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Analysis of physics concept in the traditional brown sugar making process

L Sholihah¹, U G Rahmania¹, Rumiati¹, F Munawaroh¹, R D Handayani^{1*}, and A D Lesmono¹

¹Physics Education Department, Universitas Jember, Indonesia

E-mail: rifati.fkip@unej.ac.id

Abstract. Brown sugar is one of the traditional artificial sweeteners that is widely used by Indonesian people. Unfortunately, society considers that the brown sugar-making process is only a step of unscientific traditions and habits. This research aims to explore the physical concepts of heat transfer in making traditional brown sugar. Data were gathered through interviews, documentation, and observation. Analysis of the data used is descriptive qualitative with triangulation techniques. This research represented that brown sugar manufacturing contains heat transfer processes of conduction, convection, and radiation in the *Ndewan* processes. The conduction process occurred in the furnace (heat source), which propagates in the pan during the heating process, and the convection process happened when the palm sap is heated. Also, the radiation process transpired around the furnace. This study is expected as alternative teaching material in the learning physics class to be more contextual.

1. Introduction

Indonesia has much cultural diversity that must be preserved. One way to preserve it is by integrating it into the educational curricula [1]. Based on an educational perspective, traditional knowledge or indigenous knowledge related to physics concepts can provide school curriculum designers opportunities to develop contextual learning related to traditional scientific knowledge and western science knowledge. Bridging western science and traditional science can help students, teachers, parents, and the community learn physics concepts more contextual without leaving society's local culture [2].

Physics learning based on local wisdom becomes part of a series of learning activities that can make students actively involved in building knowledge, developing science process skills, and fostering scientific attitudes [3]. Learning science based on local wisdom can be implemented by redesigning the indigenous science, then translating it into scientific science concepts. The indigenous science was obtained from observations of local cultural traditions' noble value [4].

Education tends to use as a differentiator in society and schooling systems by transferring knowledge to students, which is called dead knowledge. This learning is more focused on books or literary attitudes [5]. The classroom's learning phenomenon showed that students increasingly believe that scientific knowledge concepts are more important and appear to have no connection to local culture [6]. Thus, students consider ancient local culture unattractive because it is not related to scientific science [7][8]. The teacher's role in the 2013 curriculum is decreasing because the teacher is only as a facilitator, and students play an active role in the classroom [7][8][9]. One contributing factor is physics learning more focused on the mathematical aspect, only slightly emphasizes concepts and principles, and is not associated with traditional and local knowledge in their respective regions [8].



Students' physical learning will be more readily accepted if the material taught is related to daily life [8]. Based on the background described above, the purpose of this study is to identify the physical concepts that exist in local wisdom of making brown sugar in the Sumbermulyo Village community, Pesanggaran district, Banyuwangi regency.

2. Method

This type of research was qualitative phenomenology. Qualitative phenomenology was a research design that examines the phenomena experienced by a person in his life that is explained by participants [9]. The focus of this research was the traditional process of making brown sugar. One of the processing of brown sugar that was still done traditionally was in Sumbermulyo Village, Pesanggaran, Banyuwangi. The process of making brown sugar would be examined in terms of physical concepts related to heat transfer. This research looks directly at the phenomenon of making traditional brown sugar and then examines what has been conveyed by the speakers. Following this research design.

