Proceedings of International Conference on Technological and Social Innovations 2024

Agricultural Waste from Ladyfinger Banana Flower to Kombucha Products

Montha Meepripruk[1, a], Wilailak Suanmali[2,b], Naticha Saipechsanti[1,c], Kamonthip Hongsoongnoen[1,d] and Tharnomsup Seetawai[1,e]

[1]Faculty of Education, School of general science, Kamphaeng Phet Rajabhat University, 69 Moo1, Kamphaeng Phet, Thailand

[2]Faculty of Science and Technology, School of Enviromental science, Kamphaeng Phet Rajabhat University, 69 Moo1, Kamphaeng Phet, Thailand

[a]<montha_mee@hotmail.com>, [b]<aewilailak_s@hotmail.com>, [c]<aom0979231964@gmail.com>, [d]<kamonthip161245@gmail.com>, [e]<tharnomsup@gmail.com>

Keywords Agricultural waste, kombucha products, ladyfinger banana flower

Abstract. Agricultural waste was thrown away in Tha Phutsa Subdistrict, Kamphaeng Phet, such as ladyfinger banana blossoms. The utilization this waste for the production of value-added products, such as kombucha beverages, can result in a reduction of greenhouse gas emissions by approximately 1,760.20 $KgCO_2$/MJ. This innovation holds the potential to generate additional value ranging from 6,600 to 82,000 baht/ year. Among the ready-to-drink kombucha beverages derived from ladyfinger banana pollen tea, banana blossom tea, and honey lemon banana blossom tea, diluted at a ratio of 1:4 v/v, the most satisfying product was identified. It exhibited pH of 3.13, 3.12, and 2.73, respectively, while sweetness levels were measured at 13.20, 13.22, and 21.01 % Brix, respectively. Notably, no alcohol was detected. Market testing conducted at the Thai Banana Blossom Festival in Kamphaeng Phet from 2023, involving collaborative booth setups with entrepreneurs, revealed high customer satisfaction with kombucha from ladyfinger banana pollen tea.

1. Introduction

The environmental science and sustainable development principles inform efforts to integrate agricultural waste management practices into food production systems, thereby promoting resource efficiency, reducing environmental impact, and enhancing the sustainability of the food supply chain. By adopting a circular economy approach and leveraging innovative technologies, which can transform agricultural waste into valuable resources that contribute to a more sustainable and resilient food system. Agricultural waste contains valuable nutrients that can be recovered and upcycled into nutritious food products. For example, food processing by-products rich in proteins, fibers, and antioxidants can be transformed into functional ingredients for fortifying foods with nutritional value. Environmental science informs the development of techniques for extracting, purifying, and incorporating these nutrients into food formulations, while sustainable development principles guide the promotion of healthy and sustainable dietary patterns. Solid waste problems are becoming more and more severe according to the growth of urban society and the changing lifestyles of the people. Causes of increase in solid waste are population growth increase in industrials manufacturing urbanization and modernization [1]. When the situation of solid waste in Thailand is taken into consideration, it has been found that solid waste tends to increase every year with the slightly increasing proportion of solid waste that has been disposed of and utilized [2].

Tha Phutsa Subdistrict, Khlong Khlung District, Kamphaeng Phet Province, has a large area of cultivated ladyfinger banana tree. The area for ladyfinger banana tree cultivation is 275 rai (approximately 110 acres), with each rai able to accommodate around 320-400 ladyfinger banana tree per year. One ton of ladyfinger banana tree yields approximately 88,000 - 110,000 ladyfinger bananas

blossom, equivalent to 2,200 - 27,500 kilograms per year, generating an income of 6,600 - 82,000 baht per year [3]. Farmers remove the ladyfinger bananas blossom to reduce competition for nutrients among the banana fruits and dispose of them by burying them to create compost. This exemplary application of economic models such as the Bio Economy, Circular Economy, and Green Economy aligns with Sustainable Development Goals, which targets ending hunger, achieving food security, and promoting sustainable agriculture. The production process adheres to principles of sustainable agriculture and environmental conservation.

