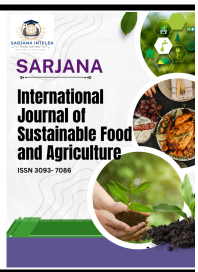
Sarjana International Journal of Sustainable Food and Agriculture

Journal homepage:
https://sarjanaintelek.my/index.php/sijsfa/index
ISSN: 3093-7086



Fermented Plant Juice: An Eco-friendly Approach to Crop Nutrition

Noor Zubaidah Abdul Rahman[1,*], Normala Ahmad[1]

[1] Faculty of Plantation and Agrotechnology, Universiti Teknologi MARA, Cawangan Melaka, Kampus Jasin, 77300 Merlimau, Melaka, Malaysia

ARTICLE INFO

Article history:
Received 18 February 2025
Received in revised form 14 April 2025
Accepted 13 May 2025
Available online 20 June 2025

Keywords:
Fermented Plant Juice (FPJ); sustainable agriculture; organic fertilizer

ABSTRACT

Sustainable farming depends on eco-friendly inputs like Fermented Plant Juice (FPJ) to meet the growing global food needs expected by 2050. Made from natural materials such as banana peels, alfalfa, or bamboo shoots using Korean Natural Farming methods, FPJ offers a green alternative to synthetic fertilizers. This review explores how FPJ is prepared, its nutrient content and its effects on crops like leaf mustard, pechay, tomatoes, head lettuce, and sweet basil. The process involves collecting plant parts in the morning, mixing them with sugar and fermenting for 5 to 15 days, which produces nutrients that vary by plant source. Research shows FPJ boosts plant growth, including taller stems, larger leaves, stronger roots and higher yields, with ideal dilutions differing by crop for instance, 2 tbsp/L for leaf mustard or 1.0% for sweet basil. These improvements come from nutrients like nitrogen and potassium, plus growth compounds like auxins and cytokinins released during fermentation. Unlike synthetic fertilizers, FPJ supports healthier soils and biodiversity, minimizing environmental damage.

1. Introduction

Sustainable agricultural practices rely heavily on environmentally friendly inputs to ensure the long-term health of farming systems [1]. One major obstacle in achieving this is the heavy reliance on specific fertilizer types [2]. Overuse of synthetic fertilizers carries serious risks, such as depleting soil nutrients and harming biodiversity. These practices also contribute to environmental damage, including water contamination from runoff and greenhouse gas emissions that threaten ecosystems. To meet the growing global food demand by 2050 while maintaining safe and sufficient yields, farmers must be encouraged to adopt greener alternatives that prioritize ecological balance. Fermented plant juice (FPJ), as a bio-fertilizer, exemplifies such an approach, offering a renewable, low-impact solution to enhance crop nutrition and soil health. Promoting these sustainable inputs is critical to balancing agricultural productivity with ecological preservation.

