Thabiea : Journal of Natural Science Teaching
Vol. 5(2), pp. 118-130, 2022
Available online at
http://journal.iainkudus.ac.id/index.php/Thabiea
p-issn: 2580-8474, e-issn: 2655-898X

Ethno STEM Analysis on Manufacturing Traditional Food "Horog-Horog"

Dody Rahayu Prasetyo [1]*, Lia Duwi Aryani[2], Fatimatuz Zahra[3], Sherly Helma Nabila[4]
Abdul Johan Sofii[5], Fatmaziza Berliane Ahdan[6]
Institut Agama Islam Negeri Kudus, Jl. Conge Ngembalrejo Bae Kudus 59322 Indonesia
**Correspondence: dody@iainkudus.ac.id*

Keywords:
Traditional Food
Horog-horog
Ethno-STEM

Abstract

The absence of research that examines traditional "horog-horog" foods based on Science, Technology, Engineering, and Mathematics (STEM), is an interesting discussion to study. The purpose of this study is to analyze STEM in the process of making "horog-horog". In addition, the process is connected basic competencies in learning. A qualitative approach was used in this study through Ethno STEM analysis. Observations, in-depth interviews, and documentation of the horog-horog manufacturing process were used to collect data. The data that has been obtained are analyzed and categorized into STEM and appropriate basic competencies. The results of this study show that there are 1) in the process of making horog-horog there are aspects of science (separation of substances, density, capillarity, simple machine, heat, plant classification, and substance content), technology (tools in the manufacturing process), engineering (screening, drying, scraping, steaming, and printing), and mathematics (predicting the dosage of materials, making process, and profit from sales results) and 2) local knowledge/skills are in accordance with basic competencies in high school. With these findings, the process of making horog-horog can be used as a learning resource. In addition, this method also includes efforts to preserve the heritage of ancestors.

To cite this article:
Prasetyo, R.P., Aryani, L.D., Zahra F., Nabila, S.H., Sofii, A.J., Ahdan, F.B. (2022). Ethno STEM Analysis on Manufacturing Traditional Food "Horog Horog". *Thabiea : Journal of Natural Science Teaching*, 5(2), 118-130.

Introduction

Ethnoscience is a unique knowledge possessed by a certain community / community (local wisdom), which contains scientific methods and procedures (Fitria & Wisudawati, 2018; Jufrida et al., 2021). Based on interviews with junior high school students and teachers in Jepara, few know traditional foods. If this is allowed, gradually the ancestral heritage will disappear and future generations will not know the history of traditional foods. Therefore, there must be efforts to preserve it through learning in schools. Suprapto et al. (2021) found that the number of ethnoscience studies from 2011-2020 has increased, although not significantly. Based on the findings in the field, teachers tend to be textual and have difficulty in linking the process of making traditional foods into learning. This shows that local wisdom is still a concern for researchers.

To be used as a learning resource, it is necessary to dig deeply into scientific knowledge in local knowledge (indigenous knowledge). Some studies that are able to explore scientific knowledge from local knowledge include: 1) Baquete et al. (2016) discovered the thermo of physics, static electricity, and the concept of mechanics in the people of Chokwe, Mozambique; 2) Handayani et al. (2018) discovered the thermo physics from the experience and diversity of the Samin people, Indonesia; 3) Jufrida et al. (2021) found the concept of measurement, classification of living things, temperature and heat in the process of making "lemang bamboo" food; 4) Rizki et al. (2022) discovered the concepts of parabolic motion, effort and energy, momentum and impulse, and the equilibrium of objects in the traditional game "Engklek"; 5) Ratnasari (2020) found the concept of changing forms, conductors and insulators, and heat transfer in the manufacture of carving, jenang, northern Javanese batik; 6) Sudarmin et al. (2020) discovered chemical processes in “batik” coloring.

In 21st century learning, students are required to have basic literacy skills that are able to improve communication, critical thinking (Prasetyo & Hindarto, 2015), creative, and collaborative (Wulandari et al., 2019). The Science, Technology, Engineering, and Mathematics (STEM) learning approach is able to support students' basic literacy skills (Pusat Penelitian Kebijakan Pendidikan dan Kebudayaan, 2019). This is also supported by Thibaut et al. (2018), all the STEM articles found were categorized into nine studies, namely: 1) integration of STEM content, focus on problems, inquiry, design, teamwork, student centered, hands-on, assessment, and 21st century skills. Ethno-STEM is an integration of ethnoscience and STEM approaches (Sudarmin et al., 2020). Thus, ethno-STEM learning can be an alternative learning that raises the local wisdom of an area.

