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An Ethnoscience Study of the *Tempe-Making* Process as a Source of Contextual Science Learning: A Case Study of The Aikmual Village

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Abstract

Contextual learning in science education (IPA) demands integration of real-world phenomena familiar to students. This study examines the ethnoscientific aspects embedded in the tempeh-making process as a contextual resource for science learning. A qualitative descriptive case study was conducted in Aikmual Village, Central Lombok, involving participatory observation, in-depth interviews with three experienced producers, and documentation. The findings reveal that the tempeh production process integrates key scientific concepts across biology, chemistry, and physics, particularly in fermentation, biochemical transformations, and heat transfer mechanisms. Eight production stages were systematically mapped to relevant science competencies at the junior and senior high school levels. The study concludes that traditional tempeh-making practices have strong potential as ethnoscience-based learning resources to enhance students' scientific literacy and contextual understanding, in line with the Merdeka Belajar curriculum.

Keywords: ethnoscience; contextual learning; science education; tempeh fermentation; local knowledge

INTRODUCTION

The Contextual Teaching and Learning (CTL) approach has been widely recognized as an effective solution to the problems of science education, which has traditionally been textual, abstract, and disconnected from students' real-life contexts. Contextual learning connects academic material to real-life situations, enabling students to construct their own knowledge through meaningful, direct experiences (Susiloningsih, 2016; Diatmika, 2018; Johnson & Sinatra, 2020). With this approach, students do not merely passively receive information but are encouraged to actively discover, analyze, and connect scientific concepts with the realities of life around them, thereby deepening and enriching their conceptual understanding (Putri et al., 2024; Nesse et al., 2020).

One source of contextual learning that holds great potential but has not yet been extensively studied academically is the process of making tempeh. This process is a traditional food biotechnology practice that occurs naturally within communities and encompasses a wealth of scientific concepts. Biologically, tempeh production involves fermentation by the mold Rhizopus oligosporus and the role of lactic acid bacteria. Chemically, this process includes protein denaturation, the Maillard reaction, protein and fat hydrolysis, and the dynamics of pH changes (Rigolon et al., 2022). From a physical perspective, it involves phenomena such as heat transfer, osmosis, gas diffusion, and the production of metabolic heat. The wealth of scientific concepts integrated into this single traditional practice makes tempe production an ideal candidate for contextual science learning that can be developed based on an ethoscience approach (Sudarmin, 2014; Ladwig & Rhee, 2021).

Various previous studies have demonstrated the effectiveness of ethnopedagogy and ethnoscience approaches as resources for science education. Ethnoscience studies on salt production in Madura (Hadi & Ahied, 2017), Maduran shrimp paste (Hadi et al., 2019), traditional snacks klepon and dawet (Elisa et al., 2022), milkfish satay (Kholidah et al., 2023), and the production of "*Lepet*" (Sholeha, 2025) have demonstrated that local cultural practices contain science concepts that can be integrated into formal education. Internationally, the

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integration of local knowledge into science education has also been shown to enhance student engagement and the relevance of learning for students from indigenous and traditional communities (Aikenhead & Ogawa, 2007; Chinn, 2007; Odora Hoppers, 2001; Semali & Kincheloe, 1999). However, these studies are generally limited to a single branch of science (physics or biology), have not integrated all three simultaneously, and have not systematically mapped their relevance to the current curriculum's core competencies. Furthermore, ethnoscience studies on traditional food fermentation processes, particularly tempeh, that examine scientific concepts holistically across biology, chemistry, and physics remain very limited in the Indonesian science education literature (Corsetti & de Lima, 2023; Utami et al., 2021).

In the field, Aikmual Village, Praya Subdistrict, Central Lombok Regency, is one of the villages with a strong tradition of tempeh production passed down through generations, where nearly all families in Batu Tambun Hamlet work as tempeh makers as their primary source of livelihood. However, the scientific richness of this tradition has never been studied academically as a source of contextual learning. Therefore, this study aims to examine the ethnoscience embedded in the *tempe*-making process in Aikmual Village and systematically map it to the core science competencies at the junior high and senior high school levels. The novelty of this study lies in its ethnoscience analysis, which integrates three branches of science—biology, chemistry, and physics—into a single traditional practice, as well as its direct mapping to the current curriculum—an approach not previously undertaken by prior ethnoscience studies. This research is expected to make a tangible contribution to the development of science teaching materials rooted in local wisdom that align with the requirements of the Merdeka Curriculum.

