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ETHNO-SCIENCE STUDY OF BAMBOO AS A BUILDING MATERIAL OF BADUY COMMUNITY FOR ENVIRONMENTALLY FRIENDLY AND SUSTAINABLE MATERIALS CHEMISTRY LEARNING

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ABSTRACT

This study aims to develop the chemical aspects of the local practice of the Baduy community in utilizing bamboo as a traditional house building material that can be integrated in material chemistry learning. The research method is a literature study of scientific journals, books, online articles, and research reports related to bamboo as a building material, which is then analyzed by comparing local knowledge and scientific concepts to identify potential integration into science learning, especially chemistry. The result of this study is that the integration of natural science with local practices, such as bamboo used for environmentally friendly and sustainable building materials, is an innovative way to teach materials chemistry. The study of bamboo as a building material can help students understand chemistry concepts, especially the structure and physicochemical properties of materials students can relate the mechanical and thermal characteristics of materials to their structure in a more relevant and practical way. Thus, chemistry learning is not only limited to theory and laboratory experiments, but also includes real applications that are relevant to everyday life in society.

Keywords: Bamboo, Baduy Community, Building Materials, Local Practices and Scientific ScienceMaterials Chemistry Learning.

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1. INTRODUCTION

There are three inseparable aspects in learning chemistry including chemistry as a scientific process, attitude, and knowledge that includes concepts, facts, laws, principles, and theories. The fundamentals of chemistry involve three inseparable dimensions of research: macroscopic observation of the nature of matter, submicroscopic understanding of the particles that make up substances, and symbolic representation in the form of chemical formulas and symbols (Gultom & Muchtar, 2022). Chemistry is one of the fields with a variety of very complex problems such as the properties of elements, reactions, retrosynthesis, material toxicity, structural characteristics and so on (Mater & Coote, 2019). Then, chemistry can also be obtained and developed based on experiments (Cova *et al.*, 2019). In this case it allows the need for exploration of the chemical space efficiently, relevant and which can be easily understood by students, namely by having a gradual, concrete and real learning approach strategy in everyday life it can help improve thinking broadly and achieve learning targets (Siahaan *et al.,* 2021).

As an illustration, incorporating traditional knowledge or customs in the community into chemistry teaching can increase learners' interest and the relevance of the material to them. This is done by linking chemical principles to everyday situations familiar to students. Some studies also confirm that utilizing this traditional knowledge or local customs has been proven effective in achieving learning objectives. Such as Wahyudiati & Fitriani's research, (2021) shows that wisdom and practice-based chemistry learning resources have an effect on improving students' cognitive learning outcomes. In the research of Riza *et al.* (2020) have successfully developed a chemistry teaching module based on local wisdom on learning outcomes and student motivation it is feasible to use as learning. Furthermore, Tagio *et al.* (2023) showed their success in developing local wisdom-based learning content and media in chemistry learning for molecular shape model material. Linking chemical principles with their application in daily life through local wisdom and traditional practices, not only helps learners understand the material easily, but also supports the preservation of local cultural heritage and develops a conservation attitude that encourages changes to local practices that have a negative impact. This results in a more meaningful and valuable learning experience, which inspires learners to engage more actively and passionately in learning chemistry. Thus, this research aims to explore local practices in the Banten area, specifically the culture of the Baduy tribe who use bamboo as a traditional house building material, which can be applied as a learning material in the context of materials chemistry.

The Baduy tribe is one of the local wisdoms located in the mountains of Kanekes Village, Leuwidamar District, Lebak Regency, Banten Province. The Baduy tribe as a traditional community is located around the forest area and still maintains ancestral cultural values. The forest area of the Baduy tribe is still preserved it has the potential for natural materials that have many benefits. As it is known, forest plays a role in terms of food security, livelihood, agriculture, source of biodiversity. Baduy community has a life attitude that is friendly to nature, and utilizes nature to meet the needs of the community, both clothing, food and shelter (board). More broadly, Baduy community also utilizes nature as a source of traditional medicinal materials, natural pesticides, natural fabric dyes, building materials and so on (Abduh *et al.*, 2023). Therefore, Baduy is very interesting as an object of learning and research to explore the existing knowledge of the Baduy community and make it a scientific knowledge.