Horog-horog is one of the typical traditional foods in Jepara district, Central Java province. According to Prasiska (2018), this food was consumed by the Japanese people before the Japanese occupation. This food is a substitute for rice because Japan forbids the people of Jepara to eat rice. The presentation of this food is usually wrapped in teak or banana leaves. Besides being eaten directly, this food can be served with other foods, for example: meatballs, pecel, satay and even drinks. The tools and materials as well as the manufacturing process are unique. The basic material used is palm starch. The manufacturing process is done traditionally with a long process and several unique stages. Local knowledge (Indigenous Knowledge) that makes horog-horog is passed down from generation to generation. Through ethno STEM learning, students can understand and even practice how to make horog-horog and study it in science, technology, engineering, and mathematics. To apply in learning, it is necessary to map knowledge and skills in the process of making horog-horog on basic related competencies. This will certainly make it easier for teachers to make science learning designs. This is an effort to preserve the heritage of the ancestors.

Method

A qualitative approach was used in this study through ethno-STEM analysis on indigenous knowledge of the "horog-horog" manufacturing process. Purposive sampling is used to select research samples. The sample used in this study was a horog-horog manufacturer who had been in production for a long time, namely Mrs. Musta'iroh. Data were collected through direct observation, in-depth interviews, and documentation of the horog-horog manufacturing process. The process of making horog-horog includes several stages, namely: 1) preparation of tools and materials, 2) washing, 3) drying, 4) scraping, 5) frying, 6) first steaming, 7) soaking, 8) second steaming, and 9) printing. In addition, the prediction of profits obtained from the sale of horog-horog is also an additional data. The results of the data obtained are analyzed and categorized by STEM. In addition, the knowledge and skills of the manufacturing process of "horog-horog" are mapped according to basic competencies in high school.

Results and Discussion

From the results of observations and interviews with the horog-horog maker (Mrs. Musta'iroh) the data shown in Table 1 were obtained. The process of making horog-horog consists of 1) preparation of tools and materials, 2) washing, 3) drying, 4) scraping, 5) frying, 6) steaming 1, 7) soaking, 8) steaming 2, and 9) molding.

Table 1. Horog-Horog Manufacturing Process

Stages	Description
Preparation of tools and materials	• Tools: Frying pan (furnace, pan, stirrer), Bucket, Steamer, Scraper (shaped like a ring made of plastic), sieve, mold (bucket, Sack, Wood &Rope) • Ingredients: Palm starch, Salt, Water
Laundering	• Palm starch is placed in a large bucket and then washed by stirring, precipitating, and filtering. This washing process is repeated 3 times. Inside 1 bucket contains ±20 kg of palm starch. • After the last wash, the water is removed and transferred to another bucket for drying
Drying	• The starch in the bucket is then given a cloth on top, then on the cloth is given wood ash then pressed for ±1 hour so that the starch is dry optimally.
Scraping	• The starch that has dried will harden and solidify, then scrape, so that it becomes powdered again. • The dredged starch is then sifted for smaller grains to be taken. the clumped starch will be crushed and sifted again, and so on. .
Frying pan	• The starch (small grains) was roasted to coagulate with the technique of being put in little by little until the pan was fully filled
First steaming	• After roasting the starch then steamed for ±2min using high heat. • After the first steaming is completed the starch will coagulate and must be kneaded to make it a smaller size.
Soaking	• Small starch is placed in a bucket that already contains brine (salt dose 1 small bowl per 1 large bucket), then allowed to stand for ±1 hour / until fluffy.
Second steaming	• Furthermore, the starch that has expanded is steamed again for ±3 minutes. • steamed starch is crushed into small grains to facilitate the printing process.
Printing	• after that, the starch is printed in the modified house
Advantage	• The selling price of 1 quintal of palm starch that has been processed into horog-horog is around IDR 700,000. The estimated gross profit is about IDR 400,000. It also had to be cut for workers' wages. So, the net profit is about IDR 200,000.

Ethno STEM Analysis on The Horog-Horog Manufacturing Process

After knowing the activities in the manufacturing process, categorization is carried out based on four aspects, namely: Science, Technology, Engineering, and Mathematics and is described as follows.

Aspects of Science. There are two aspects of Science in making horog-horog, namely:

- The tools and materials used can be studied based on the concept of science. The scraper works according to the concept of a simple plane, the frying device, and the steamer works according to the concept of heat. The basic ingredients used come from plants that are used by the stem. This can be studied based on the classification of plants.
- The stages of the horog-horog manufacturing process are: washing (the concept of separation), drying (the concept of heat), roasting (the concept of heat), soaking (the concept of pressure difference), steaming (the concept of heat), and printing.