[*] *Corresponding author.*
E-mail address: noorzubaidah.nz@gmail.com

https://doi.org/10.37934/sijsfa.1.1.17

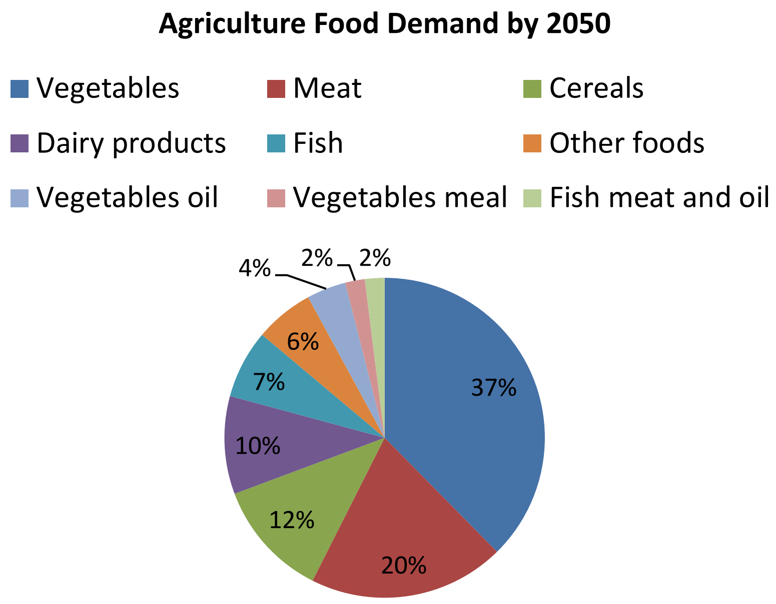


Fig. 1.Pie chart illustrating the projected agricultural food demand by 2050 [6]

Based on the pie chart above, it is evident that crops will constitute the most demanded food source by mid-century. As staple foods, crops serve as the primary carbohydrate providers [7] for nearly all countries, encompassing a diverse range of forms such as vegetables, cereals, fruits, and oils. While, demand for animal-based products like meat and fish is projected to be significantly lower. This dominance of crop-based foods underscores the urgent need to prioritize their safe and sustainable production. Ensuring crop cultivation methods that safeguard both human health and environmental integrity is critical, particularly as synthetic fertilizers—commonly used to boost yields—often degrade soil quality and harm ecosystems in long term.

Although the advantages of FPJ as a sustainable fertilizer are widely acknowledged, substantial gaps persist in the research about its optimal application across various crops and agro-ecological environments. Limited research systematically evaluates the performance of FPJ in comparison to synthetic fertilizers or investigates its long-term effects on soil microbial dynamics and nitrogen cycling. Moreover, discrepancies in preparation techniques and application procedures impede its extensive adoption. This review seeks to fill these gaps by assessing recent studies on the implementation of FPJ, identifying optimal practices, and emphasizing topics for further research to facilitate its incorporation into sustainable agricultural systems.

2. Fermented Plant Juice

Fermented Plant Juice (FPJ) is a bio-fertilizer derived from natural sources to support seed germination [9], soil health [10] and crop nutrition. It originated from the efforts by one of Korean Institute seeking to optimize crop production while ensuring environmental safety, leading to the development of Korean Natural Farming (KNF) techniques [11]. This approach emphasizes sustainability by promoting natural inputs, though it carefully balances resource use with agricultural outputs. Korean Natural Farming (KNF) emphasizes nurturing native microorganisms that boost soil health and plant growth [12]. In this approach, Fermented Plant Juice (FPJ) stands out as a method that uses fermentation to extract nutrients from plants and tap into microbial power, creating a sustainable way to improve crops. However, the type of plant or plant part used for FPJ such as leaves, shoots, or peels affects its nutrient content. It may only suit for certain crops based on their needs. This review examines recent research on how FPJ performs across various crops to highlight its potential and guide its use.

3. Preparation of FPJ

Deriving Fermented Plant Juice (FPJ) starts with gathering plant parts like tender leaves, shoots or fruits early in the morning, when they're packed with nutrients and moisture for top-notch fermentation [13]. Once collected, these plants are cut into small bits to increase their surface, making it easier for microbes to do their job. Next, the chopped pieces are blended with a sugar source such as molasses or plain white sugar to feed the local microorganisms that drive fermentation. The mix is then poured into a tightly sealed container to block out air and kept in a cool, shady spot to shield it from light damage. The duration of fermentation is a topic of contention; some farmers advocate for a 5-day period, while others favor 7 days to get a more thorough decomposition of plant chemicals. A 10-day fermentation is commonly seen as adequate for utilizing FPJ as a fertilizer; however, numerous specialists advocate for a 15-day period to maximize nutrient content and ensure stable microbial populations.