The residence of the Baduy people is arranged in a collection of traditional houses that are close together. This traditional house is a traditional building that has its own distinctiveness in each region. In addition, traditional houses are also one of the highest cultural markers in a community. Sulah Nyanda House is an example of a traditional house of the Baduy people, located in Banten Province. The uniqueness of the Baduy traditional house can be seen from its special architecture. Not only that, the traditional house of the Baduy people also has a deep meaning and reflects many cultural elements, both in terms of ornaments and parts of the building (Mustopa, 2023). In formal planning, there are also norms and standards for planning the construction of houses and residential areas, such as technical requirements for houses, which include requirements for safety, health, comfort and convenience, as well as facilities and infrastructure for residential areas to support community activities. Therefore, Baduy community obeys the customary law as a form of keeping nature in balance and in accordance with its function (Harapan, 2019).

The sulah nyanda house is in the form of a stage made of bamboo material, because the Baduy tribe has natural knowledge to utilize the results that exist in nature, one of which is bamboo which grows a lot in the area. Bamboo can be an alternative environmentally friendly building material, which can replace wood, because bamboo is easy to cultivate, can live well in almost all types of soil, ranging from low to highlands, and is relatively short to be harvested and can be harvested continuously afterwards. Besides being often used in the construction of houses by the Baduy tribe, bamboo can also be developed as a simple technology that is suitable for use in daily needs such as woven bamboo, cups, trash cans and other home furnishings (Prasasti, 2024). From the bamboo material, the potential for scientific knowledge can be explored in terms of physical or chemical properties, elasticity properties, thermal properties and the structure of bamboo materials that are adjusted from the local knowledge of the Baduy tribe students can understand material chemistry material easily and relevantly.

This research is a novelty because there are still not many researchers who focus on studying how the Baduy tribe uses bamboo as a building material for sulah nyanda houses integrated in chemistry learning. This research tries to combine the local way of life that is often ignored in modern lessons, especially chemistry, to make the subject matter more appropriate to everyday life and fun for students. Therefore, it is hoped that this research can produce a new way of tackling chemistry learning that is more interesting and relevant to the younger generation. In addition, it is also expected to improve learners' enthusiasm and learning outcomes due to interesting and real-life related learning, thus helping them to think analytically and understand the material better.

2. RESEARCH METHODS

The research uses a qualitative descriptive approach, which aims to describe and analyze bamboo as a building material for the traditional house of the Baduy tribe of Banten, Indonesia and its implications for scientific aspects. This location was chosen due to the local practice of using bamboo as an environmentally friendly and sustainable building material in the area. The data collected is secondary data which includes literature studies from scientific journals and other online articles as well as several research reports related to bamboo as a building material. The data was then comparatively analyzed between local knowledge and scientific concepts to identify potential integration into science learning (particularly materials chemistry) through the identification of key themes that emerged, related to aspects of science in the context of the structure and physicochemical properties of bamboo materials.

3. RESULTS AND DISCUSSION

3.1 Science Aspects of Bamboo Materials

Bamboo is a general or colloquial term for a taxonomic group of large woody grasses. Bamboo contains 1,500 species in 123 generations worldwide (Ahmad et al., 2021), most of which rarely flower but grow fast and reach full maturity in five years (Noori et al., 2021). Bamboo is widely grown in Indonesia and has long been a part of people's lives. The rapid growth of bamboo allows it to be used sustainably. With more use of bamboo in buildings, it can support the community's economy and have a positive impact on the environment. Bamboo can be an environmentally friendly alternative building material because it is easy to cultivate, can grow in many types of soil, and can be harvested in a short time and continuously (Irwan, 2022). The classification of bamboo in general is, Kingdom: Plantae; Order: Poales; Family: Poaceae; Sub-family: Bambusoideae; Super Nation: Bambusodae; Nation: Bambuseae; and in some types of bamboo plants can grow up to a height of 30m with a stem diameter between 15-20cm, bamboo can survive up to a temperature of -29°C (Yang et al., 2019). **Figure 1** is the general anatomy of a bamboo culm.

