Chemical physics in the process of making handicraft
Pandanus tectorius and its local wisdom

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Abstract. The making of handicraft made from pandan leaves (Pandanus tectorius) has been handed down from generation of generation. However, the number of craftsmen is decreasing. There is a need for dissemination of the science of craft making in the young generation, one of them through education. This paper would like to reveal the concept of physics and chemical concepts contained in the process of making handicrafts made from pandan leaves and local wisdom in it. The research method used is descriptive qualitative analysis through literature study and focus group discussion (FGD). The result of the research shows the existence of physics and chemistry concepts in the process of making pandan leaf-based crafts such as tensile strength, endurance to the sun ray, moisture, lignin content, and holocellulose content. In addition to physical and chemical aspects, handicraft making from pandan leaves also has much local wisdom that must be preserved. This study concludes that the concept of physics, chemistry and local wisdom contained in the making of handicrafts made from pandan leaves can be used as sources of learning in the form of enrichment materials. This effort is expected to increase the spirit of the younger generation to explore the heritage of the ancestors.

1. Introduction
Indonesia is the center of handicraft made from pandan leaves [1,2]. Some areas that develop pandan leaf crafts include Nagari Ulakan Padang Pariaman, Rajapolah Tasikmalaya, Tumbu Karangasem Bali and other places. The process of making handicrafts made from pandan leaves is passed down from generation of generation, by word of mouth [3]. From day to day the number of craftsmen is decreasing. Massive and structured effort required for the craft made from pandan leaves to continue to grow.

One of the efforts to conserve pandan leaves and other traditional handicrafts is through formal education at school early on [4]. Some ways can be done that is by making local content, create enrichment materials or create integrated contextual materials. One of the subjects that can be chosen in preserving this pandanus leaf handicraft is physics and chemistry. Lots of physical and chemical concepts contained in the process of handicrafts made from pandan leaves.

Initially, the purpose of making a handicraft in various areas is only intended for the needs of certain ceremonies. For example, the mat produced by the Ulakan Nagari community is usually used as a requirement or complement to religious events, deaths and marriage events that are rich in cultural
values and local wisdom [5]. Gradually there is a shift and expansion of functions, currently handicraft, for example, the handicrafts have a high economic value that can improve the welfare of craftsmen. Therefore, in addition to preserving the nation's cultural heritage, massive skills dissemination efforts through education and training can also increase economic benefits. Through this paper, the authors would like to express one of the efforts to disseminate the process of making hand-based crafting of pandan leaves in physics and chemistry subjects through the development of enrichment materials.

2. Method
This research is a preliminary research to reveal some concept of physics and chemistry which is embodied in the process of making handicrafts made from pandan leaves. The research method used is qualitative descriptive analysis.

The research site is the center of pandan leaf crafts in Rajapolah, Tasikmalaya. Research data obtained through location observation and direct interview for craftsmen. The main data obtained are the process of making handicrafts from start looking for and taking the basic materials until handicrafts are produced. Field data findings are analyzed and discussed in Focus Group Discussion (FGD). From various research findings, the researcher determines the focus on research on the phenomenon of physics and chemistry and little value of local wisdom that can be analyzed through literature study.

The final step of this research is to arrange the physics and chemistry teaching materials with learning context taken from the process of making the handicraft made from pandan leaves. The hope is that when handicraft production is disseminated through formal learning in schools, the younger generation's interest in preserving the heritage of their ancestors is increasing and culminating in increasing its economic value.

3. Result and Discussion
The results are divided into four main sections presented systematically, namely the process of making handicrafts in general, the concepts of physics, chemical concepts and local wisdom contained in it.

3.1. The process of making handicrafts
The pandanus leaf (Pandanus tectorius) is naturally occurring in trandline and near coastal forests in Southeast Asia, including the Philippines and Indonesia. [6] In Rajapolah, the use of pandanus leaves as mats began around 1915. The mat made by the inhabitants was called the aria mat [7]. Simply put, the process of making pandan leaves handicraft through four stages:

3.1.1. Supply of raw materials. The processing of pandan leaves starts from the picking of pandan leaves from the stem. Usually, pandan leaves that can be taken are pandan leaves that have been aged 6 months or 1 year, not too young and not too old. Pandanus leaves that have been collected are selected and taken leaves of good quality of adequate length and width. Pandanus leaf that has been selected in discarded thorns and bones so as not to interfere in the work. After the pandan leaves are clean from the thorns, then the leaves of view are divided according to the elongated groove.

3.1.2. Boiling. Pandan that has been formed then heated or boiled until wilted, this stage aims to make the leaves soft and not easily damaged. After that, the pandan leaves are removed and dried by drying them in the hot sun. After the leaves pandan soft then sliced ribbon-shaped.

3.1.3. Provision of dye. After drying, pandan leaves are colored as desired by dipping them into a liquid substance that has been cooked, then stirred until blended.

