
THE ETHNOSCIENCE STUDY ON EUCALYPTUS OIL DISTILLATION IN BURU ISLAND AS A SOURCE FOR LEARNING CHEMISTRY

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ABSTRACT

Chemistry is a branch of science closely related to daily life. Chemistry lessons are currently required to present real-life examples from the students' surrounding environment. A design for chemistry lesson is through ethnosciences-based learning. Ethnosciences cannot be separated from science and community traditions. The tradition of distilling eucalyptus oil (*Melaleuca cajuputi*) on Buru Island has been carried out traditionally for generations. This research aims to analyze and reconstruct the indigenous knowledge of the community in the eucalyptus oil distillation process into scientific knowledge that can be used as a source for learning chemistry. This research used a qualitative approach based on ethnosciences with interview, observation, and documentation methods. Data analysis employs the Miles-Huberman model, which consists of data reduction, data presentation, conclusion drawing, and verification. The results of the research showed that the eucalyptus oil distillation process can be explored in science materials or concepts related to separation techniques, differences in density, phase changes, and substance pressure. The ethnosciences study results indicated the potential of ethnosciences to be applied in chemistry education.

Keywords: Distillation, Ethnosciences, Eucalyptus Oil, Source for Learning Chemistry

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1. INTRODUCTION

In daily life, we always interact with our local environment and culture. However, the potential of local culture has not been optimally utilized and is often neglected in the learning process, including in chemistry education. Chemistry, as a branch of science known for its relevance to our daily lives, would be more effective if the teaching and learning process maximized the potential of the environment, such as local culture. On the other hand, the current globalization has evidently shifted the values of Indonesia's original local culture. The rapid development of foreign cultural values within society has had a broad impact on environmental balance. Furthermore, there is a phenomenon where students believe that scientific concepts are more important and necessary, seemingly unrelated to the local community's culture (Parmin, 2015).

Ethnoscience is a strategy for creating a learning environment that integrates culture as part of the learning process, making it useful for life. Ethnoscience also involves transforming indigenous science into scientific knowledge (Sudarmin, 2014). Indigenous science encompasses all knowledge related to community facts (Snively & Corsiglia, 2001). This knowledge is derived from beliefs passed down from generation to generation. Students can acquire this indigenous science from parents, neighbors, grandparents, or other community figures. Meanwhile, students can obtain scientific knowledge from the subjects they study at school (Yasin, 2009).

The Maluku people, particularly in Buru Regency, have long utilized scientific concepts in their daily lives, especially in the distillation process of eucalyptus oil. The eucalyptus oil distillation stills on Buru Island have been operating since World War II (Maluku Provincial Tourism Office). The local community has relied on managing eucalyptus oil through generations and distilling eucalyptus oil using traditional methods.

In the Maluku Province, particularly on Buru Island and the surrounding island clusters, eucalyptus plants are not managed professionally and intensively like industrial crops. There is no special care, such as fertilization and pest and disease prevention. Farmers or the community rely solely on nature's bounty, and weeds that interfere with the main plants are never pruned. Eucalyptus plants can be classified as hardy plants that can survive in less fertile soil conditions, endure long dry climates, and withstand hot air temperatures. These plants can be found in lowlands up to an altitude of 400 meters above sea level. Eucalyptus plants have a long biological cycle, grow quickly, and can thrive in soil with both good and poor drainage, as well as in soil with high salinity or acidity (Bula, *et al.* 2022).

The history of eucalyptus oil is considered to be related to the lifestyle of people in ancient times. In the past, people living in simple environments typically utilized nature and their surroundings for daily life. Some used nature to process food, while others turned it into medicine. Similarly, the people of Buru Island have used eucalyptus trees in their surroundings for medicinal purposes. Their distillation skills were passed down through generations. Distillation is carried out using cooking equipment called a still. The still, or 'cattle', is a kettle shaped like the types of stills made in the 16th -17th centuries. The distillation process likely began with the cultural integration of traders from Sumatra and Java along with the arrival of Europeans in Maluku (Resla, 2023).

Research into local cultural aspects in Maluku has found that the people of Maluku, particularly in Buru Regency, have long utilized scientific concepts in their daily lives, especially in the process of distilling eucalyptus oil. The eucalyptus oil distillation stills on Buru Island have been operating since World War II. The local community relies on managing and distilling eucalyptus oil through generations using traditional methods. A distiller does not possess any special skills in the distillation process; instead, the knowledge of distilling is acquired from the experience of helping their parents. According to them, not much has changed in the distillation process from the past to the present, as everything is still conducted traditionally. Based on this background, this research aims to analyze and reconstruct the indigenous knowledge of the community in the eucalyptus oil distillation process into scientific knowledge, which will serve as a source for learning chemistry.

