

Implementation of Tempeh Fermentation Room to Optimize the Tempeh Fermentation Process Equipped with Temperature and Air Humidity Controls

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Abstract: The production of tempeh in Indonesia, particularly in SMEs located at Jalan Raya Sepande No.45 Sidoarjo, still faces challenges in the manual fermentation process, especially during unstable weather conditions. Suboptimal fermentation can lead to a decline in production quality. This community service activity aims to improve the quality and capacity of tempeh production through technological innovation. The method used is a participatory approach involving training, mentoring, and discussions between the proposing team and partners. The resulting solution includes the application of appropriate technology, such as a fermentation room equipped with temperature and humidity control, as well as improvements in packaging and digital marketing. The results of this activity show an increase in production quality and quantity, income, and the human resource capacity of the partners. The conclusion of this activity is that the participatory approach and technological innovation can significantly enhance production efficiency and partner welfare.

Keywords: tempe; fermentation room; product quality

INTRODUCTION

Tempeh is one of the known sources of vegetable protein around the world. Tempeh itself is a food that contains vitamins ranging from B complex and contains a lot of antioxidants in the form of isoflavones which are substances needed by the body to stop the reaction of free radical formation (Nout & Kiers, 2005). Currently, there are approximately 81000 peanut shell processing companies in Indonesia with a production of 2.4 million tons of peanut shells per year (data from the Central Statistics Agency). According to the records of the Indonesian Center for Cooperation in Years and Tempeh (Puskopti), the production of tofu and tempeh in Indonesia reaches 250000 tons per month. Indonesia is the largest producer of tempeh and is the largest soybean market in the world and the largest in Asia. However, the production process of tempeh is still mostly carried out manually or traditionally assisted by machines that do not meet food grade standards (Ely et al., 2017).

The group of tempeh producer SMEs is a member of the Indonesian Tempe Tahu Cooperative (KOPTI) "KARYA MULIA" which is located on Jalan Raya Sepande No.45, Sidoarjo Regency. This cooperative engaged in soybean trading and tempeh sales was established on September 12, 1998 with a total of 276 members or tofu and tempeh producers. For tempeh producers who are members of the Primkopti Cooperative, there are 100 SMEs. Of the 100 tempeh SMEs, there are still many who use manual methods during the tempeh fermentation process. The majority of the residents of Sepande Village make a living as tofu and tempeh makers. This causes Sepande Village to be famous as a producer of tofu and tempeh. Most of the tempeh entrepreneurs in Sepande Village said that the tempe making activities they have been doing so far are a form of ancestral heritage that they have carried out from generation to generation. The tempeh making business in Sepande Village is a home-based industrial business.

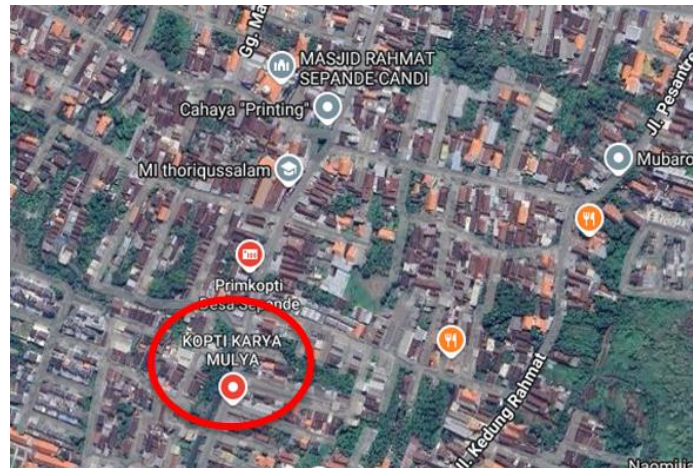


Figure 1. Map of SME locations via google maps

Based on observations in partner SMEs, there are obstacles, namely during the rainy and dry seasons which cause unstable air temperatures can affect the tempeh making process. If this happens, it will result in the activity of microorganisms that may be seen after the growth activity of *Rhizopus* sp. which exceeds its optimal period, namely after the formation of new blackish-white spores (Sari et al., 2024) (Wahyudi, 2018). This can occur if the fermentation process does not meet the temperature requirements of the appliance which ultimately results in poor tempeh production which can be characterized by the smell of ammonia from the tempeh so that it affects the level of product hygiene (Aisyah et al., 2023) (Winanti, 2014).

The existing problems will certainly have an impact on production and a decrease in SME turnover. To overcome this, there needs to be a solution that can increase production so that the turnover produced also increases (Mustiadi et al., 2019). Therefore, there needs to be an improvement in the tempeh production side in the tempeh fermentation section so that tempeh is produced with good quality. This activity aims to increase the production capacity of partners by implementing more efficient and environmentally friendly production technology through the application of the Tempeh Fermentation Room.

