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Organic Fertilizer and Biopesticide Production from Fruit-Vegetable Waste in Kasang Kota Karang Village

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ABSTRACT

Kasang Kota Karang is a village located in Kumpeh Ulu Subdistrict, Muaro Jambi Regency, Jambi Province, where most residents engage in vegetable and fruit farming. However, local farmers face challenges such as suboptimal crop growth and yields, as well as high infestation rates of plant pests and diseases, particularly in red chili cultivation. In response, a community service team from the University of Jambi collaborated with farmers through dialogue and participatory discussions to identify a potential solution: utilizing the abundant fruit and vegetable waste available in the farming area to produce Liquid Organic Fertilizer (LOF) and biopesticides. This program aimed to enhance farmers' knowledge and skills in waste processing technology and to improve their income through the potential commercialization of LOF and biopesticide products. The approach used was Participatory Rural Appraisal (PRA), emphasizing active engagement of the farming partners throughout the implementation process. Evaluation results indicated a significant increase in farmers' understanding and technical capabilities, with over 90% demonstrating improved proficiency. The farming partners expressed strong enthusiasm and commitment to applying and scaling up the use of LOF and biopesticides in their vegetable farming practices, contributing to better crop yields, increased income, and improved environmental health.

Keywords: Biopesticide; Crop Yield; Organic Material; Plant Intruder Organisms; Red Chili

INTRODUCTION

Kasang Kota Karang is a village located in Kumpeh Ulu Subdistrict, Muaro Jambi Regency, Jambi Province, and is recognized as a central vegetable production area. The village supplies a significant portion of vegetables to local markets and supermarkets in Jambi City. Among the crops cultivated, red chili is the most widely grown, followed by shallots and other vegetables (Ansar et al., 2019; Mulyono et al., 2019).

However, red chili cultivation in this village faces several challenges, including slow plant growth, low yields, and frequent attacks from Plant Disturbing Organisms (PDOs) (Morris et al., 2007; Sasson 2012). To address these issues, farmers often rely heavily on inorganic fertilizers and synthetic pesticides (Bajewa et al., 2020; Srivastav, 2020). While these agrochemical inputs may offer short-term solutions, their excessive and prolonged use has detrimental effects on crop health and the environment, ultimately threatening the sustainability of red chili farming (De Costa et al., 2021; Gupta et al., 2022).

An alternative and more sustainable solution lies in utilizing the abundant vegetable and fruit waste produced locally (Ajila et al., 2011; Augustin et al., 2019). These organic wastes can be processed into liquid organic fertilizer (LOF) and biopesticides, both of which can improve plant growth and protect crops from pest

attacks (El-Abbasi et al., 2016; Marrone, 2019). Laboratory studies have shown that LOF derived from fruit and vegetable residues contains essential macro- and micronutrients such as N, P, K, Ca, Mg, and S (ranging from 101 to 3,771 mg/L) as well as Fe, Mn, Cu, and Zn (ranging from 0.2 to 0.62 mg/L), making it comparable in efficacy to a combination of 5 tons/ha of manure and 10 kg/ha of urea (Litbang Pertanian, 2007; Tedesco et al., 2021). Furthermore, the pressed residue can be utilized as feed for poultry and ruminants.

Biopesticides also offer notable advantages over synthetic alternatives (Lengai & Muthomi, 2018; Kumar et al., 2021). They are inexpensive, environmentally friendly, non-toxic to crops, compatible with other pest control methods, and do not contribute to pest resistance (Fathy, 2012; Khandelwal et al., 2016; Romeh, 2018). However, their limitations include slower action, sensitivity to sunlight, shorter shelf life, and the need for repeated applications (Irfan, 2016; De Corato U, 2019). Research by Novalina et al. (2019) demonstrated that ingredients such as bamboo shoots, banana stems, fruits, noni fruit, kirinyuh leaves, and tobacco have positive effects on test insects when used in biopesticide formulations.

Despite the potential benefits, several challenges prevent farmers from utilizing organic waste for LOF and biopesticide production (Jouzi et al., 2016; Durán-Lara et al., 2020). These include: (1) limited knowledge about types of organic materials and their benefits for crop growth; (2) lack of awareness regarding the potential of fruit and vegetable waste as raw materials for LOF and biopesticides; and (3) insufficient technical skills in processing organic waste into effective agricultural inputs.