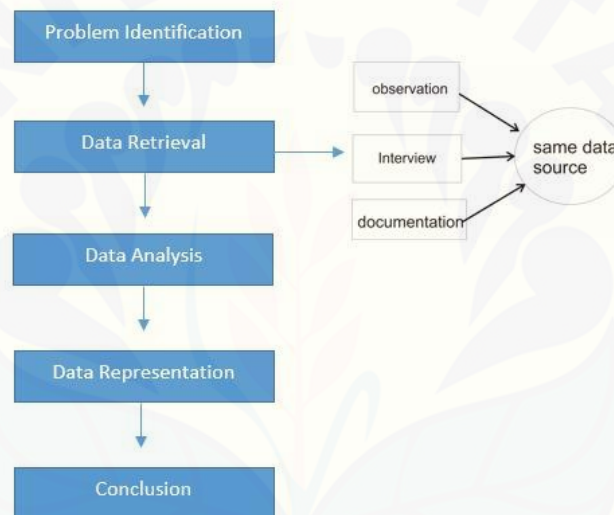


Figure 1. Research design

The data obtained in the form of interviews, documentation, and direct observation in the field. Data mining was taken from field observations to directly observe the activity at the location of traditional brown sugar production. Observations were carried out in Sumbermulyo Village, Pesanggaran, Banyuwangi. During this observation, the researcher records/records and asks questions that the researcher wants to know. The researcher also conducted open interviews to bring up the views and opinions of the speakers. There were 2 speakers interviewed. Resource 1 as the maker of traditional brown sugar in Sumbermulyo Village, Banyuwangi, and resource 2 as an observer of the process of making traditional brown sugar. Interviews were conducted directly with the interviewees so that researchers freely express their questions and know clearly the explanations expressed by the speakers. The instruments used were informants and researchers. Retrieval of documentation was also carried out during the observation as visual data in research into the manufacture of traditional brown sugar.

Data analysis techniques used in this study used descriptive qualitative. The data that has been collected is interpreted through data source triangulation techniques. The data source triangulation technique is a data source with different information by examining the evidence that comes from the source. This data source triangulation technique is also to validate the data that have been collected.

The steps in data analysis are (1) processing and preparing data, such as interview transcripts, field data and compiling data, (2) reflecting the overall meaning, (3) the coding process, and (4) data interpretation and drawing conclusions.

3. Results

This study aims at the physical concept of making traditional brown sugar, especially the concept of heat. Previously, researchers obtained data from interviews, documentation, and direct observation in the field. The results of the research that have been done are obtained several stages in the manufacture of traditional brown sugar. Based on the information from the interview results of the two sources, namely Mr. Subekhan as the maker of brown sugar (resource 1) and Mrs. Siti Aminah as an observer (source 2), the stages are as follows:

Table 1. interviews with informants 1

Researcher	<i>Nopo bapak tasek ndamel cara tradisional pas ndamel gulo abang pak?</i>	Do you still use traditional methods to process brown sugar?
informants 1	<i>Nggeh Nduk, tasek tradisonal</i>	Yes, it still uses the traditional method
Researcher	<i>Proses e pripun, Pak?</i>	How is the process of making brown sugar?
informants 1	<i>Proses e ono 3, nderes, ndewan, karo nitis. Nderes iku proses golek leggen trus di tampung. Trus lak ndewan iku pas masak leggen sampek kentel. Nitis iku nyetak gulo abang</i>	There are 3 processes, namely <i>nderes</i> , <i>ndewan</i> , and <i>nitis</i> . <i>Nderes</i> that when the process of finding leggen until accommodated left overnight. After that, <i>ndewan</i> is cooking coconut juice until it thickens. Finally <i>nitis</i> or bit of brown sugar

Table 2. interviews with informants 2

Researcher	<i>Nopo sing njenengan ngertos tentang proses ndamel gula abang?</i>	What do you know about the process of making brown sugar?
informants 2	<i>Yo leggen iku dimasak terus menerus sampe kentel siap di cetak, terus dijarno sampek adem sampe ato, Nduk</i>	Making brown sugar is done by cooking coconut palm continuously until it thickens and is ready to be printed, then left to cool and harden

Based on the results of the interview with informant 1 above, the process of making brown sugar consists of 3 stages, namely *nderes*, *ndewan*, and *nitis*. The first stage was *nderes*, which is the process by which young coconut juice is taken and stored. The container is in the form of pieces of bamboo or *bambung*. The second stage was *ndewan*, which is the process in which the collected sap water is then filtered and poured into another container to be cooked or boiled. The third stage was *Nitis*, the molding process. A sugar that has been cooked boil until thickened, then molded and allowed to become solid. Informant 2 also explained things that were broadly the same as informant 1. The two informants explained the stages to the researcher in a coherent manner using their language, which is a language that is easy for them to understand. The process of making traditional brown sugar described is a hereditary habit that they do every day. Their knowledge of the process of making brown sugar is only a tradition (original science), even though the stages they describe contain scientific processes, one of which is the physics concept of heat/heat transfer.