For consistent results, standardizing FPJ preparation is the key. Research suggests fermenting for 10–15 days strikes a balance between pulling out nutrients and keeping microbes healthy, with 15 days best for nitrogen-packed FPJ. Mixing plant material and sugar in equal parts encourages strong microbial growth while lowering contamination risks. Following Korean Natural Farming practices, morning harvests maximize nutrient quality. Keeping the mix at 20–25°C under air-free conditions also helps prevent spoilage, ensuring steady FPJ quality. These steps can streamline production, making FPJ practical for small farmers and larger operations alike.

4. Application and Efficacy in Agriculture

Table1
List of crop types evaluated for their response to Fermented Plant Juice (FPJ) application

Crop Types	Sources of FPJ	Author
Leaf mustard (*Brassica juncea*)	Mung bean (*Vigna radiata*), Banana pseudostem	Denona *et al.,* [14]
Pechay (*Brasicca rapa*)	Banana leaves (*Musa spp.)*	Diamante *et al.,* [15]
Tomato (*Solanum lycopersicum*)	Water spinach, Bamboo shoot	Alam *et al.,* [16]
Head lettuce (*Latuca saliva*)	Banana peels, *Arachis pintoi, Trichanthera gigantea*	Poliquit *et al.,* [17]
Sweet basil (*Ocimum basilicum*)	Alfalfa	Kisvarga *et al.,* [18]
Woolflower (celosia argentea)	Alfalfa	Bákonyi *et al.,* [19]
French marigold (*Tagetes patula*)	Alfalfa	Barna *et al.,* [20]
Chili pepper (*Capsicum annum*)	N/A	Paragsa *et al.,* [21]
Red pepper	Rice bran, Onion	Jang *et al.,* [22]

Denona *et al.,* [14] conducted a study to investigate the impact of varying FPJ strengths and fermentation durations on crop results and nutrient levels. The nitrogen and potassium levels were significantly increased by fermenting FPJ for 15 days, as opposed to lesser periods. A blend of 2 tbs/L was effective for leaf mustard (*Brassica juncea)*, enabling plants to absorb nutrients more efficiently. This mixture alone cultivated crops that were suitable for market, whereas weaker crops were produced by thinner or thicker dosages. The additional nitrogen likely stimulates processes such as photosynthesis and cell division, resulting in the development of larger, more robust plants. Using 2 tbs/L on leaf mustard could generate approximately 8000 kg per hectare, demonstrating the potential of FPJ to increase harvests.

The FPJ was extracted from banana leaves by Diamante *et al.,* [15] and tested on *Brassica rapa*, also known as pechay or pak choi. Four FPJ-to-water ratios were applied: 1:1, 2:1, 3:1 and 4:1. The 1:1 ratio resulted in the tallest plants, suggesting that the nutrient delivery was perfect. However, the leaf counts of the various mixtures did not vary significantly, indicating that FPJ prioritizes height over leafiness for pechay. This may be related to the high potassium content of banana leaf FPJ and growth stimulants such as gibberellins, which cause stems to be stretched more than they produce leaves.

Alam *et al,.* [16] investigated the effects of FPJ on tomato (*Solanum lycopersicu)* by incorporating bamboo stem and water spinach. They implemented it during the initial phases of growth and the blooming or fruiting process. This is likely due to the fact that juvenile shoots are abundant in auxins, which are growth hormones that induce cell stretching and splitting during fermentation. Consequently, bamboo shoot FPJ resulted in taller tomatoes. It was recommend the early use of shoot-based FPJ to increase the size of the plant. In contrast, water spinach FPJ developed leaves that were broader, likely as a result of the cytokinins or vitamins that were liberated during fermentation, which matched the plant's foliage growth rate. Both FPJ varieties accelerated the blooming and fruiting process in comparison to untreated tomatoes, demonstrating FPJ's capacity to expedite reproduction.