METHODOLOGY

The implementation method is through a participatory approach, training and mentoring as well as discussion activities to exchange experiences between the proposing team and partners. The following is the draft of the implementation method flow:

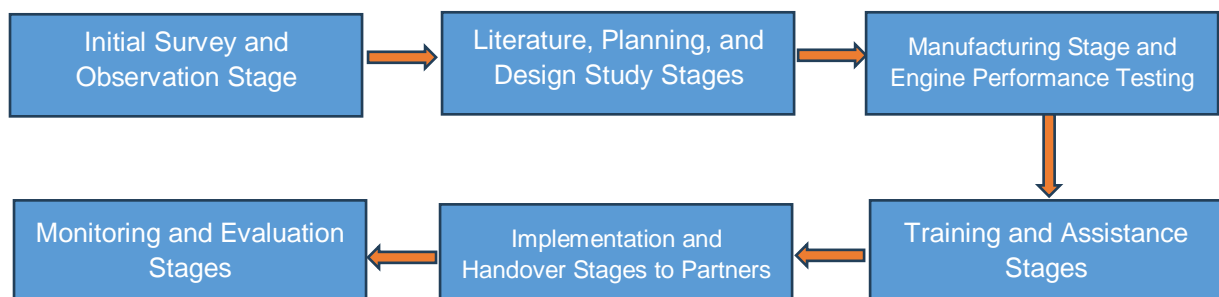


Figure 2. Flow of activity implementation

1. Initial Survey and Observation Stage
Conduct surveys and observations directly with partners to get actual conditions and data related

- to the problems experienced by partners.
2. Literature, Planning, and Design Study Stages
Conduct literature studies to answer the problems experienced by partners and make it easier to plan the manufacturing process.
 3. Manufacturing Stage and Engine Performance Testing
Carrying out the manufacturing process of the "Tempeh Fermentation Room" then testing the performance of the machine.
 4. Training and Assistance Stages
Conducting training and assistance in the operation of the "Tempeh Fermentation Room" and marketing techniques.
 5. Implementation and Handover Stages to Partners
Hand over the machine to the partner.



Figure 3. The tempeh fermentation chamber machine handed over to the partner.

6. Monitoring and Evaluation Stages
Conduct regular monitoring to find out the performance of tempeh production when using the machine. The monitoring data is used for evaluation materials.

RESULTS AND DISCUSSION

Initial Survey and Observation

Based on the results of the survey and observation, it was found that the group of tempeh producer SMEs is a member of the Indonesian Tempe Tahu Cooperative (KOPTI) "KARYA MULIA" which is located on Jln. Raya Sepande No. 45, Sidoarjo Regency. This cooperative is engaged in Soybean Trading and Tempeh Sales and was established on September 12, 1998 with a total of 276 members or tofu and tempeh producers. For tempeh producers who are members of the Primkopti Cooperative, there are 100 SMEs. Of the 100 tempeh SMEs, there are still many in the process of fermenting tempeh manually.

Literature, Planning, and Design Studies

After a literature study, the planning and design of the tempeh fermentation room, the equipment and materials needed, namely cutting saws, tig welding machines, exhaust fans, humidity sensors, drill bits 6, 8, 10 and 12 nachi, hand drills, flat sandpaper grinders, torch handles, switches, nails, elbow rulers, lights, nozzles, hollow stainless 201 20x20x1, grinding brushes, 2 mm stainless welding electrodes, Temperature sensor, 30x30 mm stainless hollow, panel box, pons sharpener, welding glasses, bending machine, steel brush, hose, seated drilling machine, lamp fittings, iron scissors, welding torch, selector switch, 304 1 mm stainless plate, paint gun sprayer, water jirigen, fan, power cable, toolset, SMAW electric welding machine, water pump, drilling bolt, gloves, impact wrench, welding helmet, triplex, and sandpaper grinding to arrange the face.

The tempeh fermentation room, which is the result of a collaboration designed to keep the indoor conditions humid so that tempeh fermentation can take place smoothly so that quality tempeh products

can be obtained. The tempeh fermentation room consists of 2 main parts, namely the indoor part and the outdoor part. The interior of the invention is divided into several components, namely racking (2), SS304 tray (3), exhaust fan (4), fan (5), lamp (6), sprayer pipe (7), nozzle sprayer (8). The fermentation outdoor part consists of an ECU unit (temperature control, humidity) (9). These components will work and be controlled or controlled by an electronic control unit that can be called an ECU. The ECU controls the outer and inner components according to the ideal temperature for the fermentation process, which is around 27-37 degrees Celsius (Wijanarko & Hasanah, 2017) (Darmawan et al., 2022). For indoor temperature measurement, fermentation uses a thermocouple temperature sensor connected to a small monitor in the fermentation room.