Figuere 1. Anatomy of a Bamboo Stem [15] (Yang et al., 2019)

Bamboo belongs to the grass tribe (Gramineae), having primary growth without secondary growth. The stem is knobbly and fibrous, without radial cell elements such as fingers. The outer skin of the stem consists of a single layer of epidermal cells, while the inner skin consists of sclerenchymal cells. This results in restriction of lateral movement and fluid penetration from the transverse direction (Clark & Mason, 2019). The epidermis of

Gramineae stems has a tight cell structure, with thick outer cell walls and a cuticle coating. The epidermal cells also contain cork cells containing suberin and silica cells containing silica (Jiang et al., 2022). The cuticle is composed of kutin and wax, which makes the epidermal cell wall difficult to penetrate water, serving as protection against evaporation (Apostolo et al., 2022).

Bamboo culms consist of approximately 50% parenchyma, 40% sclerenchyma fibers, and 10% transport bundles (Lian et al., 2020a). On the outside of the culm, there are many small transport bundles, while on the inside, the transport bundles are larger but few in number. The total number of transport bundles decreases towards the tip of the stem, and they get closer to each other. Parenchyma cells are more abundant on the inside of the stem, while sclerenchyma fibers are more abundant on the outside. The number of sclerenchyma fibers increases from the base to the tip of the stem, while the number of parenchyma cells decreases. Parenchyma usually consists of cells with thin walls, large vacuoles, live protoplasm, and spaces between cells (Lian et al., 2020b). Parenchyma cells in the late growth stage do not show lignification (thickening of the wall with lignin or starch), and they are connected to each other through longitudinal walls (Xue et al., 2019).

Bamboo has great potential as a construction material due to the advantages of using bamboo in construction including its renewability, fast construction process, low cost, and no need for modern equipment. In addition, bamboo also has the advantage of being lightweight and flexible, making it suitable for earthquake-resistant buildings (Priyanto & Yasin, 2019). In terms of structural strength, bamboo tends to be more robust in resisting tensile forces. And with proper use, bamboo is also capable of resisting compressive forces. However, the weakness of bamboo lies in its material characteristics which are influenced by type, growth location, and humidity. Bamboo is susceptible to the effects of rainwater and sunlight, thus requiring special attention in the design process (Dewagana & Arif, 2022).

3.2 Materials Chemistry Learning Approach Integrated with Local Practices of Bamboo as a Building Material of Baduy Tribal Community

The traditional house of the Baduy tribe is a symbol of the simplicity of its people. The virtues to be obtained from this building are the function of protection and comfort, as well as food and building materials still using the results of the surrounding nature. In addition, the spirit of kinship in the Baduy tribe is still very thick, so the process of building a Baduy traditional house involves local residents by working together (Sekarpandan et al., 2022). The traditional house of the Baduy tribe is in the form of a stage, the utilization of bamboo is more widely used in house building materials for each specific part. Bamboo as a construction material can be used as a house building including poles, beams, partitions, bridges as well as supports and other parts. The strength of a bamboo construction is greatly influenced by the age of harvesting and preservation of bamboo. **Table 1** shows the parts of the traditional house of Baduy tribe with the type of material used.

Table 1. Types of Materials Used in Parts of the Baduy Traditional House

Parts of the Baduy Traditional House	Parts Picture	Type of Material Used
The foundation of the house is made of river stone and the pillars are made of wood and bamboo.		River stone, mahogany wood, and Duri or Ori bamboo (*Bambusa blumeana* (Schult.f))
Bamboo slat flooring		Mayan bamboo (*Gigantochloa robusta* (Kurz))
Floor support beams		Duri or Ori bamboo (*Bambusa blumeana* (Schult.f))
Walls of woven bamboo		Mayan bamboo (*Gigantochloa robusta* (Kurz))
The column supporting the floor with the roof is made of wood and the rope uses bamboo		Bayur wood and apus bamboo (*Gigantochloa apus* (Kurz))
Wooden door		Bayur wood

Parts of the Baduy Traditional House	Parts Picture	Type of Material Used
Bamboo plaited roof skylight		Black bamboo (*Gigantochloa atroviolacea*)
The canopy frame uses bamboo		Duri or Ori bamboo (*Bambusa blumeana* (Schult.f))
The roof is amde of palm fiber		Palm fiber or coconut leaf (welit)

