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The Potential of Materials Constructing Traditional Houses of Honai Dani Tribe of Papua as a Source for Learning Biochemistry with an Ethnoscience Approach

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ABSTRACT

This research aims to explore the biochemical aspects of the local wisdom of the Honai traditional house Dani tribe of Papua and its potential integration in biochemistry learning through an ethnoscience approach. The research method is literature study from scientific journal articles, books, online articles, and research reports related to the biochemical composition of the building materials that make up the Honai traditional house. The main problem in this study is how to construct indigenous science knowledge into scientific science and identify its potential integration in biochemistry learning. The study showed that the main components of Honai houses are reeds, various types of wood, and rattan. The biochemical composition is lignin, holocellulose, alpha-cellulose and hemicellulose as well as other compositions that can be discussed on the topic of biochemical aspects of living things and further on the topic of cells and cell bonds / chemical bonds. The material composition contained in the materials that make up the honai traditional house can also be further explored in the practice of applied biochemistry, to produce other appropriate items. Thus the Honai traditional house is highly potential as a learning resource in biochemistry courses with an ethnoscience approach.

Keywords: Biochemical, ethnoscience, honai, indigenous science, local wisdom

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1. INTRODUCTION

The Dani tribe has architectural wealth in the form of Honai traditional houses, a tribe originating from the Baliem Valley, one of the areas located in the Jayawijaya Mountains of Papua. The Honai house has a unique shape like a bird's nest with a round roof and house. The materials used to construct Honai are 100% natural materials that are environmentally friendly. The Honai house is unique in terms of shape and materials designed typically as a form of adaptation to its environment. This house is made closed with a relatively small size as an effort to keep the room temperature warm, making it suitable for cold climate conditions. Geographical and climatic factors will affect the geometric shape of the building mass, placement and number of openings in the building, material selection, building construction and settlement patterns (Fauziah, 2014).

An interesting study in the Honai traditional house is its constituent materials. Learn how the constituent materials can survive the environmental conditions. This topic can be related to Biochemistry learning, by inviting students to analyse the biochemical content contained in Honai traditional house materials and the biochemical properties that make these materials suitable for their environment. Connecting the concept of biochemistry with the practice of daily life, especially through the local culture of indigenous people, makes learning more contextualised. According to Aji (2017) Ethnoscience learning can have a positive influence because it is learned in harmony with everyday cultural knowledge, this kind of learning process is called learner-centred inculturation learning. Furthermore, Sumarni (2018) explains that proper chemistry learning is learning chemistry that can make students understand chemical concepts in the use of chemical theories to explain natural phenomena, can solve problems and make decisions based on the chemical concepts they have received. So this ethnoscience approach becomes necessary in the learning approach.

Local culture can be a learning stimulus and can help construct knowledge (Sumarni, 2018). Nieto & Ling (2010), that connecting culture in various sectors determines the meaningfulness of professional services, including educational services, so teachers need to raise cultural elements to be accommodated in learning. Thus, the importance of this research aims to uncover biochemical concepts that can be found in the local wisdom of Honai traditional houses. In order to be a contextual learning resource for students in Biochemistry courses.

2. RESEARCH METHODS

This research uses a descriptive qualitative approach with a literature study method with the aim of describing the Honai traditional house of the Dani Tribe, Papua, Indonesia and analysing its building materials in terms of biochemistry. The data collected were secondary data from articles sourced from scientific journals, books, and online articles. The data was analysed in comparatively by comparing the local science knowledge with the scientific knowledge and the potential integration of this kind of knowledge into Biochemistry learning by focusing on the material topics raised in the learning.