Previous studies have explored the nutrient content and effectiveness of organic fertilizers and biopesticides, yet few have focused on the integration of waste management, farmer empowerment, and sustainable input production at the community level. The research gap lies in practical, participatory approaches that equip local farmers with both knowledge and skills to independently produce and apply these alternatives. This study introduces a novel model of community-based organic input production using locally available waste, thereby promoting sustainable agriculture and economic resilience.

The objective of this initiative is to enhance farmers' knowledge and skills in converting fruit and vegetable waste into liquid organic fertilizer and biopesticides, with the broader goals of improving crop yields, ensuring healthier produce, and providing an additional source of family income.

METHODS

This community service program employed the Participatory Rural Appraisal (PRA) approach, which emphasizes the active participation of community members in identifying problems and implementing locally appropriate agricultural solutions (Darmawati et al., 2008; Usadolo & Caldwel, 2016). The program was conducted over an 8-month period, from April to November 2022, in Kasang Kota Karang Village, Muaro Jambi Regency. The primary partner for the program was the Bina Lestari Farmers Group, consisting of 25 male and female members actively engaged in vegetable and fruit farming.

The program was carried out through the following structured activities:

1. Classroom-based sessions using lectures and group discussions to introduce concepts of organic waste utilization.
2. Demonstrations on the techniques of processing vegetable and fruit waste into Liquid Organic Fertilizer (LOF) and biopesticides.
3. Hands-on practical sessions where participants independently produced LOF and biopesticides under supervision.
4. Evaluation and monitoring to assess knowledge transfer, participant engagement, and application potential.

For LOF production, the materials used included:

1. 10 kg of chopped vegetable and fruit waste,

2. 400 mL of EM-4 microbial decomposer,
3. 200 g of brown sugar,
4. 2 kg of chicken manure,
5. 200 g of shrimp paste (terasi),
6. 40 L of clean water,
7. and a 50 L plastic container with a lid.

All materials were mixed thoroughly, sealed, and left to ferment for two weeks. The lid was opened briefly every two days to release gas buildup. Successful fermentation was indicated by a change in color, the emergence of a fermented (tape-like) smell, and visible morphological decomposition of the organic matter (Kasmawan, 2018; Yonathan et al., 2021).

For biopesticide formulation, the ingredients used were:

1. 100 g of red chili peppers,
2. 1 L of water,
3. 10 g of detergent.

The chili peppers were boiled for 15–20 minutes, cooled, filtered, and then mixed with detergent. The resulting solution was stored and used as a natural pesticide for pest control (BPTP Bengkulu, 2013; Stejskal et al., 2021).

The program evaluation was conducted in three stages:

1. Pre-implementation evaluation aimed at identifying the initial conditions of local resources (natural and human) and the challenges faced by the farmers.
2. Mid-implementation evaluation assessed participant engagement, understanding, and activeness during the training sessions.
3. Post-implementation evaluation measured the overall effectiveness of the program in achieving its intended learning outcomes.

A structured evaluation instrument in the form of a questionnaire was developed to collect data. The instrument included both closed and open-ended questions, categorized under three key indicators:

1. Knowledge acquisition: measured through questions testing recall and comprehension of core concepts (e.g., definition, benefits, materials used in LOF and biopesticide production).
2. Skill mastery: assessed through participants' ability to correctly demonstrate each step of LOF and biopesticide preparation.
3. Application potential: evaluated via self-reported readiness and intention to adopt or expand the practices learned.

Each participant's response was scored using a binary scale (1 = Yes, 0 = No), and results were aggregated and analyzed using descriptive statistics. Program success was indicated if at least 80% of participants demonstrated adequate understanding and capability in applying the technologies introduced.

In addition to the questionnaire, qualitative data were gathered through focus group discussions and spontaneous Q&A sessions between participants and facilitators. These discussions provided deeper insights into participant perspectives and perceived benefits of the training.