Ban Pruek Makrut, Tha Phutsa sub-district, Khlong Khlung district, Kamphaeng Phet province, the community enterprise group utilizes ladyfinger bananas blossoms to create two types of tea: ladyfinger bananas pollen tea and ladyfinger bananas blossom tea. This initiative aims to promote an environmentally friendly lifestyle while reducing agricultural waste and adding value to discarded peels. It serves as a source of income and contributes to natural resource conservation, supporting the concept of a circular economy. These teas are rich in betacarotene, anthocyanin, and antioxidants, offering various health benefits including skin, eye, and overall health protection. Despite their nutritional value, the tea bags have not gained expected popularity, prompting entrepreneurs to consider developing new products. These functional beverages, derived from ladyfinger banana blossom tea and ladyfinger banana pollen tea, aim to promote health and can serve as snacks for government agencies or as welcome gifts for visitors to the Tha Phutsa community. Which is kombucha, a popular beverage fermented from black or green tea and sugar with a symbiotic culture of bacteria and yeast (SCOBY), offers various health benefits due to its rich content of polyphenols and valuable metabolites. Its probiotic content supports digestive health, while compounds like D-saccharic acid-1,4-lactone (DSL) have potential liver function stimulation and cancer-preventive effects.

Based on the information provided, the researchers are interested in developing value-added beverage products from ladyfinger banana flowers. These products include ladyfinger banana pollen tea, ladyfinger banana blossom tea, and ladyfinger banana pollen tea with honey lemon aim to create functional beverages that offer health benefits, utilizing scientific knowledge to enhance the product's value. This initiative is expected to increase income for entrepreneurs by offering innovative and beneficial beverage options.

2. Material and Methods

2 . 1 The estimation for greenhouse gas (GHG) emissions from agriculture waste management in a life Cycle perspective [4]. Calculating greenhouse gas emissions from agriculture waste landfills with equation: Amount of greenhouse gas emissions from the base case (refer with: Eq. (1),

$$(kgCO_2eq) = (W\ food * EF\_swd\ food) + (Wgarden * EF\_swd\ garden). \quad (1)$$

2.2 Preparation of Kombucha

2.2.1 Material

The material consisted of two types of ladyfinger banana flower tea: ladyfinger banana blossom tea, and ladyfinger banana pollen tea and banana pollen tea with honey and lemon juice.

2.2.2 Preparation of Kombucha

The 65 grams of sugar (65.0 g/L, 6.5%), 10 grams (10.0 g/L, 1.0%) of ladyfinger banana blossom tea (S1) and ladyfinger banana pollen tea (S2) and juice and banana pollen tea (S2) with honey and lime juice (S3), and 1 liter of distilled water (90 ^{o}C) were mixed and heat until boiling for 10 min, then filter through cheesecloth and pour into a sterilized glass bottle. After cool drown to 27$\pm$3 ^{o}C, add 100 grams of the kombucha starter cultures consisted of sour broth and cellulosic layer (SCOBY) floating on the liquid surface. The kombucha starter cultures also known as SCOBY (which generally consists of Acetobacter xylinum, Gluconobacter, S. cerevisiae), were obtained from

a commercial source from Thailand. Cover the glass bottle with a clean white cloth, incubated at 27±3 ºC in the dark for 1-14 days [5] (refer with: Fig. 1)