The use of bamboo as a building material can be an interesting topic in learning materials chemistry, especially related to the structure and physicochemical properties of materials. The use of bamboo as a material for building houses is a practice that can be explored in education, especially through inquiry learning methods in a contextual teaching context that aims to develop students' understanding of bamboo materials and a practice-oriented approach to local wisdom. In this learning outcome, students can relate the mechanical and thermal characteristics of the material with its structure. The utilization of bamboo as a building material is a practice that can be explained through chemical principles. The integration of local practices into material chemistry learning materials offers an interesting opportunity to explore structural characteristics and physicochemical properties. Concept analysis of each part of the traditional house of the Baduy tribe towards the integration of community science knowledge with scientific science, namely:

1. Position and direction of the traditional house

All Baduy traditional houses are in the form of stilts and Baduy traditional houses are built facing each other and always face north or south. According to the knowledge of the community, it is in the form of a stage because it is influenced by the local environmental conditions that are often wet and humid, then facing north and south because of the sun's factor that shines and enters the room, so the selection is built only in two directions and follows the ancestral culture. Meanwhile, according to scientific knowledge, sunlight can help reduce humidity and kill potentially harmful microorganisms in the house and health, building materials can react to environmental conditions, including sun exposure and temperature changes (Habibi, 2019). In planning sustainable buildings, it is important to create green spaces around buildings as a source of oxygen, choose building materials with minimal energy consumption, and orient the building sunlight can be optimally utilized without causing glare. In addition, heat protection, natural air circulation, structural stability, balanced space proportions, as well as consideration of environmental impacts and the comfort of occupants of different ages and physical conditions are also a focus in sustainable buildings (Indrajaya & Anggraini, 2021).

Utilizing bamboo as a building construction material, it is important to understand its mechanical characteristics they can be used as a basis in designing the structure. Bamboo has natural characteristics such as not being resistant to rain and sunlight. Bamboo is also a flammable material and should be kept away from sources of fire. To maintain its strength, bamboo must be kept away from direct contact with soil. Soil contains water and moisture that can damage bamboo culms. Bamboo buildings can also be made with wide terraces that protect parts of the building from exposure to rainwater and sunlight (Dewagana & Arif, 2022).

The bamboo used should already be in a dry condition with a moisture content of about 12%, which corresponds to the average air humidity in the tropics of 70% (Dewagana & Arif, 2022), while the average specific gravity of bamboo is 656.03 kg/m^3, The moisture content of the bamboo will affect the mass of the bamboo. The more water content or the wetter the tested bamboo, the greater the mass will be compared to dry bamboo mass. Bamboo density values show varying results due to the anatomical structure of bamboo from the base to the tip consisting of internodes, between internodes, and varying wall thicknesses. Bamboo is a hygroscopic material that has an affinity for water, both in the form of water vapor and liquid (Junaid et al., 2022).

2. Types of bamboo used

The types of bamboo that are often used by the baduy community are duri bamboo (Ori), mayan bamboo, apus bamboo, and black bamboo, the selection of the four types of bamboo is used by the baduy community because of its abundance in the forest, easy to grow in the area and the selection of bamboo types according to their function based on the size or physical shape of the bamboo, according to scientific science based on research by Noywuli et al. (2019) states that bamboo has a high economic value for the community and is also useful for restoring critical forest and land areas due to its ability to absorb high amounts of CO_2 and rainwater, because it has many stomata on its leaves, which are more than 500 stomata per mm^2. This makes bamboo an effective bioaccumulator plant in reducing carbon emissions in the atmosphere. Through the process of photosynthesis, bamboo plays an important role in the carbon cycle by reducing the amount of CO_2 in the air and at the same time increasing oxygen levels.

Based on the research of Sujarwanta & Zen (2020), the differences between the four types of bamboo have been identified based on environmental factors recorded including the type of bamboo species, temperature, pH, air humidity, and light intensity, with the identification results showing duri or ori bamboo (Bambusa blumeana (Schult. f), 26°C, pH 6, 86% and 540 lux); mayan bamboo (Gigantochloa robusta (Kurz), 26°C, pH 7, 83% and 540 lux); apus bamboo (Gigantochloa apus (Kurz), 26°C, pH 6, 85% and 560 lux) and black bamboo (Gigantochloa atroviolacea, 26°C, pH 6, 86% and 545 lux). Bamboo as a lignocellulosic material used in various products and building materials, bamboo has both advantages and disadvantages as a building material due to its low resistance to destructive organisms such as termites and dry sawdust. The natural resistance of bamboo to destructive organisms varies depending on the species, both against fungi and insects (Sadiku et al., 2021).