3. RESULT AND DISCUSSION

a) Description of Honai Traditional House

The Honai's wealth of architectural knowledge is unique. The materials used in constructing the Honai are 100% natural and renewable. The dirt floor, plank walls and alang-alang roof are very environmentally friendly materials. The Honai house is different from most traditional houses in Indonesia which are structured on stilts. Consisting of two floors, the first floor with a dirt floor is usually used for gathering, deliberation, and activities at night, and the second floor with planks is used for sleeping. Even though the Honai house is narrow, it is about 3 metres high and about 5 metres in diameter. This house is filled with between 5 and 10 people. It is intended that the temperature inside the house can be kept warm. To keep the temperature warm, Honai houses also have bonfires and are not provided with windows. There is only one door located at the front of the house (Faris, 2017).

Figure 1. Exterior view of Honai traditional house

The construction of this Honai house building has 3 parts, namely the lower structure or sub structure, mid middle structure, and upper structure. This lower structure is part of the foundation and all structures below ground level, such as the arrangement of poles, bonding systems, and floor construction. Floor is built with dry weeds called Alang-alang. Honai is built with two floors. The building is only 2.5 metres high, and the ground floor and first floor are connected by a staircase made from bamboo trees. As the main column, the local community installed 4 young trees tied at the top and stuck vertically downwards. The walls are made of rough wooden planks, arranged in a circular shape with 2 layers. This wall is designed without windows, but there are still small windows that function as a place for sunlight to enter the room. The upper structure is the roof frame and the roof itself. Honai traditional houses are characterised by their curved or domb-shaped roofs. This shape is also intended to protect the surface of the wall from being exposed to water when it rains. This roof is made by arranging it in the form of a large circle, whose skeleton comes from wood that is burned on the ground, then tied at the top to form a dome. As a cover, this roof frame will be stacked with a thick layer of alang-alang.

According to Rumthe (2018), honai were originally made using no nails at all, either for connections or to strengthen the boards. The following are the materials needed to make the honai. All are simply taken from nature. Chopping board, called chopping board because both ends of the board are made pointed like a spear. The pointed end of the board will be

planted into the ground. Chopped boards are used as the walls of the honai. Wooden beams for the centre pole or main pole. The main pillar supports the roof of the honai. Buah wood for the frame of the honai roof cover. Lokop / Pinde shape like a long small bamboo serves as a bed mat, on the second floor and The Reeds called Alang-alang as the roof of the honai.

The process of constructing a honai lasts three days to one week. Firstly, the ground is dug for the main pillar that supports the honai. A large flat stone is placed as the base of the pole. The purpose is so that the main pillar does not rot quickly due to water absorption. The location of the main pillar is right at the centre point of the honai. Next is to dig the ground around the pole in a circle. Sharp-pointed chopping boards are stuck or planted following the circle that has been dug. The distance between the chopping board and the main pole is adjusted to the area of the honai to be made. Each time the boards are planted, they must be tied with rattan rope so that the walls of the boards are tight and stand firmly. The Dani people are the most skilled in making the shape of the honai circle (Rumthe, 2018).

After the main pillars and walls of the honai are established, the next step is to install the roof truss. The roof frame is installed by tying buah wood to the main pillars and walls of the honai. The buah wood is arranged in a circle like an umbrella over the honai. Reeds are collected while the roof frame is installed. These reeds are then tied like tying a broomstick with a certain size so that it does not come apart when it is installed into a roof. The reed roof is then tied with rattan rope to the roof frame. The alang-alang roof needs to be smoked so that it does not rot quickly. The last part of the process is to build a fire furnace inside the honai. This furnace serves as a heater when sleeping. Then, to prevent rainwater from entering the honai, it is necessary to dig a water channel around the honai. Finally, the honai can only be occupied after installing a sleeping mat and spreading dry grass to make it warmer.

b) Ethnoscience study of Honai traditional house in biochemistry learning

Table 1. Comparison of the Construction of indigenous science into Scientific science and Biochemical Concepts