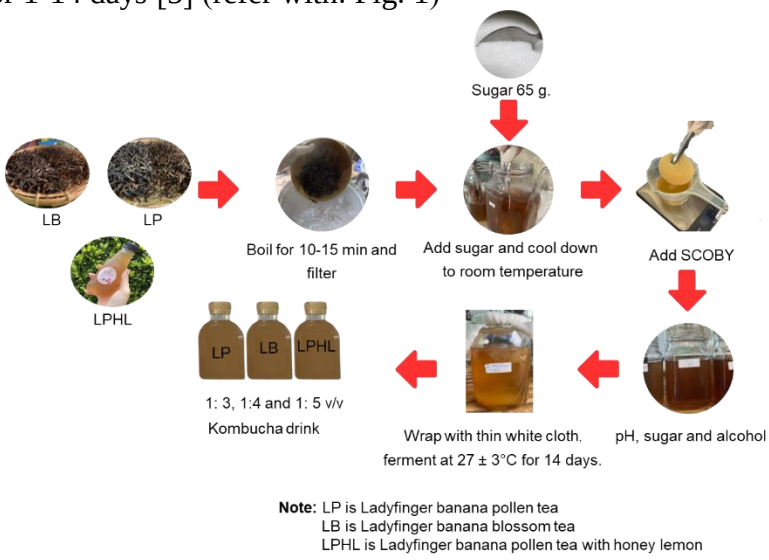


Fig. 1. The production process of kombucha cultures.

2.3 Fermentation of Kombucha

Kombucha cultures were kept under aseptic conditions. Fermentation was carried out by incubating the kombucha culture at 27 ± 3 ◦C for 14 days. The collecting samples at 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13 and 14 days this call " Kombucha culture" , filtered and analyzed the pH, sweetness, alcohol.

2.3.1 Kombucha drink

The Kombucha drink prepare by used 3 sample of kombucha, ferment for 14 days, dilute in the ratio 1:3, 1:4 and 1:5 then analyzed the pH, sweetness (Sugar), alcohol. Testing the satisfaction of stakeholders and consumers with kombucha products from all 3 samples. Select the sample in the ratio with the most satisfaction to conduct the analyzed product preferences and sensory quality assessment (refer with: Fig. 2).

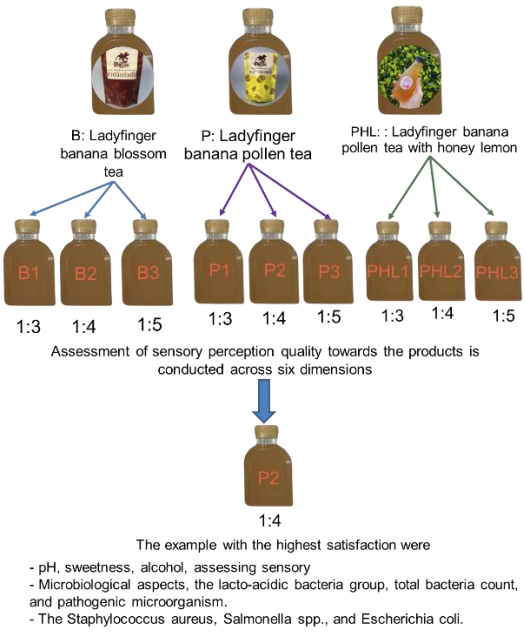


Fig. 2. The dilution and testing of kombucha drink.

2.4. The determination of pH

The pH of the 3 fermented beverages was determined by a pH meter (Mettler Toledo Instruments; Switzerland).

2.5. The determination of Sugar Content

The total sugar content was measured with a Brix/ Specific gravity refractometer (w/ ATC) from Brix scale.

2.6. The determination of alcohol

The alcohol content was calculated from website: https://www.northernbrewer.com/-pagesrefractometer –calculator from percent (%).

2.7 Sensory analysis

The three types of brewed kombucha, diluted in a ratio of 1:4 (v/v), were evaluated for sensory quality by sensory panelists, using six sensory attributes: color, clarity, aroma, taste, ease of swallowing, and overall preference. Each panelist provided a preference score ranging from 1 to 9 based on their satisfaction with each kombucha product sample. A total of 30 individuals participated in the sensory evaluation, which took place during the Thai Banana Blossom Festival in Kamphaeng Phet between October 5th and 15th, 2023. The data collected from the google form and calculate the percentage, mean, and standard deviation.

2.8 The market testing

The market testing was conducted by participating in collaborative booth setups with other entrepreneurs at an event of the Thai Banana Blossom Festival in Kamphaeng Phet from October 5th to 15th, 2023. The data collected from the google form and analyze consumer satisfaction and feedback data on kombucha products.