In a hydroponic system, Poliquit *et al.,* [17] evaluated the efficacy of FPJ from banana husks, *Arachis pintoi* and *Trichanthera gigantea* on head lettuce. The banana peel FPJ was the highlight, yielding lettuce with enhanced height, elongated leaves and a broader look. This advantage is likely the result of the substantial potassium, phosphorus, and auxin content of banana skins, which is released during fermentation. The other FPJ sources were behind in terms of their performance above ground; however, all three increased the length and strength of their roots. This root power implies that FPJ, regardless of its source, facilitates the absorption of nutrients by hydroponic plants, potentially through microorganisms or loose minerals. The banana peel FPJ dominated the yield charts, demonstrating its dominance in this configuration.

Kisvarga *et al*., [18] checked sweet basil with alfalfa FPJ at three levels, 0.5%, 1%,and 2.5% in water. The 1% mix grew the tallest stems and longest roots but 2.5% eased off those gains, pointing to a just right zone. Stem and root bulk also hit high at 1%, with stems 38% thicker than untreated basil. Stem weight stayed steady across doses, yet all FPJ plants crushed the control's skimpy mass. Root weight maxed at 1% and chlorophyll jumped most at 2.5%, up 19% from the control, likely from alfalfa FPJ's nitrogen surge. This designates 1% as the standard for basil's height, roots and vigour, providing herb cultivators with reliable guidance.

5. Impact of FPJ on Soil Physicochemical Properties

Harvests of black pepper (*Piper nigrum*) have been declining despite the continuous application of artificial fertilizers, even on fertile alluvial soils [23]. Deteriorating soil health is the primary factor, abbreviating the lifespan of pepper plants. An experimental approach involves saturating the soil with FPJ. This substance functions as a nutrient-rich fertilizer, sustains soil vitality and gradually reduces the necessity for chemical inputs. Furthermore, FPJ reduces expenses and mitigates pollution. In a comparative evaluation of various fertilizers, FPJ significantly increased soil bulk density and maintained tighter pore structure than chemical alternatives. These characteristics enhance soil's capacity to retain nutrients, minimizing leaching and increasing food availability for plants. Such advantages indicate that FPJ serves as a transformative solution for rehabilitating depleted soil, facilitating more sustainable and environmentally friendly black pepper cultivation.

6. Conclusion

This review highlights the importance of FPJ as an environmentally sustainable biofertilizer. Derived from Korean Natural Farming, FPJ utilizes natural plant components and microbial fermentation to provide vital nutrients and growth-enhancing compounds, hence improving crop performance. Experimental evidence demonstrates that the treatment of FPJ, optimized at concentrations such as 1:1 for pechay or 1.0% for sweet basil, markedly enhances plant height, root systems, leaf area, and yield, frequently exceeding that of untreated controls. The flexibility in nutrient composition, shaped by plant sources such as banana peels or bamboo shoots, enables FPJ to be customized for specific crop requirements, providing benefits over synthetic fertilizers that deteriorate soil and ecosystems over time. By diminishing dependence on chemical inputs, FPJ promotes enduring soil health, biodiversity, and environmental stability, sustainably satisfying the anticipated food demand of 2050. Nonetheless, issues regarding the time of fermentation and the consistency of applications necessitate additional investigation to guarantee consistent efficacy. Ultimately, FPJ presents a viable, sustainable alternative for crop nutrition, harmonizing agricultural productivity with ecological conservation and facilitating its wider use.

Additional research is necessary to fully realize FPJ's potential as a crucial component of sustainable agriculture. Optimizing fermentation processes through the identification of ideal durations and microbial inoculants for certain plant sources may enhance nutritional consistency and effectiveness. Longitudinal studies investigating the impact of FPJ on soil microbial diversity and nutrient cycling are crucial for understanding its role in the restoration of soil health, particularly in degraded environments. Comparative analyses contrasting FPJ with a broader range of synthetic and organic fertilizers would clarify its cost-effectiveness and environmental benefits across diverse agro-ecosystems. Moreover, assessing the scalability of FPJ, including automated production and storage systems, could enhance its adoption by large-scale farmers. These research avenues will augment the empirical foundation for FPJ, promoting its integration into global agriculture practices.