3.1.4. Pandan drying process. After the color evenly then lifted and dried again to dry. Once dry, then this pandan is ready to be woven. This ready-made raw material is woven as needed.
3.2. Physics Concepts
There are several physics concepts contained in the process of making pandan leaf crafts, namely tensile strength and moisture.

3.2.1 Tensile strength. Tensile strength is defined as the maximum load that a material can support without fracture when being stretched. Mathematically formulated by equation 1.

\[ T = \frac{\text{Force}}{\text{Original Cross-sectional Area}} \]

(1)

The main physical properties that are needed by pandan leaves is the strength of the fibers to the pull, especially in the dry due to the processing or processing of pandan leaves done in dry conditions. The tensile strength of the fiber is the maximum load that can be withheld by a test sample to break.

3.2.2 Moisture. Moisture is defined as the water content in liquid phase present in any substance. The moisture ratio and drying rate of the Pandanus leave were calculated using the following equations

\[ MR = \frac{M_t - M_r}{M_o - M_e} \]

(2)

\[ \text{Drying Rate} = \frac{M_{t+dt} - M_t}{dt} \]

(3)

Where, MR is the moisture ratio, drying rate is in g/100 g bone dry matter per unit times, M_t is the moisture content of a specific time (g water/g dry base), M_o is the initial moisture content (g water/g dry basis), M_e is the equilibrium moisture content (g water/g dry basis), M_{t+dt} is the moisture content at t + dt (g water/g dry base) and t is the drying time (min).

3.3. Chemistry concept
The chemical concepts associated with pandan leaf processing are the content of lignin and cellulose.

3.3.1. Lignin Content is defined as an organic substance binding the cells, fibres and vessels which constitute wood and the lignified elements of plants, as in straw. Chemically, lignin is formulated by C_9H_10O_2, C_{10}H_{12}O_3, C_{11}H_{14}O_4 as figure 1. Lignin is a high molecular weight complex polymer. Lignin exists between the cells and inside the cell wall. Among the cells, lignin acts as a glue to bind the cells together. In the cell wall, lignin is closely related to cellulose and serves to give a firmness to the cells.

![Chemical structure of Lignin](image)

Figure 1. Chemical structure of Lignin.
3.3.2. Holocellulose Content is defined as the total polysaccharide fraction of wood or straw and the like that is made up of cellulose and all of the hemicelluloses and that is obtained by removing the extractives and the lignin from the original natural material. Cellulose is a form of a polysaccharide as a result of photosynthesis in plants. The cellulosic structure comprises of anhydrous glucose units attached to each other on C atoms to one and four C atoms with a configuration beta [8]. Cellulose has a function to provide tensile strength to a cell, because of the strong covalent bonds in the pyranose ring and between cellulose sugar units, the higher the cellulose contents the greater the flexibility.

The combination of lignin and cellulose is often called lignocellulose. Figure 2 below is a lignocellulosic structure of a plant [9]. The main component of lignocellulose is the chain of molecular glucose chain of cellulose, ab (1-4), the hydrogen bond between various layers of polysaccharides contributes to the cellulose resistance of crystals to degradation. Hemicellulose, the second most lignocellulosic component, consists of various 5- and 6-carbon sugars such as arabinose, galactose, glucose, mannose, and xylose. Lignin consists of three main phenolic components, namely p-coumaryl alcohol (H), coniferyl alcohol (G) and sinapyl alcohol (S). Lignin is synthesized by polymerizing these components and their ratio of polymers varies from different plants, wood tissue, and cell wall layers. Cellulose, hemicellulose and lignin form structures called microfibrils, are arranged into macrofibrils that mediate structural stability in plant cell walls.

3.4. The local wisdom
In addition to physics and chemical concepts, handicrafts made from pandan leave also contain very high local wisdom. For example, in Lombok (West Nusa Tenggara), pandan leaves are used in traditional warfare ceremonies related to soil fertility processions [10]. In Tumbu Village, Karangasem regency, there are artisans of mats from pandan leaves that are only used to support traditional and religious traditions in Bali [11]. In some areas of West Java also show the same thing. There is a sacral value when using samak. One of them at the death ceremony.

![Figure 2. Structure of lignocellulose.](image)

4. Conclusion
An important part of preserving the culture and heritage of the nation is dissemination. Inheritance to knowledge is no longer through word of mouth but must be massively disseminated. It is hoped that there will be an increase in the public literacy of the noble values contained in the cultural heritage which in turn they care and want to preserve it.

Small efforts that can be done to increase people's literacy on handicraft heritage, one of which is leaf pandanus leaf is through the learning of contextual science. Through an analysis of the concepts of physics, chemistry including biology in the process of making the craft, there is multiple benefits that can be gained by learners. They will find the concept of science that is very close to their lives and they will also get new knowledge about handicraft making.
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