RESULTS AND DISCUSSIONS

The 2022 community service program PPM) conducted by the Graduate Program of Jambi University began with an initial coordination meeting with the leadership of the Bina Lestari Farmer Group in Kasang Kota Karang Village, Muaro Jambi Regency, Jambi Province. This initial stage focused on determining the implementation site, scheduling activities, preparing the necessary materials and tools, and selecting the chili farm where organic liquid fertilizer (POC) and biopesticides would be applied.

Figure 1. Saung as a Place for PPM Activities and Red Chili Plantations for POC and Biopesticide Applications

Following this, the team delivered educational materials and conducted training sessions on the production of POC and biopesticides. Participants, 25 farmers from the Bina Lestari group were provided with printed handouts to serve as training guides. The training took place in a local communal shelter (saung) and featured interactive discussions between facilitators and participants. The discussions revealed participants' strong interest in understanding the purpose, benefits, and potential of producing POC and biopesticides from locally abundant vegetable and fruit waste.

Figure 2. Presentation of Materials and Discussions with PPM Participants (Manager and Members of Bina Lestari group)

Subsequent activities included practical demonstrations and hands-on sessions. Participants actively prepared the materials and tools, chopped the vegetable and fruit waste into small pieces to accelerate decomposition, and measured the ingredients based on recommended proportions. This participatory process, aligned with the Participatory Rural Appraisal (PRA) method, encouraged dynamic collaboration between the farmer group and facilitators.

Figure 3. Preparation of Materials Needed for Making POC

Figure 4. Choaring Vegetables and Fruits as Raw Materials for POC

In the final stage of POC production, all materials were mixed and placed into composting containers (decomposers), then left to ferment for two weeks. Upon inspection, the resulting POC exhibited the expected characteristics: a change in color, a distinctive fermentative odor (similar to tape), and complete decomposition of solid ingredients. This indicated the successful production of liquid organic fertilizer.

Figure 5. Stirring All the Ingredients that have been Prepared and Put into the Decomposer

Figure 6. Fiinished and Filtered POC

The next phase involved the preparation of biopesticides using red chili extract.

Figure 7. Preparation of Biopesticide using Red Chili as the Main Ingredient: (a) Required Materials, (b) Boiling of Red Chili, (c) Filtering the Boiled Solution, (d) Adding Detergent

The process included boiling the chilies, filtering the solution, and mixing it with detergent to produce a natural pesticide suitable for pest control in chili farming.

Figure 8. Application of POC and Biopesticide

The program concluded with the field application of both the POC and the biopesticide on a chili plantation owned by a member of the Bina Lestari group.

To evaluate the program's effectiveness, a three-stage assessment was conducted: (1) initial evaluation of participants' baseline knowledge and local resources, (2) mid-activity evaluation to gauge engagement and comprehension, and (3) final evaluation to measure learning outcomes. The final evaluation showed a significant increase in participants' understanding from 56.67% to 97.33% as determined by their ability to correctly answer questions related to the training content. This surpasses the success benchmark of 80% comprehension set by previous guidelines (Darmawati et al., 2008).

These findings indicate that the program was successfully implemented and achieved its intended objectives. The PRA approach proved effective in fostering active participation, encouraging knowledge exchange, and enabling the co-creation of practical innovations by the farmer group. Participants not only understood the techniques introduced but also expressed readiness to adopt and scale up POC and biopesticide production using locally available resources, offering a sustainable and environmentally friendly alternative to chemical inputs.

CONCLUSION

Based on the outcomes of the Community Service Program (PPM) conducted by the Graduate Program of Jambi University in Kasang Kota Karang Village in 2022, it can be concluded that the program was successfully implemented and achieved its objectives. A significant 97.33% of participants (out of 25 individuals) showed a marked increase in understanding regarding the technology for processing vegetable and fruit waste into Organic Liquid Fertilizer (POC) and biopesticides. The farmer group is now prepared to develop and transfer the acquired knowledge to other farmer groups in Kasang Kota Karang Village, thereby expanding the benefits of this technology.

The produced POC and biopesticides will be utilized to control Plant Pest Organisms (OPT), particularly on chili plants, with the aim of reducing maintenance costs, producing healthier crops, and minimizing reliance on synthetic chemicals that could harm the environment. Furthermore, the participants expressed strong enthusiasm for scaling up this technology from household level to industrial scale, which is expected to increase the financial income of the farmer group.