Acknowledgement
This research was not funded by any grant.

References

[1] Bhagat, Rakshit, Sohan Singh Walia, Kartik Sharma, Rajbir Singh, Gurshaminder Singh, and Akbar Hossain. "The integrated farming system is an environmentally friendly and cost-effective approach to the sustainability of agri-food systems in the modern era of the changing climate: A comprehensive review." *Food and Energy Security* 13, no. 1 (2024): e534. https://doi.org/10.1002/fes3.534

[2] Adnan, Nadia, Shahrina Md Nordin, Imran Rahman, and Amir Noor. "The effects of knowledge transfer on farmers decision making toward sustainable agriculture practices: In view of green fertilizer technology." *World Journal of Science, Technology and Sustainable Development* 15, no. 1 (2018): 98-115. https://doi.org/10.1108/WJSTSD-11-2016-0062

[3] Tripathi, Sachchidanand, Pratap Srivastava, Rajkumari S. Devi, and Rahul Bhadouria. "Influence of synthetic fertilizers and pesticides on soil health and soil microbiology." In *Agrochemicals detection, treatment and remediation*, pp. 25-54. Butterworth-Heinemann, 2020. https://doi.org/10.1016/B978-0-08-103017-2.00002-7

[4] Chen, Jiao, Shaoyu Lü, Zhe Zhang, Xuxia Zhao, Xinming Li, Piao Ning, and Mingzhu Liu. "Environmentally friendly fertilizers: A review of materials used and their effects on the environment." *Science of the total environment* 613 (2018): 829-839. https://doi.org/10.1016/j.scitotenv.2017.09.186

[5] Tian, Xiaoyu, Bernie A. Engel, Haiyang Qian, En Hua, Shikun Sun, and Yubao Wang. "Will reaching the maximum achievable yield potential meet future global food demand?." *Journal of Cleaner Production* 294 (2021): 126285. https://doi.org/10.1016/j.jclepro.2021.126285

[6] ABARES https://www.agriculture.gov.au/sites/default/files/sitecollectiondocuments/abares/publications/Outlook2012FoodDemand2050.pdf

[7] Kreitzman, Maayan, Eric Toensmeier, Kai MA Chan, Sean Smukler, and Navin Ramankutty. "Perennial staple crops: Yields, distribution, and nutrition in the global food system." *Frontiers in Sustainable Food Systems* 4 (2020): 588988. https://doi.org/10.3389/fsufs.2020.588988

[8] Bryant, Christopher J. "Plant-based animal product alternatives are healthier and more environmentally sustainable than animal products." *Future Foods* 6 (2022): 100174. https://doi.org/10.1016/j.fufo.2022.100174

[9] Mohd Zaini, Nurul Solehah, Hamidah Idris, Jamilah Syafawati Yaacob, Wan Abd Al Qadr Imad Wan-Mohtar, Nik Iskandar Putra Samsudin, Arina Shairah Abdul Sukor, Elicia Jitming Lim, and Muhamad Hafiz Abd Rahim. "The potential of fermented food from Southeast Asia as biofertiliser." *Horticulturae* 8, no. 2 (2022): 102. https://doi.org/10.3390/horticulturae8020102

[10] NEHA, PADALIYA. "AN APPRAISAL OF ENVIRONMENT FRIENDLY AGRICULTURAL PRACTICES IN NORTH INDIA." PhD diss., ICAR-NDRI, KARNAL, 2023.

[11] Keliikuli, Ana K. "Unraveling the Mystery of the Natural Farming System (Korean): Isolation of Bacteria and Determining the Effects on Growth." PhD diss., 2018.

[12] Cho, Youngsang. *(English) JADAM Organic Farming: ULTRA Powerful Pest and Disease Control Solution, Make all-Natural Pesticide, The way to Ultra-Low-Cost agriculture!*. JADAM, 2020.