MATERIALS AND METHODS

Time and Place

This study was conducted in March 2026 in Aikmual Village, Praya Subdistrict, Central Lombok Regency, West Nusa Tenggara. Specifically, observations were made in Batu Tambun Hamlet, which serves as the center of traditional tempeh production in the village. This location was selected through purposive sampling because nearly all residents work as tempeh artisans, and the production process is still carried out using traditional methods rather than modern machinery.

Research Design

This study employs a qualitative descriptive approach using a case study design. The case study design was chosen because this research aims to conduct an in-depth examination of a specific phenomenon, namely, the tempe-making process, within the real-life context of the community in Aikmual Village (Creswell, 2009; Yin, 2018). The ethnoscience approach was used as an analytical framework to identify and classify the science concepts embedded in the traditional practice of tempe-making (Sudarmin, 2014). Case studies with this design are commonly used in ethnopedagogical research because they allow researchers to gain a deep and contextual understanding of a specific case (Merriam & Tisdell, 2016; Stake, 1995).

Research Subjects and Objects

The subjects of this study were three key informants, experienced *tempe* makers in Aikmual Village, Central Lombok, who were selected through purposive sampling based on the criteria of having at least ten years of experience and using traditional production methods. These three informants were chosen because they were considered capable of comprehensively representing all stages of the tempeh-making process. The study focuses on the traditional tempeh-making process and the scientific concepts it encompasses, covering all eight stages of production from soybean washing to fermentation.

Research Procedures

Data was collected using three methods: direct participatory observation at the production site, in-depth semi-structured interviews with artisans, and written documentation of the production process. The research was conducted through four systematic stages. First, the researcher conducted initial observations and mapped the entire tempeh-making process from upstream to downstream together with the artisans using a structured observation sheet that included a list of production stages, environmental conditions (temperature, time, ingredients), and physical phenomena that could be observed directly. Second, the researchers conducted in-depth interviews regarding fermentation conditions, the types and quantities of yeast used, the optimal fermentation duration, factors influencing *tempe* quality, and the artisans' local knowledge of the processes they perform, using a semi-structured interview guide validated by experts. Third, each production stage was documented in detail using a camera or recording device to capture the process, and field notes were taken to record details not captured by the camera. Fourth, the collected data were analyzed using an ethoscience analysis sheet containing categories of science concepts (biology, chemistry, physics) and a mapping column to core competencies, to identify, classify, and map science concepts into these categories.

Data Analysis Techniques

The data from observations and interviews were analyzed using qualitative descriptive analysis in three stages: data reduction, presentation of data in mapping tables, and drawing conclusions (Sugiyono, 2018). Science concepts were identified by comparing each stage of the tempeh-making process with biological, chemical, and physical concepts based on the current science curriculum. Subsequently, the identified concepts were mapped onto core science competencies at the junior high and senior high school levels to assess their relevance as sources of contextual learning (Bravo-Torija & Jimenez-Aleixandre, 2018; Kim & Tan, 2013).

RESULTS AND DISCUSSION

Result

An Overview of the Tempe-Making Process in Aikmual Village

Field observations in Aikmual Village, particularly in Batu Tambun Hamlet, Central Lombok, indicate that the tempeh-making process has been passed down through generations and has become a deeply rooted tradition in the local community. Nearly all households in this hamlet produce tempeh daily as their primary source of livelihood, with production capacity ranging from 10 to 50 kilograms of soybeans per day per artisan. The main raw materials used are local soybeans, tempeh starter in powder form, and perforated polyethylene plastic as packaging.

Based on observations and in-depth interviews with three key informants, the tempeh-making process in Aikmual Village takes approximately 48 to 72 hours, from processing raw materials to the tempeh being ready for harvest. This process can be summarized into eight main stages that are consistently followed by all producers, as shown in Table 1

Table 1. Stages of the Tempe-Making Process in Aikmual Village and the Underlying Science Concepts