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It is our sincere hope that the knowledge and skills shared during this activity will be beneficial in encouraging sustainable agricultural practices and improving environmental awareness within the community.

REFERENCES

Ajila, C. M., Brar, S. K., Verma, M., & Rao, U. J. S. P. (2011). Sustainable Solutions For Agro Processing Waste Management: An Overview. In *Springer eBooks* (pp. 65–109). https://doi.org/10.1007/978-94-007-1591-2_3

Ansar, M., Wahyudi, I., & Tangkesalu, D. (2019). Growth and yield of shallots planted between chili plants. *AGROLAND the Agricultural Sciences Journal (e-Journal)*, *6*(2), 63–70. http://jurnal.untad.ac.id/jurnal/index.php/AgrolandInternational/article/download/12144/10407

Augustin, M., Sanguansri, L., Fox, E., Cobiac, L., & Cole, M. (2019). Recovery of wasted fruit and vegetables for improving sustainable diets. *Trends in Food Science & Technology*, *95*, 75–85. https://doi.org/10.1016/j.tifs.2019.11.010

Baweja, P., Kumar, S., & Kumar, G. (2020). Fertilizers and pesticides: Their impact on soil health and environment. In *Soil biology* (pp. 265–285). https://doi.org/10.1007/978-3-030-44364-1_15

BPTP. (2013). Technical Instructions for Making Botanical Pesticides [in Bahasa]. *BPTP Bengkulu.* BPPP, Kementrian Pertanian.

Darmawati, Nieldalina, & Moehar, D. (2008). *PRA (Participatory Rural Appraisal): An Effective Approach to Support the Implementation Of Participatory Extension in Efforts to Accelerate Agricultural Development* [in Bahasa]. Jakarta. Bumi Aksara

De Corato, U. (2019). Improving the shelf-life and quality of fresh and minimally-processed fruits and vegetables for a modern food industry: A comprehensive critical review from the traditional technologies into the most promising advancements. *Critical Reviews in Food Science and Nutrition*, *60*(6), 940–975. https://doi.org/10.1080/10408398.2018.1553025

De Costa, D. M., De Costa, J. M., Weerathunga, M. T., Prasannath, K., & Bulathsinhalage, V. N. (2021). Assessment of management practices, awareness on safe use of pesticides and perception on integrated management of pests and diseases of chilli and tomato grown by small-scale farmers in selected districts of Sri Lanka. *Pest Management Science*, *77*(11), 5001–5020. https://doi.org/10.1002/ps.6542

Durán-Lara, E. F., Valderrama, A., & Marican, A. (2020). Natural organic compounds for application in organic farming. *Agriculture*, *10*(2), 41. https://doi.org/10.3390/agriculture10020041

El-Abbassi, A., Saadaoui, N., Kiai, H., Raiti, J., & Hafidi, A. (2016). Potential applications of olive mill wastewater as biopesticide for crops protection. *The Science of the Total Environment*, *576*, 10–21. https://doi.org/10.1016/j.scitotenv.2016.10.032

Fathy, H. (2012). EcoSmart Biorational Insecticides: Alternative insect control Strategies. In *InTech eBooks*. https://doi.org/10.5772/27852

Gupta, A., Singh, U. B., Sahu, P. K., Paul, S., Kumar, A., Malviya, D., . . . Saxena, A. K. (2022). Linking soil microbial diversity to modern agriculture practices: A review. *International Journal of Environmental Research and Public Health*, *19*(5), 3141. https://doi.org/10.3390/ijerph19053141

Irfan, M. (2016). Testing of botanical pesticides against plant pests and diseases [in Bahasa]. *Jurnal Agroteknologi*, *6*(2), 39. https://doi.org/10.24014/ja.v6i2.2239

Jouzi, Z., Azadi, H., Taheri, F., Zarafshani, K., Gebrehiwot, K., Van Passel, S., & Lebailly, P. (2016). Organic farming and small-scale farmers: Main opportunities and challenges. *Ecological Economics*, *132*, 144–154. https://doi.org/10.1016/j.ecolecon.2016.10.016

Kasmawan, I.G.A, Sutap, N., dan Yuliara, I.M. (2018). The production of liquid organic fertilizer uses simple composting technology [in Bahasa]. *Buletin Udayana Mengabdi, 17*(2): 67-72.

