

Training and assistance of black garlic production in Waru Village, Parung District, Bogor Regency

Sukrianto ^{a,1,*}, Dessy Iriani Putri ^{a,2}, Tia Astika Endah Permatasari ^b, Danindra Ziva ^a, Sri Wahyuni ^a

^a Faculty of Agriculture, University of Muhammadiyah Jakarta, Jl. K.H. Ahmad Dahlan, Ciputat Timur, Tangerang Selatan 15419, Indonesia

^b Faculty of Medicine and Health, University of Muhammadiyah Jakarta, Jl. K.H. Ahmad Dahlan, Ciputat Timur, Tangerang Selatan, Indonesia

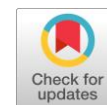
¹ sukrianto@umj.ac.id; ² dessy.irianiputri@umj.ac.id

* Corresponding Author

Received 22 October 2024; accepted 27 December 2024; published 30 December 2024

ABSTRACT

The Family Empowerment and Welfare Program (PKK) plays an important role in improving family welfare in Waru Village, Parung District, Bogor Regency. Since the COVID-19 pandemic, public awareness of health has increased, making it essential to implement a program for developing innovations in processing garlic into black garlic within the PKK of Waru Village. Black garlic is known to have greater health benefits compared to regular garlic, particularly as an antioxidant and immunity booster. This program involves several stages, including socialization, training on black garlic production, the application of fermentation technology, and assistance to ensure the success of black garlic production and marketing. Evaluation results indicate a significant improvement in participants' knowledge and skills regarding the production process and the benefits of black garlic, as measured through pre-test and post-test assessments. This program is expected to empower the community in the long term, both in terms of health and economic benefits, through the commercialization of black garlic products.



KEYWORDS

Antioxidant
Assistance
Black garlic
Fermentation
Training



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1. Introduction

PKK, an acronym for Pemberdayaan dan Kesejahteraan Keluarga (Family Empowerment and Welfare Program), has the main duties and functions (Tupoksi) as stated in Presidential Regulation No. 99 of 2017, Article 11, which include the following: internalizing and practicing Pancasila values; mutual cooperation; food security; clothing; housing and household management; education and skills development; health; the development of cooperative living; environmental sustainability; and healthy planning. Meanwhile, the provisions regarding the methods for implementing the master plan and strategy for the PKK movement are regulated under the Ministry of Home Affairs Regulation No. 36 of 2020. According to Ministry of Home Affairs Regulation No. 36 of 2020, PKK is one of the community institutions at the village/urban village level that facilitates community participation in family welfare empowerment. It operates at the neighborhood association (Rukun Warga or RW) and community unit (Rukun Tetangga or RT) levels, or equivalent, coordinating Dasawisma groups. In running the PKK Movement, the village head establishes a Village PKK Steering Team (TP PKK Desa), which is typically chaired by the village head's spouse.

The Tim Penggerak Pemberdayaan dan Kesejahteraan Keluarga (Family Empowerment and Welfare Steering Team), abbreviated as TP PKK, serves as a government partner and collaborates with other community organizations/institutions. Its functions include acting as a facilitator, planner, implementer, controller, and motivator at various levels to ensure the successful execution of PKK programs. Therefore, PKK plays an important role in improving family welfare. The role of PKK in improving family welfare is also carried out by the TP PKK of Waru Village. As a partner of the village government, TP PKK plays a vital role in the development of Waru Village, Parung District, Bogor Regency. The responsibilities of TP PKK in Waru Village include enhancing the services of Integrated Health Service Posts (Posyandu), Environmental Security Posts (Poskamling), cultivating Family Medicinal Plants (Toga),

promoting the concept of a Healthy Home in Waru Village, restructuring administrative processes, mentoring youth and Karang Taruna (Community Youth Development), providing community coaching, and assisting with administrative activities in the village for the benefit of the community.