4. Discussion

Brown sugar is a sugar produced from the evaporation of coconut juice (*Cocos nucifera* Linn). Coconut juice, which is usually called leggen, is heated to evaporate the water content so that it forms a solid or crystal. The process of making traditional brown sugar explains that there are 3 stages, namely murders, ndewan, and notes. The first stage is nderes, which is the process by which young coconut juice is taken and stored. The container is in the form of pieces of bamboo or bumbung. The second stage is ndewan, which is the process in which the collected sap water is then filtered and poured into another container to be cooked or boiled. The third stage of Nitis, the molding process. A sugar that has been cooked boil until thickened, then molded and allowed to become solid. Their knowledge of the process of making brown sugar is only a tradition (original science), even though the stages they describe contain scientific processes, one of which is the physics concept of heat/heat transfer. Their knowledge of the process of making brown sugar is only a tradition (original science), even though the stages they describe contain scientific processes, one of which is the physics concept of heat/heat transfer.

The heat transfer in traditional brown sugar production occurs in the non-animal process, namely cooking coconut sap. The heat/heat transfer analysis in the process of making traditional brown sugar is as follows:

4.1 Conduction

Heat conduction occurs due to molecular collisions that occur when objects are heated. As a result, the heat that propagates will make the molecules release kinetic energy which will hit other molecules along the heated object [10]. In the explanation of this conduction, the process occurs in heating the pan to cook sap and heat propagation on the sap stirrer.



Figure 2. Illustration of the conduction process

The conduction process occurs in the heat source (furnace) which propagates in the pan during the heating process. In the process of making brown sugar using an aluminum skillet. Where aluminum is a light metal that has good electrical and thermal conductivity and has good corrosion resistance [11].

4.2 Convection

The results of observations and interviews show that the community thinks that leggen or coconut juice can thicken because it is continuously cooked and requires a srumbung so that the coconut juice does not spill when it is cooked. In fact, in this process, there is a concept of heat transfer by convection, which is when the coconut juice is heated. Heat convection is the process by which heat flows through the mass movement of molecules from one place to another.



Figure 3. Illustration of the convection process

Convection is characterized by the movement of molecules [13]. Convection heat transfer occurs when the liquid sap thickens. This thickening of the nira is caused by the presence of a sap that is heated at the bottom of the pan rising to the top to replace the cold sap from above. The convection process occurs when the coconut juice is heated, which is indicated by the movement of the foam. Convection is the heat transfer due to movement/flow/mixing of hot to cold parts [12]. The rate of convection/movement can be determined from the equation

$$q = hA \Delta T$$

Which is where the rate of heat transfer is directly proportional to its temperature. So that when at high temperatures the foam moves faster. In order not to melt, the srumbung is used. This Srumbung serves to limit the movement of heat transfer.

4.3 Radiation

The radiation process occurs around the furnace (heat source) where what is felt is heat. Our bodies feel warm or hot when near a flame because of the heat transfers through radiation from the flame (higher temperature) to our body (lower temperature).



Figure 4. Illustration of the radiation process

Heat transfer through radiation is slightly different compared to heat transfer by conduction and heat transfer by convection. Heat transfer through conduction and convection occurs when objects that have different temperatures touch each other. Conversely, radiation heat transfer can occur without touch. Radiation is the emission of energy from a matter in the form of electromagnetic waves (photons) [13].

The concepts of physics in the process of making traditional brown sugar based on local wisdom can be integrated into learning physics. Local wisdom-based learning makes the interaction between educators and students, by giving meaning to what is seen, heard, read, and learned from cultural heritage to develop the potential of students to think rationally [7]. The elaboration of traditional knowledge in the science curriculum has strong implications for students [14]. Local wisdom applied in this study is intended to introduce students to students so that students are expected to understand and love local wisdom in their area. The concept of physics contained in the manufacture of traditional brown sugar is useful in learning so that students are more familiar with the culture that exists in society as a source of learning. Learning that is based on local wisdom and involves traditions in the environment where students live will give a contextual impression [15]. Learning that is related to the real-life of students will make students think easier because the concepts are applied by real experiences in everyday life. This will make students more active, creative, and able to think critically so that learning physics is fun. Learning with the ethnoscience approach will provide understanding for students to better appreciate nature and utilize science in their daily lives [16].

5. Conclusion

Based on the research conducted, it can be concluded that there is a physics concept of heat transfer in the process of making traditional brown sugar. Heat transfer occurs during *Ndewan* processes, namely conduction, convection, and radiation. People only know the extent of their customs and daily habits to form original scientific knowledge, even though the process of making traditional brown sugar can be studied scientifically. The results of the analysis of the physics concept of heat transfer in the process of making brown sugar can be integrated into education as a form of introduction to the original science of society (community traditions) as outlined in the physics learning process at school

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