This is supported by the research of Dewy et al. (2022); Fitria & Wisudawati (2018); Kurniawan et al. (2019); Sudarmin et al. (2020); Sumarni & Kadarwati (2020); Tresnawati et al. (2021). They state that all human activities that produce products can be studied by science.

Aspects of Technology.

The tools and materials used in making horog-horog are all traditional and there are tools that have been modified, shown Figures 1 and 2.

Figure 1. Horog-horog molding

Figure 2. Scraping Tool

Aspects of Engineering

Washing, drying, scraping, frying, steaming and molding are techniques in the process of making horog-horog. There are several unusual techniques in the process of making horog-horog, namely in the process of drying, scraping, soaking, steaming, and molding. On the drying process. using a cloth to absorb the water in the starch by pressing it. In addition, to maximize drying is also used wood ash laid on the fabric. In the scraping process, the tool used is shaped like a ring with a large size. In Figure 2, from any direction, dry starch will be sprawled. In the soaking process, brine is used to make the starch expand (Figure 3). Steaming on starch is carried out 2 times, as well as printing using a modified tool (Figure 1).

Figure 3. Soaking Process

Aspects of Mathematics

Predicting the amount of materials used, the time at some stages, and the profit of the sales results obtained are included in mathematical skills. These skills are based on observation, measurement, and information about the relationships between variables and observations. Thus, predictive skills have an important role in reasoning and foster mathematics learning (Lim et al., 2010).

Reconstruction of Scientific Knowledge in The Process of Making Horog-Horog

Tools and materials

A frying pan (pan) is a tool made of metal and its working principle utilizes heat transfer by conduction. Steamer is a tool made of metal that utilizes heat transfer by conduction and convection. In addition, it also traps heat hot water vapor. Thus, the hot steam (gas) can spread evenly on the starch, so it can ripen in each part. The scraping device is shaped like a ring including a simple machine (curved plane) so that it is easier to use in scraping from various directions. The printing press is made in such a way as to resemble a cylinder aimed at maximizing volume in the vertical direction. In addition, palm starch (Arenga pinnata) has the following classification of living beings, namely: Kingdom: Plantae; Divisions: Tracheophyta; Subdivision: Spermatophyta; Class: Magnoliopsida; Order: Arecales; Family: Arecaceae; Genus: Arenga; and Species: Pinnata. In addition, palm starch contains 26.19% amylose and 73.81% amylopectin, so that the finished horog-horog has a slightly sticky and chewy texture (Rahim & Kadir, 2017).

Laundering

Deaning is a simplest way of separating the solution and solids, namely by pouring the land-wetting liquid so that the sediment is left at the bottom of the vessel (Subaryono, 2010). This method actually utilizes the principle of particle density, particles with a large density compared to water tend to sink, whose small density tends to float shown Figure 4.

Figure 4. Washing Process

Drying

The cloth serves to absorb water, especially plus wood ash on it, further increasing absorption. In addition, pressing the ash on the cloth makes the water in the starch more absorbed. Water absorption occurs due to the phenomenon of capillarity. Capillarity is the ability of a liquid to penetrate into the fine pores. This is what makes water from the bottom (starch) to the top (flour). In addition, pressing ash and fabric, makes the starch denser (large density) so that there is no room for water. Since water has a density smaller than starch, making it will rise to the top of the starch. In addition, Wood ash contains nutrients such as, calcium, which consists of about 20 percent, potassium, which can be about 5 percent, magnesium, phosphorus, and sulfur, which consists of about 2 percent. These elements such as potassium can bind water (Fahmi, 2016). The drying result is shown Figure 5.

Figure 5. Drying process

Scraping

Scraping was carried out on dry and solid starch using a ring-shaped tool (Figure 2). This is done to facilitate the process of frying without oil. The working principle of scrapers such as excavators, where there is effort (E), load (L), fulcrum (F), arm effort (EA), arm load (EL), and shear direction (Hareesha, 2018). The working principle of the excavator is shown in Figure 6a. If we analyze the working principle, it is like a simple machine type 3, where the effort is between the fulcrum and the load. In detail, the scraper is placed on the starch (dry and solid) with the hand position as shown in Figure 6b. In its use, the scraper is not placed horizontally. However, it forms a small angle to the horizontal. Which acts as a Load (L) is the tip of the tool. This part will scrape the starch. Meanwhile, the center of the tool is given a relatively small effort. The back of the instrument acts as the fulcrum (F). The last step, pulled back slowly. Relatively small angle and small force, applied to produce small grains of starch when pulled. The force (effort) given is relatively small in this tool. Because if the force (effort) given is too large, then this tool will scrape the starch too deep when pulled back. In addition, the pulling force behind is also getting bigger, so the energy needed by people will be even greater. As a result, the resulting starch will be in the form of large lumps not in the form of small grains. Thus, it takes great patience in using this tool.