Since the COVID-19 pandemic, public awareness of the importance of maintaining health has significantly increased, including among the residents of Waru Village, Parung District, Bogor Regency. Several programs have been implemented by the PKK of Waru Village to promote community health, such as the cultivation of Family Medicinal Plants (Toga) and the promotion of Healthy Homes in Waru Village. However, the PKK of Waru Village still needs innovative programs to further enhance its efforts. One program that could be adopted is the processing of garlic into black garlic. In addition to boosting the immune system, the production of black garlic can also strengthen family economic resilience by commercializing the processed black garlic.

Garlic (*Allium sativum*) has been used worldwide for over 4,000 years as a traditional medicine, known for its antioxidant properties [1]. However, many people are reluctant to use garlic due to its strong odor and bitter taste when consumed raw. In fact, the pungent odor and bitterness of garlic can be eliminated through a heating process. Heating at temperatures above 60°C inhibits the activity of the enzyme alliinase, which plays a role in converting alliin compounds into allicin in garlic [1].

Black garlic is made by fermenting garlic through a specialized process, making it distinct from regular garlic and providing additional benefits [2]–[4]. Black garlic contains antioxidants that are highly beneficial for the body. During its production, the temperature and moisture levels used in the fermentation process significantly influence its effectiveness. Black garlic is also rich in nutrients, such as proteins and unique compounds, offering even greater health benefits than regular garlic [5]–[8]. The blackening of garlic into black garlic is caused by the Maillard reaction. The Maillard reaction happens in three stages. In the initial stage of heating, the condensation of sugar groups and amine groups happens, but the resulting color is not yet significantly brown. In the second stage, the garlic begins to turn brown, and in the final stage, the reaction produces a black color due to caramelization and the formation of polyphenols. The process of heating garlic into black garlic involves temperatures between 60–70°C over a duration of 5–45 days [9], [10].

It is essential to control the temperature and moisture levels during fermentation to produce high-quality black garlic. Therefore, community empowerment and assistance are needed to help people understand the benefits of black garlic and acquire the skills to produce it. The knowledge and skills gained through community empowerment programs are expected to increase public awareness of consuming black garlic as a supplement to boost immune system resilience. In general, the fermenters used for producing black garlic are CAMION (Black Garlic Fermentation Machine) (Putri, 2020). However, in this program, a simpler technology is used, namely a rice cooker. The rice cooker was chosen as a simpler alternative because it is easier for PKK members to use and more affordable.

The purpose of this activity is to enhance community knowledge and understanding of the benefits of black garlic, as well as to foster interest and awareness in producing, consuming, and marketing black garlic. This program contributes by increasing the capacity of the community, particularly members of the PKK in Waru Village, through training and assistance in black garlic production. Through this initiative, the community gains new knowledge and skills in processing garlic into a value-added product. Furthermore, the program helps utilize local potential, namely garlic, by transforming it into a high-value economic product (black garlic), contributing to the diversification of local products and the improvement of community income.

The implications of this article are that it can serve as a model for other universities to adopt in implementing community service programs focused on skill development and economic sustainability. Additionally, it can inspire other communities to leverage local potential and establish MSMEs (Micro, Small, and Medium Enterprises) based on value-added products, thereby driving rural economic growth.

2. Method

The activity was conducted from July to December 2024. The program partners were members of the PKK in Waru Village, Parung District, Bogor Regency, consisting of four pokja (working groups). The program was done in several stages: socialization, training, technology application, and evaluation.

The socialization phase was conducted before the training sessions. Its purpose was to introduce the community service team and provide a brief explanation of the activities to be carried out during the program. The training sessions included delivering material on the health and immunity benefits of black garlic and hands-on practice in producing black garlic. Both the material presentation and the practical sessions were conducted by the academic team, accompanied by student members. After the participants were trained on the benefits of black garlic and the process of converting garlic into black garlic, the next stage involved the application of fermentation technology. The technological innovation applied in this program is the introduction of a black garlic fermenter. Typically, black garlic production uses fermenters such as CAMION (Black Garlic Fermentation Machine) (Putri, 2020). However, this program used a simpler technology, a rice cooker. The rice cooker was chosen as a simpler alternative because it is easier for PKK members to use and more affordable.