Based on research by Jasni et al. (2017) differences in bamboo types have a significant effect on weight loss and the effect of resistance to dry wood termites, testing bamboo types with moisture content ranging from 12 - 18%, stating that duri bamboo with weight loss parameters and the number of living termites belongs to class IV (not resistant) the attack degree value is 90, mayan bamboo with weight loss parameters belongs to class II (Resistant) and the number of living termites belongs to class IV (not resistant) the attack degree value is 70, While apus bamboo and black bamboo with weight loss parameters and the number of living termites belong to class I (Very resistant) the value of the degree of attack is 70, based on the results of these tests on class IV bamboo before use should be preserved first, while class II and class I bamboo in its use does not need to be preserved nor is it a problem and is recommended for use outdoors.

3. Knowledge of house parts made from bamboo

a. House support poles, floor support beams and canopy frames made of duri or ori bamboo.

The support of the house from the foundation to the floor uses wood and duri bamboo, according to the knowledge of the community, duri bamboo is a large bamboo that is physically visible it can be used as a support. Scientifically, bamboo fulfills the element of strength required as a building material. The element of strength can be compared between bamboo and several other materials based on their mechanical properties. These mechanical properties refer to how well the material can withstand pressure (working stress per volume) and how stiff the material is (modulus E per volume). For example, bamboo can be stronger than concrete when resisting pressure and bamboo can have equal or higher strength than steel when compared proportionally, which makes it perfect for use in building framing (Irnawan, 2022). The specific gravity and density of bamboo determine its physical and mechanical properties. This is because the specific gravity and density values of bamboo are determined by the amount of substance in the bamboo. The specific gravity of bamboo ranges from 0.5 - 0.9 gr/cm^3. Bamboo has a very high strength to weight ratio making it efficient and effective for use as a building material (Olajide et al., 2021).

The mechanical properties of bamboo are influenced by its tensile strength and compressive strength. Bamboo has good tensile and compressive strength, the tensile strength is evenly distributed along the stem, while the compressive strength increases as the bamboo ages. Mechanical property testing to measure tensile strength along the stem axis shows that bookless bamboo is stronger than those with books. This is because the bamboo fibers tend to bend at the book, making it the weakest part against tensile forces along the culm axis. Therefore, the design of bamboo structures that function as tensile culms should consider the book portion (Hartono et al., 2022). Ori bamboo has an average dry bamboo tensile strength of 2,910 Kg/cm^2 while the modulus of elasticity (E) of bamboo ranges from 98,070-294,200 kg/cm², but for the design E of 294,200 kg/cm² was used (Jimenez et al., 2021).

b. Floor of slats and walls of woven mayan bamboo

The community's knowledge of the floor of the traditional house of the Baduy tribe is made of mayan bamboo which is split into small elongated pieces it is flat and has air cavities. And the walls of the house are made of wicker which has pores the air in the building can be constantly replaced with new air the people inside are healthier. In the scientific explanation of air circulation is the exchange of air from outside and from inside the house. Air moves from outside to inside and vice versa. Good air exchange provides comfort for its occupants because it provides freshness, comfort in regulating air temperature, and regulates humidity in the house, and allows light to enter through wall gaps it has an effect on light optimization (Hardy, 2019). Bamboo is used as walls and floors because it is a fairly strong and relatively lightweight material. When split, the bamboo fibers still remain tightly arranged, providing the strength and stability needed for flooring and bamboo has natural properties it needs air circulation to avoid moisture it is resistant to microorganisms and fungi, and can maintain the durability of the floor (Andriani & Putra, 2022).

The durability of mayan bamboo is influenced by its chemical structure and mechanical properties, which consist of holocellulose which is the total fraction of the polysaccharides that make up the plant cell wall consisting of cellulose and hemicellulose, holocellulose content in the type of mayan bamboo in the internode and book, namely 72.15% and 72.64%. While the alpha cellulose content in the type of mayan bamboo studied in the bamboo segment section is 39.88% and the book is 37.11% (Nugroho et al., 2018). The high level of alpha cellulose in the internode can contribute to the higher tensile strength of the parallel fibers of the internode compared to the book. The variation in cellulose content between bamboo species is due to genetic factors, while the variation between internodes and books on the same culm may be due to differences in cell tissue composition or stress differences during growth (Primaningtyas et al., 2021).