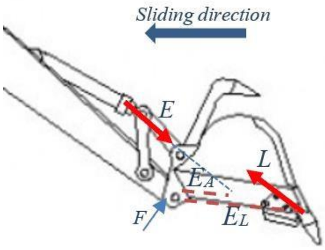

Figure 6a. Excavator Working Principle

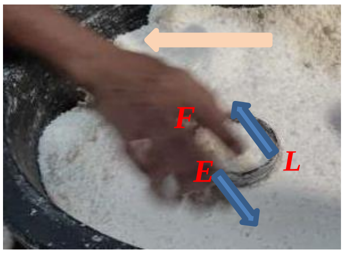

Figure 6b. Simple machine aspect analysis

Frying pan

This frying process utilizes heat transfer by conduction. In this process is carried out without the use of oil and is commonly called roasting. The purpose of this process is to reduce the water content in the starch. In addition, making the outer surface of the starch will become dry while inside it is not too dry. In the study of Zhao et al. (2020), proved that the roasting process can extend shelf life because it deactivates lipase and peroxidase. However, because the roasting process with high heat can reduce the quality of the starch. This is because the substances contained that are beneficial to the body are damaged by high heat. In addition, due to the roasting process, it can increase oil absorption capacity, water absorption index, and decrease water content (Hatamian et al., 2020). This process is shown in Figure 7.

Figure 7. Frying process

Steaming

Steaming in this process is the process of reducing hot steam out of the steamer. This is because it is restrained by a container (a cone-shaped bamboo webbing, inserted on a steamer with a pointed tip in the lower position) which is used as a starch holder. The hot steam under the container will enter the gap, and spread evenly on the flour. Thus, each part of the flour will cook evenly. In addition, the steaming process is carried out using furnaces with wood fuel. It can maintain high temperatures in the combustion process and reduce production costs (Yunianto et al., 2014). In addition, it also maintains traditions that are carried out for generations. Plus, manufacturers feel that they use firewood, making the taste of horog-horog more delicious, compared to using LPG gas. The steaming process is shown Figure 8.

Figure 8. Steaming process

Soaking

The solution used to soak the starch is brine. In addition to giving flavour, this soaking process can also make the starch expand (Figure 9). This happens because of the pressure difference, the pressure in the starch is lower than the pressure of the brine, so the solution will enter the starch. The cause is heat in the frying and steaming process.

Figure 9. Soaking process

Printing

This process is the last process in the process of making horog-horog. After a second steaming, the horog-horog is inserted into the mold by pressing-press. The process is shown Figure 10. This is the goal of making it solid. In addition, the volume of horog-horog becomes more maximum and easy to carry because it is in a bucket. After printing, traders will cut it into pieces and wrap it in small pieces using teak/banana leaves, as shown in Figure 11.

Figure 10. Printing process

Figure 11. Presentation of horog-horog using teak leaves

Prediction of Ingredients, Process and Profit

The ability to predict the amount of materials used, the length of the manufacturing process, and the profit from the sale of horog-horog producers are obtained from the experience and knowledge of ancestors. The ability to predict the amount of material appears in the washing and soaking process. In the washing process, 1 bucket can contain ± 20 kg of dry starch. This shows that there is a relationship between volume and mass. In the soaking process, salt (1 small bowl) is mixed with water (a quarter of the volume of a large bucket) to soak the steamed starch. Although the exact amount of salt can not be known, it can give the right salty taste to the horog-horog. This shows that there is a relationship between dose and yield (taste). Making horog-horog is relatively long, each process can be estimated completion time. The longest process is the drying process for ± 1 hour. The reason is that there are quite a lot of materials and they still use traditional tools. This shows that there is a relationship between activity and duration of work. The profit earned is the difference between sales and production costs. In addition to the raw materials used, employee wages are also included in production costs. Thus, horog-horog producers must be able to predict the production costs incurred and sales results, so as to minimize losses. In this description, the ability to predict the relationship between variables can be classified. This ability is needed in learning mathematics. Lim et al. (2010) which states that prediction is a mental act on cognitive aspects and a person's conceptual basis in constructing mathematics. This supports learning mathematics in the classroom.