The evaluation conducted in this program focuses on understanding, skills, and welfare improvement. The understanding evaluation measures the target participants' increased comprehension of the material presented. This evaluation was carried out twice using pre-test and post-test assessments. The same set of questions was given to the same participants at different times—before and after the explanation regarding the benefits and production of black garlic. The use of pre-test and post-test was chosen because it is effective in evaluating the learning outcomes of training participants [11]. The results from the pre-test and post-test will be analyzed using a paired sample t-test. A paired sample t-test is a comparative hypothesis test used to determine whether there is a significant difference in the averages of two related or paired samples [12]. The paired sample t-test will be conducted using SPSS software, with the following hypotheses:

- H0: There is no difference in participants' knowledge scores before and after the intervention.
- H1: There is a difference in participants' knowledge scores before and after the intervention. The test criterion is to accept H₀ if Sig ≤ α 0.05

The evaluation of black garlic production practices is measured based on the average percentage of black garlic products that meet a quality standard of over 75%. The evaluation of the welfare of target participants is assessed based on the income generated from the production and marketing of black garlic.

3. Results and Discussion

3.1. Socialization

The program began with a socialization session for the PKK members of Waru Village to introduce the community service program. During this session, the importance of product innovation, such as black garlic, and its marketing opportunities to increase family income was explained. This activity was conducted on August 27, 2024. The Community Service Team show in Fig. 1.



Fig. 1. The Community Service Team, Along With The PKK Leaders Of Waru Village, during The Socialization Session

3.2. Black Garlic Production Training

The training session was conducted on September 2, 2024, and covered several key topics:

- The Health Benefits of Black Garlic

This topic was presented by Prof. Dr. Tria Astika Endah Permatasari, S.KM., M.KM. During the session, black garlic was introduced as an alternative herbal remedy with various health benefits, including boosting the immune system, helping to regulate cholesterol levels, and acting as a powerful antioxidant. These benefits are attributed to the active phenolic compounds and their derivatives in black garlic, which enable its use as an effective antioxidant [9], [13]–[17]. Black garlic is the result of aging raw garlic through high-temperature heating under controlled humidity for a specific period, which increases its reducing sugar and alkaloid content, resulting in therapeutic effects such as antioxidant, antitumor, and immune-boosting properties [18]. The compounds S-allyl cysteine and diallyl disulfide in black garlic have been scientifically proven to exhibit anticancer effects. Black garlic contains 143 kcal of energy, 14.29 grams of carbohydrates, 3.57 grams of protein, 7.14 grams of fat, 3.6 grams of fiber, 571 mg of sodium, 71 mg of calcium, 4.3 mg of vitamin C, and 1.29 mg of iron.

- Black Garlic Production Process

The black garlic production process was presented by Ir. Sukrianto, M.A. During the training, participants were introduced to a simple technology using a rice cooker for garlic fermentation, chosen for its affordability and accessibility to the community. The process begins by preparing a clean rice cooker and lining its base with 6–8 sheets of tissue paper. Garlic cloves are then placed tightly in the first layer, covered with another 6–8 sheets of tissue, followed by the second layer of garlic. This process is repeated until all layers are prepared, with the final layer also covered with 6–8 sheets of tissue. The rice cooker is then sealed tightly, plugged in, and set to the "warm" mode (not "cook") for 15 days to allow the fermentation process to happen [19], [20].

- Black Garlic Marketing

This topic was presented by Dessy Iriani Putri, S.P., M.Si. Participants received basic marketing training covering topics such as pricing strategies and the use of digital platforms, including social media, to expand market reach. The session also addressed market opportunity identification, which included market analysis, industry trends, and aligning interests with capabilities. Market analysis involves understanding consumer needs and preferences. Industry trends are observed by tracking current business developments, such as lifestyle changes, technological innovations, or regulatory shifts that could create new opportunities. Identifying market opportunities based on interests and capabilities involves selecting businesses aligned with the entrepreneur's interests and skills, as this alignment can increase the probability of success. The community service team took a group photo with the PKK members after the training session was completed as show in Fig. 2.