2.9 Statistical Analysis

In all the experiments, three samples were analysed, and all the assays were carried out at least in triplicate. The statistical analysis was performed using SPSS and Microsoft Excel 2003. The results are expressed as percentage, mean values and standard deviation (SD).

3. Results

3.1 Greenhouse gas emission

Greenhouse gas emissions values for tree branch waste management leaves by landfill method (Type of landfill without management system, more than 5 meters deep) and large plot of Ban Thong Khung bananas, Tha Phutsa Subdistrict, Khlong Khlung District. Kamphaeng Phet Province The area for ladyfinger banana tree cultivation is 275 rai (approximately 110 acres), with each rai able to accommodate around 320-400 ladyfinger banana tree per year. One ton of ladyfinger banana tree yields approximately 88,000 - 110,000 ladyfinger bananas blossom, equivalent to 2,200 - 27,500 kilograms per year, generating an income of 6,600 - 82,000 baht [3] by the community cutting and discarding the banana blossoms to reduce food competition for the banana fruit, calculated as the amount of greenhouse gas emissions from this equation (1) is (kgCO2eq) = (W food*EF_swd food) + (Wgarden*EF_swd garden) will decrease approximately 1,760.20 $KgCO_2$/MJ.

3.2 Kombucha product

The three examples of fermented beverages were ladyfinger banana blossom tea, ladyfinger banana pollen tea, and ladyfinger banana pollen tea with honey lemon kombucha with fermented for a period of 14 days (refer in Fig. 3).