Stage	Process Description	Embedded Science Concepts
Sorting and Washing of Soybeans	Soybeans are sorted to select high-quality seeds, then washed repeatedly with clean water to remove dirt, dust, and damaged or moldy beans.	Physics: density (damaged beans float), gravitational force; Chemistry: solubility of organic impurities in water
First Boiling (30–60 minutes)	Soybeans are boiled in water for 30–60 minutes until partially cooked. This process softens the seed structure and prepares the soybeans for dehulling.	Physics: heat transfer (conduction through the pot, convection in water, radiation from the heat source); Chemistry: protein denaturation, starch gelatinization, initial Maillard reaction
Dehulling and Splitting of Soybeans	The soybean hulls are removed mechanically, by hand or with simple tools, and the beans are split into two halves to increase the surface area available for mold growth.	Physics: mechanical force, pressure, surface friction; Biology: anatomical structure of soybean seeds (seed coat/testa, cotyledon)
Soaking (12–24 hours)	Soybeans are soaked in water at room temperature for 12–24 hours. During soaking, natural fermentation by lactic acid bacteria occurs, lowering the pH.	Biology: activity of lactic acid bacteria (*Lactobacillus* sp.), lactic acid fermentation; Chemistry: production of lactic acid, pH reduction to 4–5; Physics: osmosis (water absorption into soybeans), diffusion
Second Boiling and Draining	Soybeans are boiled again to eliminate contaminating microorganisms from the soaking process, then drained and cooled to room temperature before inoculation.	Physics: heat transfer; Biology: heat sterilization, inactivation of contaminant bacteria; Chemistry: partial protein hydrolysis due to heat
Tempeh Starter Inoculation	Tempeh starter (containing spores of *Rhizopus oligosporus*) is evenly distributed over the cooled and drained soybeans. Inoculation is performed at room temperature.	Biology: spores of *Rhizopus oligosporus*, asexual reproduction of molds; Chemistry: initial enzyme activation; Physics: uniform distribution of spore particles
Packaging in Perforated Plastic	The inoculated soybeans are tightly packed in perforated plastic to allow air circulation during fermentation.	Physics: gas diffusion (O_2 enters and CO_2 exits through perforations); Biology: oxygen requirement of molds (obligate aerobes); Chemistry: gas balance in a closed system
Fermentation (48–72 hours at 28–32°C)	Tempeh is incubated at warm room temperature for 48–72 hours. Mold grows, forming white mycelium that binds the soybeans into a compact mass. The product is ready when the mycelium evenly covers the surface.	Biology: growth of *Rhizopus oligosporus* mycelium, production of protease and lipase enzymes, activity of secondary bacteria; Chemistry: protein hydrolysis into peptides and free amino acids, lipid hydrolysis into fatty acids and glycerol, pH increase to 6–8; Physics: metabolic heat production (exothermic reactions), heat transfer from the tempeh mass to the environment

Biological Concepts in the Tempe-Making Process

The biological concepts identified in the tempeh-making process in Aikmual Village fall into three main categories. First, fermentation by the mold Rhizopus oligosporus, which begins to germinate within 4 to 6 hours after inoculation and forms white mycelium that binds the soybeans into a solid mass. Second, enzymatic activity (protease and lipase) that physically alters the texture, aroma, and color of the soybeans during fermentation; these changes can be directly observed by the artisans. Third, the role of lactic acid bacteria during the soaking phase, which causes a measurable drop in pH from 6–7 to 4–5 over a 12–24-hour period, as confirmed by all informants. The first informant stated: “If the water starts to taste sour and has a distinctive odor, it means the soaking is sufficient, and the soybeans are ready to be drained.” This statement indicates that the artisans empirically use changes in pH as an indicator of the readiness of the soaking process.

Chemical Concepts in the Tempe-Making Process

Three key chemical concepts were identified from the observations and interviews. First, protein denaturation during boiling was visually indicated by a change in the texture of the soybeans, which initially were hard but became soft and easy to split. Second, the Maillard reaction, which can be directly observed by the appearance of a yellowish-brown color and a distinctive aroma in boiled soybeans, differs from that in raw soybeans. Third, the dynamics of pH changes: the artisans empirically observed that the soaking water becomes acidic (pH drops to the 4–5 range) during soaking, then the fermented soybeans return to near-neutral (pH rises to 6–8) as the tempeh matures. The second informant explained: “A 48-hour fermentation time is usually just right—the tempeh isn’t too sour and doesn’t have a pungent ammonia smell; if it’s pungent, it means it’s been left too long.” This statement directly reflects the artisans’ empirical knowledge of pH dynamics during fermentation.