No	Indigenous science	Scientific science	Biochemical Concepts
1.	The main material for making the roof of the Honai traditional house, Alang-alang, is used as a roof because it is resistant to water, does not rot quickly and is an abundant source.	Alang-alang with the scientific name Imperata cylindrica L. is a plant of the Poaceae family. Alang-alang has a fast growth rate. It has high lignin content making it difficult to break down naturally. The chemical content of alpa-cellulose is highly related to its strength and has antibacterial properties.	Biochemical Aspects of Living Things Chemical content of Alang-alang: Lignin 31.29%, Holoseslulose 59.62%, Alpha Cellulose 40.22%, Hemicellulose 18.40% (Sutiya, 2012). Cell Bonding and Chemical Bonding Lignin is closely related to cellulose, serving to provide firmness to the cell. Lignin also has an effect in minimising dimensional

No	Indigenous science	Scientific science	Biochemical Concepts
			changes related to changes in water content, lignin also enhances the toxic properties of wood which makes wood resistant to fungal and insect attacks (Haygreen and Bowyeer, 1989).
2.	The wood material used in making Honai is iron wood (oopihr) because of its strength, and is not easily weathered. And its sufficient presence in the Papua Forest.	Based on a literature review by Dwi Puji Lestari, Faculty of Forestry, Bogor Agricultural University (2011), ironwood is also known as Merbau wood. In Indonesia there are three kinds of merbau, namely, Intsia bijuga, Intsia palembanica, and Intsia acuminata. All three species grow in Papua, but only Intsia bijuga and Intsia palembanica are commercially utilised. Because it is hard, Merbau wood is very durable and has excellent resistance from various conditions and weather. The hard texture of merbau wood makes it resistant to mould and termites. The moisture content of merbau wood is below 15%. Thus, the possibility of merbau wood shrinkage is quite small, so it does not crack easily. The low level of moisture content also affects the strength of merbau wood, merbau wood does not shrink easily when processed using the drying process. The lower the moisture content of the wood, the higher the flexural strength value of the wood.	Biochemical Aspects of Living Things Merbau wood, like other woods in general, is composed of lignin and cellulose. The strength of wood is closely related to the composition of moisture content, lignin and cellulose contained therein. In Komarayati's research (2018), acetic acid and ethylic acid were found in Merbau wood. These substances have anti-bacterial and anti-fungal properties which are also closely related to the durability of merbau wood.
3.	The use of rattan as a tie on the roof and walls is due to its strong and elastic character.	Rattan or in scientific language called Calamus. sp is a woody plant because it has xylem and ploem tissue. The anatomical structure of rattan is simpler	Biochemical Aspects of Living Things The anatomical structure of rattan is closely related to its biochemical properties

No	Indigenous science	Scientific science	Biochemical Concepts
		than the more complex anatomical structure of wood. Rattan does not have cell elements that are transversely directed, so rattan is easily split and is elastic, meaning that it can be bent to a certain extent without damage (Sanusi, 2019).	and physical-mechanical properties. Cell Bonding and Chemical Bonding The cell wall is composed of primary chemical components such as cellulose, hemicellulose, and lignin and secondary chemical components in the form of extractive materials such as starch. Lignin serves as an adhesive that causes the cell walls to become hard and stiff. Meanwhile, components such as starch cause rattan to be easily attacked by fungi (Sanusi, 2019).
4.	Reed roofs need to be smoked so that they do not rot quickly.	Alang-alang has a high water content, which is related to the process of decay and the development of microorganisms, so smoking serves to reduce the water content in alang-alang.	Biochemical Aspects of Living Things Chemical content of reeds: Water 97.76, Lignin 31.29%, Holoseslulose 59.62%, Alpha Cellulose 40.22%, Hemicellulose 18.40% (Sutiya, 2012).