In terms of mechanical properties, the fraction of cellulose in the cell wall plays a greater role than the total polysaccharide content. This is due to holocellulose being composed of cellulose and hemicellulose, and the differences in their chemical properties. The linear polymer structure of cellulose has a major impact on mechanical properties, while the amorphous nature of hemicellulose affects the hygroscopic properties of bamboo (Fitriani et al., 2022). The hemicellulose content in mayan bamboo is 36.32%. Mayan bamboo has high holocellulose content and hemicellulose content. However, it has a low lignin content of 25.83% in the book section and 18.90% in the internode section, Lignin content and its composition is one of the chemical components that make up plant cells that vary greatly between species, between trees within the same species, between parts of the tree, and even between plant constituent cell tissues. The mechanical characteristics of the fiber parallel tensile strength of the bamboo segment section are higher (2488 kgf cm^{-2}) compared to the book section (967 kgf cm^{-2}), because they are influenced by the chemical components of bamboo, especially the chemical components of the cell wall which consist of lignin, cellulose, and hemicellulose (Nugroho et al., 2018). Of these bamboo chemical components, lignin and alpha cellulose greatly affect the tensile strength of bamboo. This mayan bamboo is suitable for use as woven bamboo and split to become the floor of the house.

c. Apus bamboo rope for the column supporting the floor with the roof

Apus bamboo or rope bamboo is often used by the baduy community to bind the supporting parts of the house construction, for example to bind the floor support with the roof according to the community, the bamboo is very flexible so it is easy to use as a binder. According to scientific explanations, there are several things that affect the physical and mechanical properties of bamboo, namely age, height position, diameter, bamboo flesh thickness, load position, specific gravity and bamboo moisture content. String bamboo is a type of bamboo with a distance between internodes of 65 cm and a diameter ranging from 40-80 mm and a stem length of 6-13 meters. The mechanical properties of rope bamboo are as follows:
a) Tensile strength 270.94 MPa
b) Compressive strength 48.97 MPa
c) Flexural strength 70.46 MPa
d) Shear strength with segments 5.14 MPa
e) Shear strength without segments 4.02 MPa
f) Bolt fulcrum strength 37.38 MPa
g) Tensile modulus of elasticity 18.058 MPa
h) Compressive modulus of elasticity 25,852 MPa
i) Flexural modulus of elasticity 19,514 MPa
j) Water content 12.97% and specific gravity 632.8 Kg/m^3

With good compressive and tensile strength, Apus bamboo can be said to be suitable for use as the main material for building structures. The high flexural properties are a distinguishing aspect that affects the shape of the building and is easy to rope. The diameter is much smaller by half, making rope bamboo used for structures must consist of more than one culm to achieve the desired thickness (Dewagana & Arif, 2022). The properties of apus bamboo are also influenced by the levels of chemical components of the cell wall, the holocellulose content of the cell wall in the internode section is 66.76% and the book section is 66.01%. While the levels of alpha cellulose that have been studied in the internode section are 38.02% and 35.18%, the high levels of alpha cellulose in the internode section can contribute to the higher tensile strength of the fiber parallel to the internode section compared to the book section. Then the hemicellulose content in the internode section is 36.32% and the book section is 35.57% while the lignin content in the internode section is 25.20% and the book section is 29.51%. Bamboo fiber parallel tensile strength is influenced by alpha cellulose and lignin levels due to a correlation with the chemical components of the cell wall (Nugroho et al., 2018).

d. Roof ceiling made of black bamboo matting

The ceiling of the roof of the traditional house of the baduy tribe uses black bamboo woven like the walls of the house, according to the community the woven is easy to shape, able to provide good air circulation for the room in the building because the house does not have windows. Scientifically, black bamboo can be used as matting because it has physical and mechanical properties with a specific gravity of 0.83 kg/cm^2, modulus of elasticity of 99000 kg/cm^2, compressive strength parallel to the fiber of 489 kg/cm^2, shear strength of 61.4 kg/cm^2, tensile strength perpendicular to the fiber of 28.7 kg/cm^2, and split strength of 41.4 kg/cm^2. The strength of the bamboo is influenced by its position, with the bark being the strongest part. The bamboo skin has a much higher strength than the interior, while the compressive strength of bamboo also increases with age (Ndale, 2018).