Physics Concepts in the Tempe-Making Process

Four physical phenomena were identified during field observations at the production site. First, heat transfer: during boiling over a wood stove, a convection current was clearly visible as water bubbles rose, accompanied by radiant heat from the flame. Second, osmosis: soybeans that were initially hard and dry swelled noticeably after being soaked for 12–24 hours; artisans could feel and measure this change in volume directly. Third, gas diffusion through holes in the plastic wrap: artisans systematically create and adjust the number of holes in it based on experience. The third informant explained: “If there are too few holes, the tempeh turns black and smells bad; if there are too many, the tempeh dries out quickly. We already know from experience how many holes are just right.” Fourth, metabolic heat: a pile of tempeh undergoing fermentation feels physically warm to the touch, with a measured surface temperature higher than the surrounding room temperature, as confirmed by all informants through the researcher’s direct observation.

Mapping Science Concepts to Core Competencies

Based on the ethoscience analysis conducted, all science concepts identified in the tempe-making process can be mapped to the core science competencies for junior high and senior high school levels, as presented in Table 2.

Table 2. Mapping of Science Concepts in Tempe Production to Core Competencies

Science Domain	Key Concepts	Related Stages	Relevance to Junior/Senior High School Science Curriculum
Biology	Fermentation by *Rhizopus oligosporus*; mycelial growth; activity of protease and lipase enzymes; role of lactic acid bacteria	Soaking, Inoculation, Fermentation	Junior High School (Grade IX): Conventional biotechnology; Senior High School (Grade XII): Cell metabolism, enzymes, and biotechnology
Chemistry	Protein denaturation; Maillard reaction; protein and lipid hydrolysis; pH dynamics; production of lactic acid and free amino acids	First and Second Boiling, Soaking, Fermentation	Senior High School (Grade XI): Chemical reactions, kinetics, acid–base; Senior High School (Grade XII): Carbon compounds, biochemistry
Physics	Heat transfer (conduction, convection, radiation); osmosis; diffusion of O_2 and CO_2 gases; metabolic heat (exothermic reactions)	Washing, First and Second Boiling, Soaking, Packaging, Fermentation	Junior High School (Grade VII): Temperature and heat; Senior High School (Grade XI): Thermodynamics, heat transfer; Senior High School (Grade X): Diffusion and osmosis

Tempe Makers’ Perceptions of the Potential of the Tempe-Making Process as Educational Material in Schools

At the end of the interview session, the three informants were asked for their opinions on incorporating the tempeh-making process into the school curriculum. In general, all three artisans welcomed the idea. The first informant, a 58-year-old male artisan with over 35 years of experience, stated that he would feel proud if the skills passed down through generations in his family could be learned by the younger generation in school. According to him, many young people have not understood the tempe-making process even though they grew up in a community of tempe artisans; thus, if this knowledge were introduced in schools, at least the children would come to know and appreciate the traditions of their village.

The second informant, a 40-year-old female artisan, expressed her hope that, if the tempeh-making process were incorporated into the curriculum, teachers would first consult directly with artisans to ensure that no incorrect information is conveyed to students. She also stated her willingness to serve as a resource person or to host students at her production site. The third informant, the youngest artisan (32 years old), gave the most enthusiastic response. She argued that learning based on the tempe-making process would be more engaging and easier for students to understand than simply learning from textbooks, because this process is tangible, can be observed firsthand, and its results can be experienced concretely.

These findings indicate that tempe artisans in Aikmual Village are not only open to the potential for process-based learning in their craft but also actively hope that their local knowledge will be recognized and formally integrated into education. Social support from this artisan community is a vital asset for the future development of ethnoscience-based science teaching materials, and affirms that the integration of local knowledge into science education can proceed collaboratively between schools and the local community.

Discussion

The Potential of Ethnoscience in Tempe Production as a Source of Contextual Learning

The findings of this study consistently indicate that the tempe-making process in Aikmual Village, Central Lombok, incorporates a rich, diverse, and in-depth set of scientific concepts spanning three major branches of natural science: biology, chemistry, and physics. The richness of scientific concepts found in this traditional practice aligns with Sudarmin’s (2014) view that a community’s local knowledge always contains scientific dimensions that, when studied scientifically, can significantly enrich science education. This is also consistent with the perspective of Aikenhead & Ogawa (2007), who assert that a community’s indigenous and scientific knowledge are not two conflicting domains but can complement and enrich one another in an educational context.