2. RESEARCH METHODS

This research used a qualitative approach based on ethnoscience. According to Rahmat (2020), A qualitative research is used to describe a phenomenon that is happening, and to explain how the phenomenon as what it is. The research site was in Jamilu Village, Buru Regency. This location was chosen because the community still maintains the traditional method of distilling eucalyptus oil using wooden stills. Data collection methods included direct observation of the eucalyptus oil distillation process, starting from harvesting eucalyptus leaves to producing eucalyptus oil, supported by documentation of each distillation step. Interviews aimed to gather information about the tradition of eucalyptus oil distillation. Interviewees consisted of traditional leaders and community members who are eucalyptus farmers and oil distillers. The reconstruction of local knowledge focuses on the traditional tools and stages used in the eucalyptus oil distillation process. Data analysis followed the Miles-Huberman (2005) analysis technique, which includes data reduction, data presentation, conclusion drawing, and verification (Abdussamad & Sik, 2021).

3. RESULTS AND DISCUSSION

The process of distilling eucalyptus oil varied in distinct ways across different regions. In Buru Regency, the distillation process involved traditional tools, materials, and methods that differed slightly from those used in other areas. The distillation skills were passed down through generations. The distillation was carried out using cooking equipment made from eucalyptus wood, called a still. Eucalyptus oil obtained from distillation has specific characteristics such as color, odor, specific gravity, refractive index, solubility in ethanol, optical rotation, and cineole (C₁₀H₁₈O) content.

Cineole has a boiling point of 174°C - 175°C. Other active ingredients contained in it include terpineol, pinene, and limonene. These substances are what make eucalyptus oil feel warm on the body and have the distinctive aroma of eucalyptus (Guntur, 2018). There are some factors in eucalyptus oil processing which ascertain the quantity (yield) and quality of oil products. Factors influencing yield i.e. climate and soil, harvesting month, plants age, plants species, plants spacing, leaves condition, and oil processing (Alam, *et al.* 2019). To

gain a deeper understanding of the eucalyptus oil distillation process in Buru Regency, pay attention to the following discussion.

A. The Steps of the Traditional Process for Distilling Cajuput Oil

1. Sorting eucalyptus leaves (*Melaleuca cajuputi*) obtained from eucalyptus plantations involves the following steps. The sorting of eucalyptus leaves is conducted by collecting all the eucalyptus leaves without separating the young leaves from the older ones.



Figure 1. Process of Sorting Eucalyptus Leaves

2. Storing eucalyptus leaves in a closed condition before distillation. The storage of eucalyptus leaves is carried out on surfaces lined with plastic or sacks to prevent direct contact with the ground. The leaves are also stored at room temperature, and the storage period should not exceed one week.



Figure 2. Eucalyptus Leaf Storage Process

3. Preparing the distillation setup involves assembling the essential components: the kettle, condenser, and stove



Figure 3. Process of Preparing the Distillation Equipment

4. Pouring water into the kettle until it reaches the filter. This is for the distillation process, which is conducted at a temperature of 150°C to 200°C (Aryani, 2020).



Figure 4. Process of Filling Water into the Kettle

5. Filling water in the cooling circulation. The cooling process in eucalyptus oil distillation aims to cool the eucalyptus vapor passing through the cooling pipe, causing it to condense into drops of eucalyptus oil (Siaruddin & Widiyanto, 2014).



Figure 5. Cooling Water Filling Process

6. Inserting leaves into the kettle



Figure 6. Inserting Eucalyptus Leaves Process

7. Installing the kettle lid until no steam comes out



Figure 7. Installing the Kettle Lid Process

- Lighting the heating furnace fire



Figure 8. Lighting the Furnace Fire Process

- Distilling for about 7-8 hours starting from the first drop



Figure 9. Distillation Process

- Separating oil and water from the distillation results



Figure 10. Water and Oil Separation Process

- Repeating steps 3-10 until the sorted leaves have all been cooked and produce several eucalyptus oil genes. The eucalyptus oil produced from the distillation process yields about 1-2% (Rahmah, *et al.* 2022).



Figure 11. Repeating the Distillation Process

B. Reconstructing Indigenous Science into Scientific Knowledge

To analyze the relationship between indigenous science and scientific knowledge in the eucalyptus oil distillation process, a comparison can be presented in a table format. Here's an example table structure:

Table 1. Analysis Results of Reconstruction of Indigenous Science into Scientific Knowledge