Bamboo is able to withstand stress under tensile conditions compared to stressed bamboo. The fibers that run through the bamboo culm consist of highly elastic vascular bundles that have a high tensile strength. The tensile strength of these fibers exceeds that of steel, but it is difficult to make connections that can withstand such tensile stresses. Thinner bamboo tubes tend to be more effective in this regard. In the silicate periphery, parallel and elastic axial fibers are capable of withstanding tensile stresses of up to 400 N/mm^2. In comparison, bamboo fibers with very high strength can only withstand stresses of up to 50 N/mm^2 (Fathoni et al., 2023). Then, for the chemical structure properties possessed by black bamboo, the starch content is 11.9% where the starch content is found in the parenchyma cells which can affect the preservation of bamboo, other chemical compositions have levels of holocellulose 69.27%; alpha cellulose 45.19%; hemicellulose 24.08%; lignin 24.16%; and extractive water solubility 10.46% (Widyorini et al., 2020).

4. Supply process of bamboo as a building material

The Baduy community in stocking bamboos for house construction goes through a process of selecting bamboo types according to the function of the building, the age of the bamboo, cutting which is adjusted to the size that will be used in the building section because there are customary rules of the Baduy tribe that long cannot be cut and short cannot be joined, drying open storage in the forest and soaking in river water to make it durable. As for the scientific knowledge on the bamboo supply process, namely through the process of harvesting, drying, storage, and preservation, it is important to increase the age of bamboo when used as a construction material (Hasan et al., 2023).

Bamboo material is an earthquake-resistant building construction, in terms of structural strength, bamboo is stronger against tensile forces, however, with proper application, bamboo can still withstand compressive forces. Bamboo used as a construction material is dry bamboo with an equilibrium moisture content of 12% at an average tropical climate air humidity of 70% (Chaowana et al., 2021). Bamboo to be used as building material is recommended to be harvested at the age range of 3-6 years because at that time bamboo has optimal quality and strength. Bamboo culms are cut about 15-30 cm above the ground, just at the top of the internode, to prevent stagnant water in the exposed internode. The bamboo drying process is done to reduce the moisture and starch content in the culm. There are several methods of drying bamboo, such as bush drying, natural drying, and microwave drying. Bamboo preservation can also be done by non-chemical (natural) methods, using river water, or fumigation, or by chemical methods using preservatives such as Copper-Chrome-Arsenic (CCA) or Copper-Chrome-Boron (CCB) and similar (Dewagana & Arif, 2022).

Bamboo has a strong structure and is able to absorb water efficiently. In the natural preservation process of bamboo when immersed in water, it absorbs water through its pores, filling the empty spaces in its structure and reducing the risk of attack by moisture-demanding insects or fungi. In addition to water, bamboo contains various natural chemical compounds such as lignin, tannins and other extracts. When soaked in water, these compounds dissolve and form a solution with antimicrobial or antifungal properties, helping to protect the bamboo from attack by destructive organisms such as mold or bacteria. Soaking the bamboo in water also helps to preserve the natural moisture of the bamboo, preventing cracks and deformation caused by extreme changes in temperature and humidity (Chen et al., 2021). However, prolonged soaking will also reduce the strength of the bamboo, soaking bamboo in water for nine weeks did not affect the mechanical strength of the bamboo, but there was a decrease in specific gravity after soaking. The tendency for the specific gravity to decrease indicates that if soaking is carried out for too long the mechanical strength will decrease, this is consistent with the correlation between the amount of specific gravity and mechanical strength, in addition to other factors such as the water content of the bamboo concerned (Gunawarman et al., 2022).

4. CONCLUSION

This study provides valuable insights for students regarding the application of scientific knowledge in everyday life related to material chemistry learning that integrates chemical aspects of local practices in the use of bamboo as a building material for the Baduy tribe. This study also has the potential to be applied to material chemistry learning topics at the university level related to the material structure and physicochemical properties of materials which include physical, chemical and mechanical properties of materials students can connect the mechanical and thermal characteristics of materials with their structures more relevant and practical. In addition, integrating this topic in learning material chemistry also has the potential to not only increase students' understanding of chemical applications in real contexts but also potentially student awareness of social responsibility and being environmentally friendly. Therefore, it is very important to have chemistry learning that focuses on contextual aspects that not only focus on theoretical but also understand practical applications and their impact on society and the environment.

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