The ethoscience approach applied in this study has proven capable of revealing the layers of scientific concepts hidden behind the practice of tempe-making, which has long been viewed as merely an economic activity. This aligns with the findings of Hadi et al. (2019), who identified a wealth of science concepts in the production of Maduran terasi, as well as the findings of Elisa et al. (2022), who identified physics concepts in the traditional snacks klepon and dawet. A similar pattern was also found in Sholeha's (2025) study, which examined the concept of force in lepet making, and in Purnomo et al. (2020), who explored ethoscience in the broader context of traditional Indonesian food processing. Collectively, these findings confirm that Indonesia's local cultural practices hold immense ethoscience potential that remains largely untapped in science education, aligning with the systematic review by Corsetti & de Lima (2023), which also identified the same trend in the international literature.

From a biological perspective, Rhizopus oligosporus has been shown to produce protease and lipase enzymes during fermentation that break down soybean proteins and fats, enhancing nutritional value and fundamentally altering the texture and aroma of tempeh (Sari et al., 2022; Rahmawati & Nurhayati, 2022). The role of lactic acid bacteria (Lactobacillus sp.) during soaking in creating selective acidic conditions is also a concrete example of microbial ecology that can be studied within the context of conventional biotechnology (Dwinaningsih, 2010). From a chemical perspective, protein denaturation caused by temperatures above 60°C makes proteins more accessible to fungal enzymes, while the Maillard reaction produces melanoidins and aromatic compounds that can be directly observed through sensory evaluation (Winarno, 2021). The fluctuating pH dynamics from 6–7 (initial) to 4–5 (soaking) and then back to 6–8 (end of fermentation) reflect the complex interactions between lactic acid metabolites and protein hydrolysis products, such as ammonia (Nuraini et al., 2021). From a physical perspective, all three heat transfer mechanisms (conduction, convection, radiation) operate simultaneously during boiling; osmosis explains the swelling of the beans during soaking; and gas diffusion through the pores of the plastic supports the aerobic respiration of mold (Sholeha, 2025; Wahyudi, 2018). These mechanisms, previously known only empirically by artisans, can now be systematically integrated into formal science education.

Integrating the tempeh-making process as a source of contextual learning offers several strategic advantages. First, the learning material becomes highly relatable and relevant to students' lives, particularly those from families of tempeh makers (Mensah, 2011). Second, science concepts that have long been viewed as abstract—such as protein denaturation, osmosis, diffusion, and heat transfer—can be visualized concretely through direct observation of the tempe-making process (Noh & Scharmann, 1997). Third, this approach simultaneously preserves and values the local wisdom of the Lombok community as part of a valuable cultural identity, in line with the principles of culture-based science education (Dawson, 2018; Chinn, 2007).

Relevance to the Merdeka Curriculum

The results of mapping science concepts in the tempe-making process to core competencies demonstrate a very strong alignment with the current Merdeka Curriculum. The Merdeka Curriculum explicitly promotes context-based, meaningful learning rooted in local wisdom (Ministry of Education and Culture, 2022). In this context, the tempe-making process in Aikmual Village is an ideal learning resource because it meets all three of these criteria simultaneously. This relevance aligns with the findings of Kartika et al. (2018) and Berk & Hamurcu (2022), who empirically demonstrated that local wisdom-based science learning significantly improves students' conceptual mastery and scientific attitudes compared to conventional learning.

At the junior high school level, the concepts of fermentation and the role of microorganisms in the tempeh-making process align directly with the conventional ninth-grade biotechnology curriculum. At the senior high school level, the concepts of enzymes and cellular metabolism are relevant to the twelfth-grade biology curriculum; the concepts of chemical reactions and acids and bases are relevant to the eleventh-grade chemistry curriculum; and the concepts of heat transfer and thermodynamics are relevant to the eleventh-grade physics curriculum. The depth and breadth of science concepts found in this single traditional practice demonstrate its potential as an integrative, cross-grade-level learning resource, in line with the findings of Ottander & Ekborg (2012), who emphasize the importance of contextual and socio-scientific issues in expanding the scope of science learning across topics and grade levels.

These findings reinforce the results of Widiastuti's (2021) study, which showed that context-based science teaching materials incorporating local wisdom significantly improved students' conceptual understanding. In line with this, Sari et al. (2021) found that ethnoscience-based science learning effectively develops students' critical thinking skills by encouraging them to analyze scientific phenomena in the real-life contexts of their daily lives. The integration of local wisdom into science education is also supported by research conducted in Pujut, Central Lombok, which showed that ethnoscience-based science modules received positive feedback from teachers and students and were deemed suitable as supplementary learning resources.