The Honai Traditional House of the Dani tribe has several advantages both in terms of its round structure and in terms of building materials that are friendly and responsive to the environment (Kastela et al, 2021). This advantage can make Honai's house a source of learning with an ethnoscience approach. For example, opening the lesson with the question "why is the Honai Traditional House strong and durable even though the materials only come from nature in the form of organic components which generally rot and decompose easily?" Teachers and students together can discuss the biochemical components that make up Alang-alang, wood and rattan as the main materials for making traditional Honai houses, which makes these materials strong and long-lasting. Students can carry out analyzes both through literature studies and various experiments to study the main materials that make up traditional Honai houses, what are the chemical, biological and physical factors that make these materials strong and responsive to exposure to the environment.

Apart from that, carrying out advanced teaching through conducting applied biochemistry practicums by uncovering the potential for using these materials as raw materials for making objects other than houses that are in accordance with the properties of the material. In several studies, reeds, wood and rattan have been studied for their potential as materials for making several objects such as pulp and paper, metal absorbent

filters, herbicides, and others (Sutiya, 2012; Cahyati, 2019). There are also various environmentally friendly objects that replace plastic materials, such as rattan baskets, rattan furniture and many others (Suheryanto, 2015; Adani, 2013).

c) Biochemical Components Materials that make up the Honai Traditional House

The main materials that make up the Honai traditional house consist of reeds, iron wood (Merbau), fruit wood and rattan, which is a wood-derived material whose chemical components consist of Lignin, Holocellulose, Alpha-cellulose and Hemicellulose. Lignin is a highly irregularly branched polyphenolic polyether, consisting of the primary monolignols, p-coumaryl alcohol, coniferyl alcohol and sinapyl alcohol, which are connected via aromatic and aliphatic ether bonds as well as non-aromatic C–C bonds. The high complexity and inhomogeneity of the lignin structure is, in many cases, even further increased by currently applied pretreatment technologies and adds additional challenges for lignin's downstream processing and valorization . Lignins can be roughly distinguished by their origin plant species and the processing method. In case of origin, three major types of lignin can be distinguished; where softwood lignins are comprised almost solely of coniferyl alcohol; hardwood lignins of both coniferyl and sinapyl alcohol; and grass lignins of all three types. Lignin shows many unique properties such as resistance to decay and biological attacks, ultraviolet (UV) absorption, high stiffness, and the ability to retard and inhibit oxidation reactions (Beisl et al, 2017).

The presence of cellulose in nature is not in pure form but still in the form of lignocellulose as shown in the figure. In woody plant tissues, cellulose can be found together with hemicellulose, starch and lignin. The combination of cellulose, hemicellulose and lignin is called lignocellulose (Rowell 2005). Cellulose is the most abundant natural polymer, biocompatible, and environmentally friendly because it is easily degradable, non-toxic, and renewable (Mulyadi, 2019).

Cellulose functions to provide tensile strength to the stem, due to strong covalent bonds in the pyranose ring and between sugar units that make up cellulose, the higher the cellulose content, the higher the bending strength, but the lower the strength level (Tellu, 2006). Lignin functions as an adhesive material that adheres cellulose molecules to each other so that the cell wall becomes hard and stiff. Lignin is a filler material and reduces changes in cell wall dimensions due to changes in moisture content (Tellu 2008).

The explanation of the chemical composition and characteristics of the honai traditional house building materials above, explains that one of the factors that cause Honai traditional houses to have good building strength is the combination of lignin and cellulose content contained therein, the environmentally friendly cellulose content also provides clarification that Honai traditional house materials are environmentally friendly.

4. CONCLUSION

The main components of the Honai house are reeds, various types of wood, and rattan, the biochemical composition of which are lignin, holocellulose, alpha-cellulose and hemicellulose and other compositions that can be discussed on the topic of biochemical aspects of living things and further on the topic of cells and cell bonds / chemical bonds. The material composition contained in the materials that make up the honai traditional house can also be further explored in the practice of applied biochemistry, to produce other

appropriate items. Thus the Honai traditional house is very potential as a learning resource in biochemistry courses with an ethnoscience approach.

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