No.	Distillation Process	Indigenous Science	Scientific Knowledge
1.	Storing leaves in a closed condition before cooking.	To keep the leaves fresh even when stored for several days before cooking	to reduce evaporation (change of state from liquid to gas) of oil from eucalyptus leaves Science concept: Change of state
2.	Filling water into the cooking pan until it is close to the filter	This water is used in steaming eucalyptus leaves	The water will evaporate after being cooked for some time, where the water vapor will carry the eucalyptus oil vapor together with it to the condenser Science Concept: Changes in the state
3.	The kettle containing the leaves is closed very tightly before the cooking process begins.	To prevent leaks that cause a reduction in the amount of eucalyptus oil	The kettle is tightly closed so that the steam produced can later exit in 1 direction through the condenser (cooler). The kettle cover is completely closed to prevent the release of water vapor containing oil which can reduce the yield of oil produced Science concept: Steam Pressure
4.	The steam that comes out of the kettle towards the cooler changes into liquid.	Steam cooling occurs	A condenser is a cooling tube used in a distillation system to convert vapor to liquid. Science concept: Separation technique (Distillation)
5.	The process of separating water and oil as a result of distillation using a jerry can with holes in the bottom.	The distillation results consist of water and oil which are then separated through the bottom of the jerry can which has been perforated, the water is drained out until all the water layers are gone.	The resulting distillate is separated between oil and water by utilizing the principle of differences in density. The density of water is greater than the density of oil, so the water layer is at the bottom and will be removed first Science concept: Density

Ethnoscience-based learning involves reconstructing indigenous science to translate it into scientific concepts (Perwitasari, *et al.*, 2016). This Indigenous science is obtained through interviews and observations of cultural practices and local wisdom related to eucalyptus oil

distillation in Buru Regency. The observations and interviews with respondents, who are both eucalyptus farmers and distillers in Jamilu Village, Buru Island, revealed the following stages in the eucalyptus oil distillation process: sorting leaves in the eucalyptus garden, storing the leaves in a closed state before distillation, preparing a series of distillation kettles, filling the kettle with water and cooling circulation, putting the leaves into the kettle until full, closing the kettle lid tightly, heating the furnace, separating the water and eucalyptus oil.

The stages in the eucalyptus oil distillation process, when studied further, have connections to scientific knowledge that can be integrated into education, particularly in chemistry. The real-life process of eucalyptus oil distillation is expected to provide students with a more concrete and meaningful learning experience, helping them understand concepts better because they relate closely to their everyday lives (Parmin, 2017).

Ethnoscience is the knowledge that comes from culture and is part of a society with a science concept. The knowledge is the language, customs, traditional food, moral values, habits, rules, and prohibitions on technology created in a society with scientific knowledge (Rusmansyah, *et al.* 2023). In education, ethnoscience learning can be a breakthrough that combines culture with science in the learning process. The application of ethnoscience-based learning will strengthen students' understanding of science concepts because the students study culture and local wisdom to reveal the scientific knowledge in it. In addition, students can apply the concept of science and connect the material with community knowledge so that scientific literacy will also increase (Rosidah, *et al.* 2024).

Using an ethnoscience approach, students will be actively involved in the learning process so that the understanding they have is better than conventional learning (Atmojo, 2012). The original scientific knowledge of the community that exists in the community as a development pattern is passed down continuously between generations is not structured and systematic in a curriculum, is local, informal, and is generally the knowledge of the community's perception of a particular natural phenomenon (Battiste, 2005; Porsanger, 1999). The characteristics of traditional community knowledge in this case the original scientific knowledge of the community lie in not being formalized as a source of learning, is knowledge based on experience, and the knowledge is not permanent and scientifically studied to find the relationship between concrete facts and their causes (Sudarmin, 2014).

The findings of this research align with research conducted by Najib (2018), which examined the ethnoscience of tile-making processes as supplementary teaching material for integrated science lessons; Mukti *et al.* (2022), who explored the Belaq Tangkel ritual among the Sasak people as a learning source for science education; and Ilhami, *et al.* (2020), who investigated the maaowo tradition at Lake Bakuok as a source for biology education. Additionally, the research by Andayani *et al.* (2021) found that most teachers have not yet utilized an ethnoscience approach in chemistry teaching, both in the classroom and laboratory settings. Developing chemistry education with an ethnoscience approach is necessary to enhance students' thinking skills and build their character.

4. CONCLUSION

The traditional distillation of eucalyptus oil (*Melaleuca cajuputi*) is a community tradition in the Buru district where the abundant cajuput trees are utilized to produce a traditional medicine with many benefits. The scientific explanation found in the eucalyptus oil distillation process by the Buru island community can be used as a learning resource in chemistry education. The findings of the original science, which have been interpreted into scientific terms in the distillation of cajuput oil, have various functions and meanings for farmers. Therefore, the local wisdom of eucalyptus oil distillation is still practiced in daily life, evolving with the times. The distillation process of eucalyptus oil can explore scientific concepts related to phase changes, separation techniques, density, and pressure of substances. Ethnoscience studies indicate the potential of ethnoscience to be applied in chemistry learning.

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