The Relationship of Indigenous Knowledge and Basic Competencies in The Horog-Horog Manufacturing Process

After analyzing the data from observations and interviews, a relationship was carried out between knowledge/skills of making horog-horog to basic competencies in learning in the classroom. The relationship between knowledge/skills and basic competencies is shown Table 2.

Tabel 2. The Relationship of Indigenous Knowledge, Basic Competencies, Subject Matter, and Level of Education

Indigenous knowledge	Basic Competencies	Subject Matter	Level of Education
Recognizing starch-producing plants (Aren)	3.2 Classifying living things and objects based on observed characteristics	Science	7th grade junior high school
Knowing the content of palm starch from its texture	3.7 Analyze the relationship between the structures of the constituent tissues of the organs in the digestive system in relation to nutrients, bioprocesses and functional disorders that can occur in the human digestive system.	Biology	11th grade high school
Precipitating palm starch	4.3 Present the results of investigations or works on the properties of solutions, physical changes and chemical changes, or separation of mixtures	Science	7th grade junior high school
Drying palm starch using the help of cloth (capillarity) and wood ash (adsorption)	3.8 Describes the pressure of substances and their application in everyday life, including blood pressure, osmosis, and the capillarity of transport tissue in plants	Science	8th grade junior high school
	4.8 Presents experimental data to investigate the pressure of liquid substances at a certain depth, buoyancy force, and capillarity, for example in plant stems	Science	8th grade junior high school
Scraping dry starch using a simple machine (scraper)	4.3 Present the results of an investigation or problem solving about the benefits of using a simple aircraft in everyday life	Science	8th grade junior high school
Sifting starch with the aim of obtaining fine grains	4.3 Present the results of investigations or works on the properties of solutions, physical changes and chemical changes, or separation of mixtures	Science	7th grade junior high school
Frying without oil (roast) on starch in the form of fine grains	4.4 Conducting experiments to investigate the effect of heat on the temperature and shape of objects and heat transfer	Science	7th grade junior high school

Indigenous knowledge	Basic Competencies	Subject Matter	Level of Education
Soaking roasted starch with brine	3.2 analyze various bioprocesses in the cell which include membrane transport mechanisms, reproduction, and protein synthesis	Biology	11th grade high school
Steaming soaked starch	3.4 Analyze the concepts of temperature, expansion, heat, heat transfer, and their application in everyday life including the mechanism of maintaining the stability of body temperature in humans and animals	Science	7th grade junior high school
Printing steamed starch	4.7 Solving contextual problems relating to the surface area and volume of the arched side chamber construct (tube, cone, and sphere), as well as the combination of several curved side chamber constructs	Mathematic	9th grade junior high school
Assessing net profit	3.9 Recognize and analyze various situations related to social arithmetic (sales, purchases, deductions, profits, losses, single interest, percentage, gross, net, tare)	Mathematic	7th grade junior high school

The determination of basic competencies in each knowledge / skill in making horog-horog refers to Peraturan Menteri Pendidikan dan Kebudayaan Republik Indonesia 2018 (Peraturan Menteri Pendidikan dan Kebudayaan Republik Indonesia, 2018). After that, the knowledge / skills of making horog horog are adjusted to scientific knowledge / skills in these basic competencies. The congruence between local and scientific knowledge/skills is shown from the scope of the science material and the operational verbs used. The full description is shown in Table 2. The mapping that has been done turns out not only on science subjects but also on mathematics subjects. The basic competencies that have been described have covered grades 7 to 9 of junior high school and even exist in high school. With the many conformities of basic competencies with horog-horog manufacturing knowledge / skills, it can be used as a reference for teachers in applying ethno-STEM-based learning in the classroom. If this can be applied, local wisdom or indigenous knowledge of horog-horog making can be preserved.

Conclusion

The conclusion of this study is 1) in the process of making horog-horog there are aspects of science (separation of substances, density, capillarity, simple planes, heat, classification of plants, and substance content), technology (tools in the manufacturing process), engineering (screening, drying, scraping, steaming, and printing processes), and mathematics (predicting the dosage of materials, product volume, and profit from sales results) and 2) local knowledge/skills are in accordance with basic competencies in high school. With these findings, the process of making horog-horog can be used as a learning resource. In addition, this method also includes efforts to preserve the heritage of ancestors.

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