Fig. 2. The Community Service Team Took A Group Photo With The PKK Members After The Training Session Was Completed

3.3. Technology Implementation

As part of the technology implementation, participants were provided with rice cookers and raw materials to begin production. A total of 8 rice cookers were distributed to 4 PKK working teams in Waru

Village, with each team receiving 2 units. Each team was also supplied with 4 kg of single- clove garlic and tissue paper to support the fermentation process. This simple technology significantly accelerated the production of black garlic, which typically requires more expensive commercial fermentation equipment. The result of this technology implementation was the creation of a black garlic product by the Waru Village PKK under the brand name “Bawang Hitam KABITA as show in Fig. 3.



Fig. 3. Black Garlic Product of Waru Village PKK “Bawang Hitam KABITA”

The production of black garlic using a 6L rice cooker required 15 days at a temperature of 60– 70°C. Heating black garlic at 60–70°C increased its reducing sugar content [21]. This duration was longer compared to using CAMION (Black Garlic Fermentation Machine). The reduction in moisture content was faster when using CAMION compared to a rice cooker. On the 14th day, the moisture content of black garlic using CAMION was 33.63% [22], while on the 15th day, the moisture content of black garlic using a rice cooker was 53.60% [23]. However, despite the longer fermentation process, the PKK members of Waru Village, as target participants, preferred using rice cookers due to their practicality as show in Fig. 4.



Fig. 4. (Left) Training Participants Arranging Garlic in the Rice Cooker; (Right) Community Service Team Assisting in Weighing the Garlic

3.4. Activity Evaluation

Understanding was evaluated through pre-test and post-test assessments to measure the participants' knowledge improvement. The evaluation results indicated a significant increase in the participants' knowledge based on the comparison between the pre-test and post-test scores. The training provided proved effective in enhancing the participant's understanding of the black garlic production process, its health benefits, and strategies for marketing the product. The comparison of pre-test and post-test scores, illustrating the knowledge improvement of the participants, is shown in the Fig. 5.

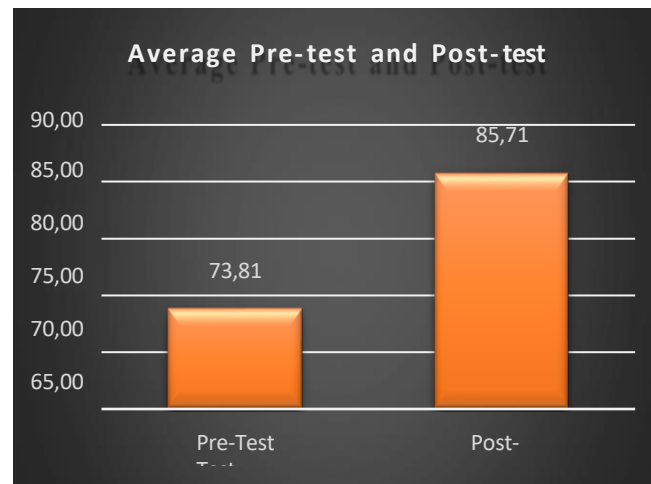


Fig. 5. Average Pre-test and Post-test Result

The Fig. 5 illustrates a significant difference between the pre-test and post-test scores of the participants. Before the training, the average pre-test score was recorded at 73.81. After the training, there was an increase in the post-test score, with an average of 85.71. This indicates an improvement in the participants' understanding of the benefits and production of black garlic by 16.12%. This improvement clearly reflects the participants' higher comprehension of the material after attending the training.

Not only was there a striking difference in the average scores but this knowledge improvement was also supported by a more in-depth statistical analysis using the Paired Samples t-test. This test was employed to evaluate whether the difference between the pre-test and post-test scores was statistically significant. The results confirmed that the participants' knowledge improvement did not occur by chance but was a direct outcome of the training intervention provided.

