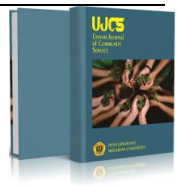
UJCS 5(4) (2024)

Unram Journal of Community Service

https://jurnalpasca.unram.ac.id/index.php/UJCS



Arduino-Based Moringa Cultivation and Innovation in Processed Moringa Products to Prevent Stunting, Cangkring Village, Jenggawah District, Jember Regency

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Received: October 31, 2024
Revised: November 25, 2024
Accepted: December 6, 2024
Published: December 31, 2024

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DOI: 10.29303/ujcs.v5i4.731

Abstract: The industrial era 4.0 is a new phase in the development of technology in agriculture. Technologies such as drones, sensors, cloud computing, and agricultural automation are examples of the use of the Internet of Things (IoT) as technological advances in agriculture. Moringa is rich in beneficial nutrients, especially for pregnant and lactating mothers so that it can prevent stunting. Internet of Things (IoT) technology is applied to monitor the growth conditions of Moringa in real time, increasing harvest yields in terms of quality and quantity. This program has proven effective in increasing the understanding of the Cangkring village community and can be used as a way to prevent stunting, as well as improve the quality of life in areas with a high prevalence of stunting

Keywords: Moringa; Stunting; IoT; Arduino

Introduction

Agriculture is one method to find food needs (Sandi & Fatma, 2023). Indonesia is a country with fertile soil texture, making it very suitable as a place for farming. Indonesia is in a tropical climate and is crossed by many volcanoes which make its soil fertile. However, many farmers in Indonesia still use conventional methods in cultivating their agricultural land. Efforts are needed to be able to adapt to the industrial era 4.0 which can increase agricultural efficiency and productivity.

The industrial era 4.0 is a new phase in the development of technology in agriculture. Technologies such as drones, sensors, cloud computing, and agricultural automation are examples of the use of the Internet of Things (IoT) as technological advances in agriculture (Fadhillah, 2024). The Internet of Things is a system that utilizes the internet to share data, so that human assistance is not needed to do something. Examples of IoT in the agricultural industry can help determine air temperature, soil humidity, smart sensors, automatic fertilizer application, and many other automations that can be done by utilizing this technology.

Moringa oleifera, better known as kelor, is a plant that is often found in home gardens and is known to be rich in macro and micro nutrients that are beneficial for pregnant women and toddlers. This plant has superior nutritional content, including protein, vitamins and iron. Moringa is able to meet children's daily nutritional needs of 42% protein, 125% calcium, 61% magnesium, 41% potassium, 71% iron, 31% vitamin A, and 22% vitamin C. A comparison of the nutritional content between fresh and dried moringa shows that fresh moringa has 3 times the potassium of bananas, 4 times the vitamin A of carrots, 7 times the vitamin C of oranges, 4 times the calcium of milk, and 2 times the protein of yogurt. Meanwhile, dried moringa has 15

How to Cite:
Saputra, R. D., Afidah, Z., Syahputra, D. S., Ardiansyah R, M., Maulida, Z., & Nuraini, L. (2024). Arduino-Based Moringa Cultivation and Innovation in Processed Moringa Products to Prevent Stunting, Cangkring Village, Jenggawah District, Jember Regency. *Unram Journal of Community Service*, *5*(4), 381–384. https://doi.org/10.29303/ujcs.v5i4.731

times the potassium of bananas, 10 times the vitamin A of carrots, ½ times the vitamin C of oranges, 17 times the calcium of milk, and 9 times the protein of yogurt. In addition, fresh and dried moringa have the same iron content, which is 25 times higher than spinach (Usman et al., 2023). Based on the nutritional content, moringa is recommended as a nutrient-rich supplement for breastfeeding mothers and children during growth.

Scientific research shows that innovation in processing moringa leaves in food can increase the weight of toddlers, because fresh moringa leaves contain 0.7 g of iron and 6.7 g of protein per 100 g. Protein, energy, fat, and iron in moringa play an important role in the formation of hemoglobin, so that the formulation of Moringa oleifera can prevent stunting in toddlers (Usman et al., 2023). Moringa has great potential to be developed both in terms of nutrition and health. This can be done through village empowerment programs.

Cangkring Village is part of Jenggawah District, Jember Regency, East Java Province, which was chosen as the location for the program implementation because this village has a fairly high prevalence of stunting. There were 27 cases of stunting recorded in January 2023 and 29 cases in February 2023. However, there was a decrease in stunting cases in December 2023 to 19 cases. The integration of Internet of Things (IoT) technology in this program aims to add significant value in optimizing moringa cultivation through real-time monitoring of environmental conditions, moringa plant growth and development, such as soil moisture, soil nutrient levels, and air humidity (Yasin and Hermawanto, 2019).

Method

In this study, the method used was a quantitative survey by distributing questionnaires to farmers who had planted moringa according to the developed guidebook. This questionnaire was designed to evaluate the effectiveness of the Arduino-based moringa cultivation guidebook, as well as to obtain input on the utilization of processed products..unique moringa such as moringa cookies and flour. A total of 20 farmers and mothers who process moringa who have used this guidebook were selected as participants in the study. The selection of participants was done purposively, namely based on the criteria that they have followed the cultivation methods described in the guidebook for at least one planting season.