Khandelwal, N., Barbole, R. S., Banerjee, S. S., Chate, G. P., Biradar, A. V., Khandare, J. J., & Giri, A. P. (2016). Budding trends in integrated pest management using advanced micro- and nano-materials: Challenges and perspectives. *Journal of Environmental Management*, *184*, 157–169. https://doi.org/10.1016/j.jenvman.2016.09.071

Kumar, J., Ramlal, A., Mallick, D., & Mishra, V. (2021). An overview of some biopesticides and their importance in plant protection for commercial acceptance. *Plants*, *10*(6), 1185. https://doi.org/10.3390/plants10061185

Lengai, G. M. W., & Muthomi, J. W. (2018). Biopesticides and their role in sustainable agricultural production. *Journal of Biosciences and Medicines*, *06*(06), 7–41. https://doi.org/10.4236/jbm.2018.66002

Litbang Pertanian. (2007). Utilization of vegetable and fruit waste as liquid organic fertilizer and animal feed [in Bahasa]. http://jakarta.litbang.pertanian.go.id.

Marrone, P. G. (2019). Pesticidal natural products – status and future potential. *Pest Management Science*, *75*(9), 2325–2340. https://doi.org/10.1002/ps.5433

Morris, M., Kelly, V. A., Kopicki, R. J., & Byerlee, D. (2007). Fertilizer Use in African Agriculture. *The World Bank eBooks*. https://doi.org/10.1596/978-0-8213-6880-0

Mulyono, D., Hilman, Y., Sastro, Y., & Setiani, R. (2019). Various cropping patterns of chili and shallot crops as land intensification program in some production centers. *IOP Conference Series Earth and Environmental Science*, *399*(1), 012082. https://doi.org/10.1088/1755-1315/399/1/012082

Novalina, N., Wilyus, W., Hanibal, H., & Sakrani, S. (2019). Potential of liquid organic fertilizer containing local microorganisms as biopesticide against insect pests in rice plants (*Oryza sativa* L) [in Bahasa]. *Seminar Nasional Pembangunan Pertanian Berkelanjutan Berbasis Sumber Daya Lokal*, 278–287. http://conference.unja.ac.id/SemnasSDL/article/download/38/26

Romeh, A. A. (2018). Integrated Pest Management for Sustainable Agriculture. In *The handbook*

of environmental chemistry (pp. 215–234). https://doi.org/10.1007/698_2018_267

Sasson, A. (2012). Food security for Africa: An urgent global challenge. *Agriculture & Food Security*, *1*(1). https://doi.org/10.1186/2048-7010-1-2

Srivastav, A. L. (2020). Chemical Fertilizers and Pesticides: Role In Groundwater Contamination. In *Elsevier eBooks* (pp. 143–159). https://doi.org/10.1016/b978-0-08-103017-2.00006-4

Stejskal, V., Vendl, T., Aulicky, R., & Athanassiou, C. (2021). Synthetic and natural insecticides: Gas, liquid, gel and solid formulations for stored-product and food-industry pest control. *Insects*, *12*(7), 590. https://doi.org/10.3390/insects12070590

Tedesco, D. E. A., Scarioni, S., Tava, A., Panseri, S., & Zuorro, A. (2021). Fruit and Vegetable Wholesale Market Waste: Safety and nutritional characterisation for their potential re-use in livestock nutrition. *Sustainability*, *13*(16), 9478. https://doi.org/10.3390/su13169478

Usadolo, S. E., & Caldwel, M. (2016). A stakeholder approach to community participation in a rural development project. *SAGE Open*, *6*(1). https://doi.org/10.1177/2158244016638132

Yonathan, C. J., Ristam, Y. P. G., Wijaya, V. A., & Krisbianto, O. (2021). Focus group discussion and quantitative sensory analysis to identify sensory parameters of new food product. *Journal of Tourism Culinary and Entrepreneurship (JTCE)*, *1*(1), 61–78. https://doi.org/10.37715/jtce.v1i1.1800