Table 1. Sig. (2-tailed) Value

Paired Differences	T	Df	Sig. (2-tailed)
Pre-test – Post-test	-7.072	13	0,000

The Sig. (2-tailed) value indicates the probability/p-value from the Paired Samples t-Test, with a result of 0.000. This value confirms that there is a significant difference in the knowledge of the training participants/partners before and after the program, with a p-value < 0.05 (95% confidence level). Overall, the results obtained from the pre-test and post-test measurements, as well as the paired samples t-test, reveal that this activity had a significantly positive effect on the participants. It is hoped that the knowledge gained will not only benefit the participants in the short term but also be applicable in the long term and quickly implemented in the partners' business activities. The evaluation of skills was measured based on the successful production of black garlic. The skills evaluation indicated that the target participants acquired the ability to produce black garlic after completing the training. From 32 kg of garlic processed, the participants successfully produced 24 kg of black garlic. The shrinkage rate of garlic into black garlic over 18 days is approximately 10% [23], meaning that 32 kg of garlic would theoretically yield 31.68 kg of black garlic. Thus, the participants' success rate in producing black garlic was 75%, which met the predetermined target. These results align with the findings of Putri et al [24], which indicated that training methods and materials significantly affect participants' competencies, including knowledge, skills, and attitudes. They also correspond with Hadi's [25] program, which showed that training effectively increases the knowledge and understanding of PKK women's groups.

The welfare evaluation of the target participants was measured based on the income generated from selling the black garlic they produced. In one month or two production cycles, the participants successfully sold 16 pieces of 80-gram black garlic, 68 pieces of 150-gram black garlic, 62 pieces of 200-gram black garlic, and 41 pieces of 200-gram black garlic. As a result, the income generated amounted to Rp4,545,000 in one month. This indicates that the community empowerment program effectively improved the participants' economic well-being. The economic improvement achieved through training in the

empowerment program aligns with the concept of enabling, which involves creating an environment that fosters the development of community potential and empowering, which strengthens the potential already possessed by the community. The training provided in this community empowerment program was also highly successful. This success is attributed to the strong and positive correlation between training and income, better training leads to higher income.

4. Conclusion

The innovation implemented in this community empowerment program was the production of black garlic from raw garlic using rice cooker technology, which not only provides health benefits as an antioxidant but also has the potential to enhance family income through product commercialization. The program consisted of several stages, including socialization, black garlic production training, fermentation technology implementation, and evaluation. The outcome of the training was that the PKK of Waru Village successfully produced a commercialized black garlic product under the brand name "Bawang Hitam KABITA." The evaluation results showed a 16.12% increase in participants' knowledge of the production process and benefits of black garlic after the training, a 75% success rate in production, and an additional income of IDR 4,545,000. This program not only provided short-term positive impacts for the participants but is also expected to empower them in the long term through the development of a black garlic commercial business.

Acknowledgment

We extend our gratitude to the Directorate of Research, Technology, and Community Service (DRTPM) under the Directorate General of Higher Education, Research, and Technology, Ministry of Education, Culture, Research, and Technology of the Republic of Indonesia, as the funding institution with the main contract number: 066/E5/PG.02.00/PM.BATCH.2/2024 and derivative contract numbers: 1045/LL3/DT.06.01/2024 and 115/R.UMJ/VIII/2024. We also express our gratefulness to the Regional Higher Education Service Institution (LLDIKTI) Region III, Universitas Muhammadiyah Jakarta, the Research and Community Service Institution (LPPM UMJ), as well as the Faculty of Agriculture and Faculty of Medicine and Health Sciences of UMJ for their support and facilities provided.

Declarations

Author contribution. All authors contributed equally to the main contributor to this paper. All authors read and approved the final paper.

Funding statement. None of the authors have received any funding or grants from any institution or funding body for the research.

Conflict of interest. The authors declare no conflict of interest.

Additional information. No additional information is available for this paper.

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