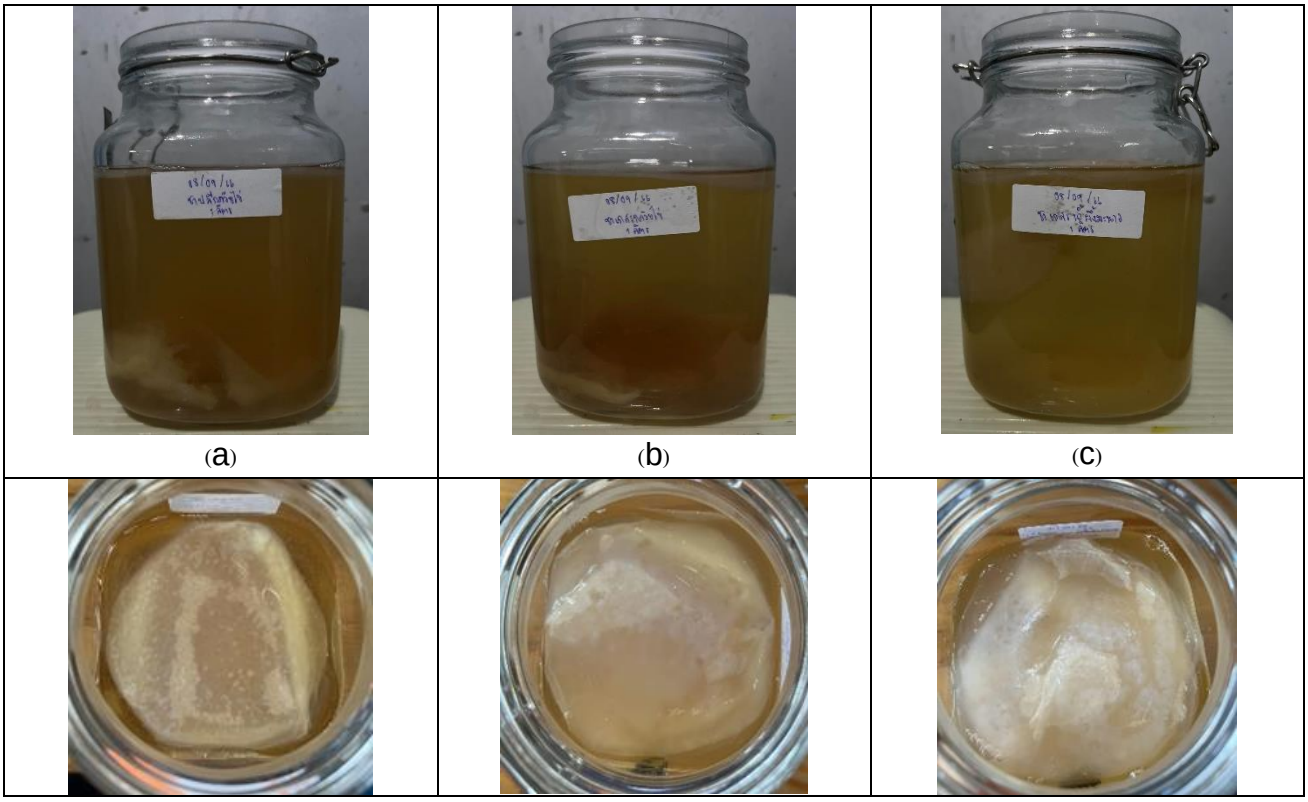


Fig. 3. The 3 types Kombucha (a) S: Ladyfinger banana blossom tea
(b) S2: Ladyfinger banana pollen tea and
(c) S3: S2 with honey and lime juice.

3.3 The pH between fermentation days of fermented broth kombucha (refer with: Fig.4)

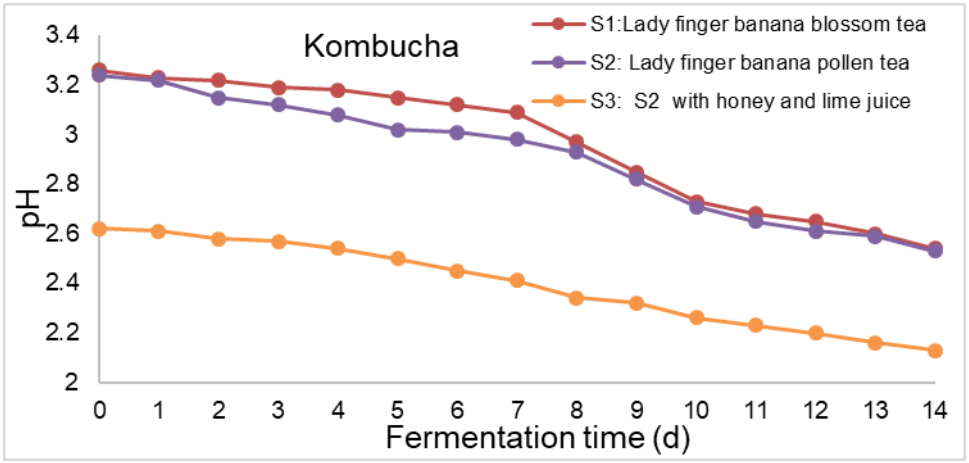
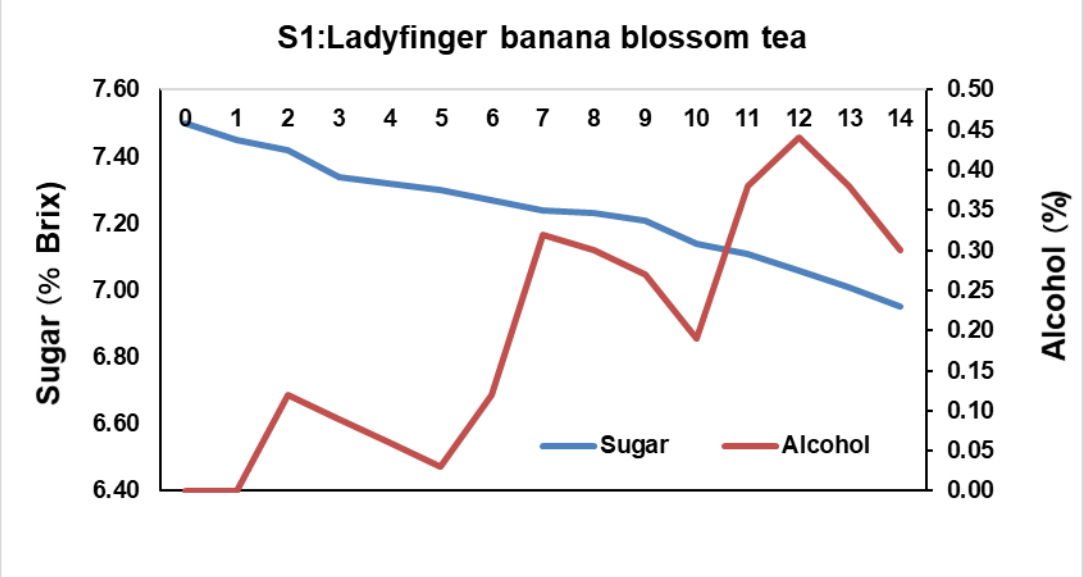