The data analysis technique in this study used a Likert scale to measure the level of participant perception of the effectiveness of the Arduino-based moringa cultivation guidebook and the quality of processed moringa products such as moringa cookies and pudding. Each statement in the questionnaire was measured using a 5-point Likert scale, where participants were asked to indicate their level of agreement with the statement, with options ranging from "Strongly Disagree" to "Strongly Agree." The data obtained were then analyzed descriptively to calculate the average, median, and frequency distribution of participant responses. In addition, correlation analysis can also be carried out to see the relationship between perceptions of the cultivation guide and harvest results or levels of satisfaction with processed moringa products. The results of this analysis provide a comprehensive picture of the effectiveness of the guidebook and the acceptance of processed moringa products among farmers and the community.

Effectiveness of Technology-Based Moringa Culture Training in Cangkring Village

In an effort to overcome the problem of stunting which is still a serious challenge in Indonesia, especially in Cangkring Village, Jenggawah District, Jember Regency, a technology-based moringa cultivation training program has been implemented. Stunting, or a condition of stunted growth in children, is often caused by an unbalanced nutritional intake and a lack of maternal knowledge about health and nutrition. The Asian Development Bank (2022), reported that Indonesia ranks second in Southeast Asia in terms of stunting prevalence in children under five years of age, with a figure reaching 31.8% in 2022 (Budury et al., 2022). Cangkring Village was chosen as the location for implementing this program because of the high prevalence of stunting. This program aims to continue to reduce this figure through a holistic approach that combines technology and the use of local plants, namely moringa (Moringa oleifera).

*Moringa oleifera*better known as moringa, is a plant known to be rich in macro and micro nutrients that are very beneficial, especially for pregnant women and toddlers. This plant is able to meet the daily nutritional needs of children with very high protein, calcium, magnesium, potassium, iron, vitamin A, and vitamin C content (Usman et al., 2023). Based on this nutritional content, moringa is recommended as a nutrient-rich supplement for breastfeeding mothers and children during growth. Recent scientific research also shows that processing moringa leaves in food can increase toddler weight and prevent stunting, thanks to its high iron and protein content (Winarno et al., 2023).

This program not only focuses on the educational aspects of nutrition and health, but also integrates technology.*Internet of Things* (IoT) to optimize moringa cultivation. This technology allows real-time monitoring of environmental conditions and moringa plant growth, including soil moisture, soil nutrient levels, and air humidity, so that harvest yields can be increased in

terms of both quantity and quality (Yasin and Hermawanto, 2022).

Figure 1. Training in making derivative products from Moringa (Moringa oleifera)

To measure the effectiveness of this program, pretests and posttests were conducted on program participants to evaluate the increase in their knowledge and awareness of the importance of moringa and the use of technology in moringa cultivation. The pretest results showed that before the program was implemented, the majority of participants had a low understanding of the benefits of moringa and effective ways to cultivate moringa using technology. However, after participating in this program, the posttest results showed a significant increase in participants' knowledge and readiness to implement the knowledge they had gained. The following are the pretest and posttest results of the technology-based moringa cultivation education and innovation program in Cangkring Village:

Table 1. Pretest and posttest results of Cangkring village residents

Question	*Pretest* (%)		*Posttest* (%)	
	Yes	No	Yes	No
Do you know the potential of Moringa in preventing stunting?	10%	90%	95%	5%
Do you know the nutritional benefits contained in Moringa leaves?	15%	85%	98%	2%
Do you understand how to cultivate Moringa conventionally?	20%	80%	90%	10%
Do you know the benefits of IoT technology in moringa cultivation?	5%	95%	90%	10%
Are you ready to apply technology in moringa cultivation?	0%	100%	85%	15%
Do you know how to process moringa leaves into food products?	10%	90%	95%	5%
Do you understand the nutritional requirements required for moringa cultivation?	12%	88%	92%	8%
Do you know how to control pests and diseases in moringa plants?	8%	92%	89%	11%
Do you understand the importance of Moringa as a nutritional supplement for pregnant women and toddlers?	13%	87%	97%	3%
Do you know the steps to improve the quality of processed moringa products?	7%	93%	91%	9%
Average	10%	90%	98%	8%

The results of the pretest and posttest reflect the success of the program in improving participants' understanding, which is expected to contribute to reducing stunting rates in the area. The significant increase in posttest results indicates that the approach used in this program, namely a combination of nutrition education and technology, is effective in improving community knowledge and skills. This study also supports previous literature that emphasizes the importance of an integrative approach in community empowerment programs, especially in areas with a high prevalence of stunting (Budury et al., 2022; Winarno et al., 2023; Yasin and Hermawanto, 2022). With these results, the technology-based moringa cultivation training program in Cangkring Village can be used as a model for implementation in other areas with similar conditions, in order to achieve national goals in reducing the prevalence of stunting and improving the quality of life of the community as a whole.

Conclusion

The arduino-based moringa cultivation training program in Cangkring village aims to reduce stunting rates through the integration of technology and the use of moringa plants. Moringa is rich in beneficial nutrients, especially for pregnant and lactating mothers so that it can prevent stunting. Internet of Thing (IoT) technology is applied to monitor the growth conditions of moringa in real time, increasing harvest yields in terms of quality and quantity. This program has proven effective in increasing the understanding of the Cangkring village community and can be used as a way to prevent stunting, as well as improve the quality of life in areas with a high prevalence of stunting.

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