-black. Also, it was noted that traces of black spots were seen in the veins and veinlets of uncovered leaf. This implies that more starch were present in uncovered leaf compared to covered leaf. This implies that light is needed in the production of photosynthates. Also, it could be deduced that such products are concentrated in the vascular tissue particularly phloem since the veins and veinlets were darker in color.

CONCLUSION AND RECOMMENDATION

The various observations and tests implemented could indirectly affirm the properties connected to bayog. The researcher recommends that quantification of the different minerals and biomolecules should be done to understand the peculiar property of bayog which is thicker and stronger culms.

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