Practical Implications for Science Education

This study offers several important practical implications for science education. First, science teachers in Central Lombok, particularly those teaching in villages with a tradition of tempeh-making, can directly apply the findings of this study to develop contextual learning activities. For example, teachers can take students on field trips to tempeh production sites as part of field observation activities related to biotechnology, chemical reactions, or heat transfer.

Second, the results of this study can serve as a basis for developing ethnoscience-based science teaching materials or learning modules that highlight the tradition of tempe-making in Aikmual Village. The development of such teaching materials aligns with the requirements of the Merdeka Curriculum, which encourages the creation of contextual, locally-based teaching materials. Mukti et al. (2022) emphasize that integrating ethnoscience into science education can simultaneously enhance students' active engagement and scientific literacy, two outcomes that are highly prioritized in the Merdeka Curriculum. When designing teaching materials based on these findings, teachers need to consider how content knowledge and pedagogical knowledge can be effectively combined (Henze & van Driel, 2009), as well as how students' conceptions of the nature of science can be built through authentic local contexts (Molina-Andrade & Utges, 2011).

Third, this study shows that the empirical knowledge possessed by tempe artisans in Aikmual Village, although acquired through generations without formal science education, has, in fact, internalized profound scientific principles. The artisans understand that temperature, humidity, fermentation time, and air circulation are critical factors determining tempe quality, even though they explain these in the local language and within a local framework of understanding. This is the essence of ethnoscience: local knowledge that is, in essence, parallel to scientific knowledge (Semali & Kincheloe, 1999; Odora Hoppers, 2001). This phenomenon also reflects what Taber (2019) refers to as "indigenous science"—scientific knowledge that has developed independently within communities through centuries-long processes of observation and experimentation, and is therefore worthy of recognition and integration into formal science education.

CONCLUSION

The tempe-making process in Aikmual Village, Central Lombok, has been shown to incorporate a wealth of diverse, in-depth scientific concepts that integrate the three main branches of science. From a biological perspective, the process involves fermentation by Rhizopus oligosporus, the growth and sporulation of fungal mycelium, the enzymatic activity of proteases and lipases, and the role of lactic acid bacteria. From a chemistry perspective, concepts include protein denaturation, the Maillard reaction, protein and fat hydrolysis, pH dynamics, and the production of organic acids and free amino acids. From a physics perspective, concepts include heat transfer via conduction, convection, and radiation; osmosis during soaking; gas diffusion during fermentation; and the production of metabolic heat from exothermic reactions. All eight stages of the tempeh-making process were successfully mapped to the relevant core science competencies at the junior high and senior high school levels. Furthermore, tempeh artisans in Aikmual Village responded positively and enthusiastically to integrating the tempeh-making process as a learning resource in schools, indicating strong social support from the local community.

From a scientific perspective, this study contributes to the development of ethoscience literature based on traditional fermented foods that integrates three branches of the natural sciences simultaneously—an approach that has not been widely adopted in previous research (Utami et al., 2021; Corsetti & de Lima, 2023). However, this study has limitations, including the limited number of informants, restricted to three artisans in a single hamlet, and the fact that the effectiveness of the teaching materials developed from this study has not yet been directly tested in the Classroom. Therefore, future research is recommended to develop and test the effectiveness of science teaching modules or materials based on the ethoscience of tempe production in Aikmual Village in enhancing students' conceptual understanding and scientific literacy (Berk & Hamurcu, 2022; Soja et al., 2021), as well as to expand the study to other tempe-producing villages in West Nusa Tenggara to obtain a more comprehensive picture.

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AUTHOR'S CONTRIBUTION

Table of Author Contributions

Contribution Indicators	Author				
	1	2	3	4	5
Conceptualization	✓				
Literature Review	✓		✓	✓	✓
Research Design / Methodology	✓	✓	✓		✓
Instrument Development	✓	✓		✓	✓
Data Collection	✓	✓	✓	✓	✓
Data Curation	✓		✓		
Formal Analysis	✓	✓			✓
Data Interpretation	✓		✓	✓	
Writing – Original Draft	✓		✓	✓	✓
Writing – Review & Editing	✓	✓	✓	✓	✓
Visualization / Tables	✓		✓	✓	✓
Supervision	✓	✓	✓		✓

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