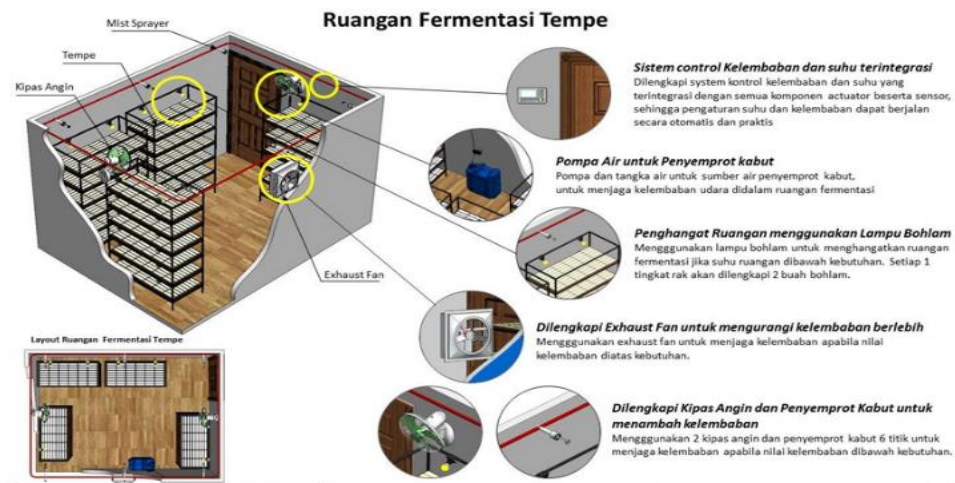


Figure 4. Tempeh fermentation room design

The technology of this tempeh fermentation room innovation is that if the thermocouple temperature sensor detects the fermentation room temperature below 27°C, the ECU will turn on the burner to help raise the temperature in the fermentation room and still lower the rotation of the exhaust fan or fan so that the ideal temperature of fermentation can be achieved. If the thermocouple temperature sensor detects the fermentation temperature above 37°C, the ECU will turn on the water DC motor which will turn on the sprayer to spray water splashes in the fermentation room to lower the indoor temperature so that the ideal temperature in the fermentation room is achieved (Irawan et al., 2022). The design of the tempeh fermentation room is made of large capacity and the tray container is made of 304 stainless steel which is food grade standard which is safe for food ingredients and does not change the taste and nutrition of the food ingredients, and stainless steel is also a lightweight material and will not rust. The ECU can work automatically which makes tempeh producers not have to maintain the fermentation room and measure it every few hours so that it can increase the productivity of their tempeh products. The advantage of the tempeh fermentation room is better control of fermentation parameters (Rahmad et al., 2017). By using automatic sensors and controls, temperature, humidity, and air circulation can be regulated with precision (Yunas & Pulungan, 2020) (Fitriana et al., 2024). In addition, some models of tempeh fermentation chambers are equipped with a visual monitoring feature, so that manufacturers can monitor the fermentation process in real-time. With the innovation of the tempeh fermentation room, it is hoped that it can increase the productivity and overall quality of tempeh. In addition, the use of this innovation can also provide advantages for tempeh producers in improving production efficiency and expanding their market by offering better tempeh to consumers.

Manufacturing and Engine Performance Testing

The manufacturing process and machine performance testing are carried out to realize the product and ensure that the tempeh fermentation room can function properly and according to the needs of the user.



Figure 5. Manufacturing and Performance Testing of Tempeh Fermentation Chamber Machine

Training and Mentoring

Training on the use of the tool is carried out so that partners can use and utilize tempeh fermentation room technology to improve the quality and productivity of tempeh. In addition, assistance is carried out to monitor the extent of technology transfer achievement.

Implementation and Handover to Partners

In the field of production, 1 unit of tempeh fermentation room was created and applied to partners so. able to increase the productivity and quality of tempeh as well as increase the skills of partners in TTG operation due to the training in the operation and maintenance of TTG tempeh fermentation rooms. In addition, improvements in product packaging have been realized by using higher quality materials and labels, so that it is able to increase the number of sales. In addition, the existence of management training related to digital marketing is also able to improve product branding through digital marketing in e-commerce.

Handover and application of tools to partners to increase partner production capacity and improve the quality of the tempeh produced.



Figure 6. Implementation and handover to partners

Monitoring and Evaluation

Periodic monitoring to determine the performance of tempeh production when using the machine. The monitoring data is used for evaluation materials.

The usefulness of this innovation has a social impact, namely increasing people's income and improving health and nutrition. Production has increased, making income also increase. In addition, the community's need for vegetable protein is abundant and this can improve the quality of health and nutrition in the community. The economic impact of this innovation is that the welfare of farmers and the tempeh industry increases because the amount of production increases. Another economic impact is the increase in tempeh export capabilities where this can affect the country's economy and society. Improving product packaging using higher quality materials and making product label designs can increase the number of sales after training and mentoring. Improvements have also been made to marketing methods that were initially conventional, now they are more modern with training and assistance related to online marketing in e-commerce(Wasil et al., 2023)(Gumilang, 2019).

CONCLUSIONS

The conclusion of this community service program activity is to increase production capabilities and increase consumers with appropriate technological innovations, namely the tempeh fermentation room equipped with temperature and air humidity regulators applied to partners accompanied by training and assistance on how to operate and market more modern products. So, skills such as idea development and TTG operation skills are needed to increase consumer needs and product promotion. The solution to increase the capacity of partner products is the implementation of TTG in the form of a tempeh fermentation room. Furthermore, the solution to increase the number of partner turnover is to improve product packaging, switch marketing methods from conventional to modern through e-commerce, and improve product quality supported by the TTG of the tempeh fermentation room.

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