[13] Miller, Sherri A., David M. Ikeda, Eric Weinert Jr, Kim CS Chang, Joseph M. McGinn, Cheyanne Keliihoomalu, and Michael W. DuPonte. "Natural Farming: fermented plant juice." *Tropical Agriculture and Human Resouces* 2 (2013): 1-7.

[14] Denona, Mylene A., Ardniel A. Baladjay, and Nicolas A. Turnos. "Enhancing leaf mustard (Brassica juncea L.) productivity using nitrogen-based fermented plant juice (FPJ)." *Journal of Agricultural Research, Development, Extension and Technology* 2, no. 1 (2020): 31-39. https://doi.org/10.5281/zenodo.8248046

[15] Diamante, Renante A., Noel A. Banca, Angie C. Almarza, Kenth Joshua B. Espina, and John Rey A. Alipe. "Performance and Growth of Pechay Using Fermented Plant Juice." *United International Journal for Research & Technology* 4 (2022).

[16] ALAM, MD AMIRUL, and FARZAD ASLANI. "EFFECTS OF FERMENTED PLANT JUICE AND FRUIT JUICE ON GROWTH AND YIELD OF TOMATO FOR SUSTAINABLE PRACTICES SITI ZAHARAH SAKIMIN, NUR AZWANI ABD RAHIM, ABDUL SHUKOR JURAIMI."

[17] Poliquit, Derby E., Louise R. Horca, Eliza V. Gamusa, and Nilda C. Jamin. "Banana peel, A. pintoi, and T. gigantea on fermented plant juice (FPJ) extracts and coco-water as growth and yield (Lactuca sativa L.) grown hydroponic systems." *Journal of the Austrian Society of Agricultural Economics* 17 (2021): 651-660.

[18] Kisvarga, Szilvia, Döme Barna, Szilvia Kovács, Gábor Csatári, Ibolya O. Tóth, Miklós Gábor Fári, Péter Makleit, Szilvia Veres, Tarek Alshaal, and Nóra Bákonyi. "Fermented alfalfa brown juice significantly stimulates the growth and development of sweet basil (Ocimum basilicum L.) plants." *Agronomy* 10, no. 5 (2020): 657. https://doi.org/10.3390/agronomy10050657

[19] Bákonyi, Nóra, Szilvia Kisvarga, Döme Barna, Ibolya O. Tóth, Hassan El-Ramady, Neama Abdalla, Szilvia Kovács et al. "Chemical traits of fermented alfalfa brown juice: Its implications on physiological, biochemical, anatomical, and growth parameters of Celosia." *Agronomy* 10, no. 2 (2020): 247. https://doi.org/10.3390/agronomy10020247

[20] Barna, Döme, Szilvia Kisvarga, Szilvia Kovács, Gábor Csatári, Ibolya O. Tóth, Miklós Gábor Fári, Tarek Alshaal, and Nóra Bákonyi. "Raw and fermented alfalfa brown juice induces changes in the germination and development of french marigold (Tagetes patula L.) plants." *Plants* 10, no. 6 (2021): 1076. https://doi.org/10.3390/plants10061076

[21] Paragsa, Emy Rose C., and Loid Ismael B. Pastrana. "Performance of chili pepper (Capsicum annuum L.) applied with different levels of fermented plant juice." PhD diss., Pilar Satellite College, Capiz State University, 2023.

[22] Jang, Se Ji, and Yong In Kuk. "Evaluation on the performance of red pepper (Capsicum annuum) and tomato (Lycopersicon esculentum) under various fermented liquid fertilizers." *Research on Crops* 21, no. 2 (2020): 306-314. http://dx.doi.org/10.31830/2348-7542.2020.053

[23] Kevin, M. T. S., O. H. Ahmed, C. Y. Khew, P. S. Lai, J. A. M. Zehnder, and Effendi W. Mohd. "Alluvial soil and pepper gas exchange properties enhancement with compost, fermented juices and biochar." (2021): 209-215.