Fig. 4. The pH between fermentation days of fermented broth kombucha.

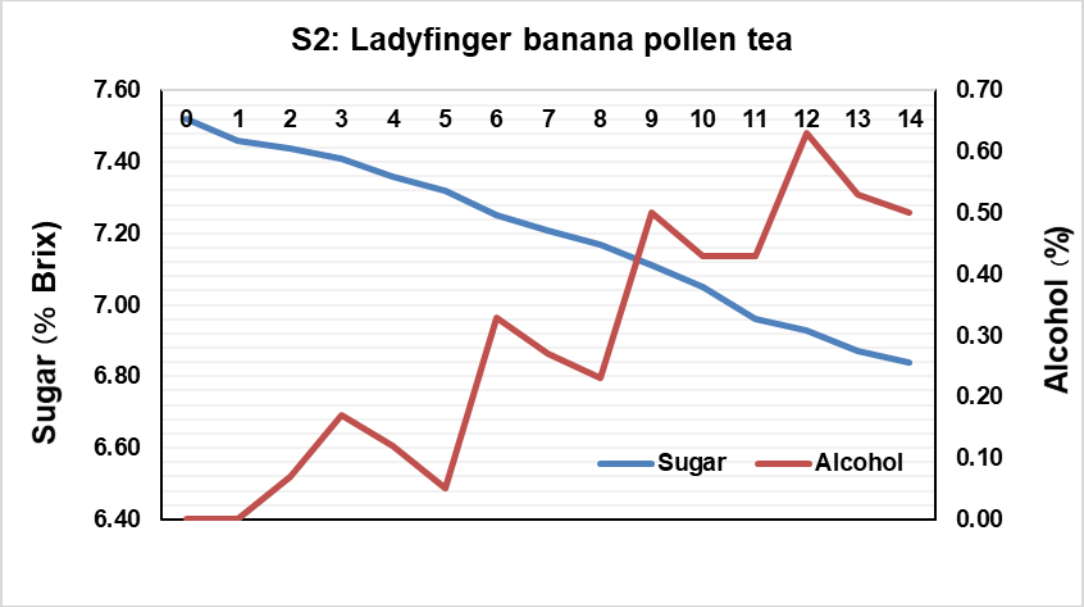
The pH values of kombucha products from S1: Ladyfinger banana blossom tea and S2: Ladyfinger banana pollen tea and S3: ladyfinger banana pollen tea (S2) mixed with honey lemon decrease over the fermentation period. The pH decreases from 3.26 and 3.24 to 3.09 and 2.98, respectively, on day 7 of fermentation, and further decreases from 2.54 and 2.53, respectively, by day 14. Meanwhile, ladyfinger banana pollen mixed with honey lemon decreases from 2.62 to 2.41 on

day 7 and continues to decrease to 2.13 by day 14 (refer with: Fig.4), there is a continuous decreasing trend in the pH values of all three kombucha products. The pH values of all kombucha types fall within the standard range set by the Food and Drug Administration [6], which specifies that the suitable pH range is between 2.5 and 4.2. Prolonged kombucha fermentation results in a decrease in pH due to the accumulation of acetic acid in the product [6].

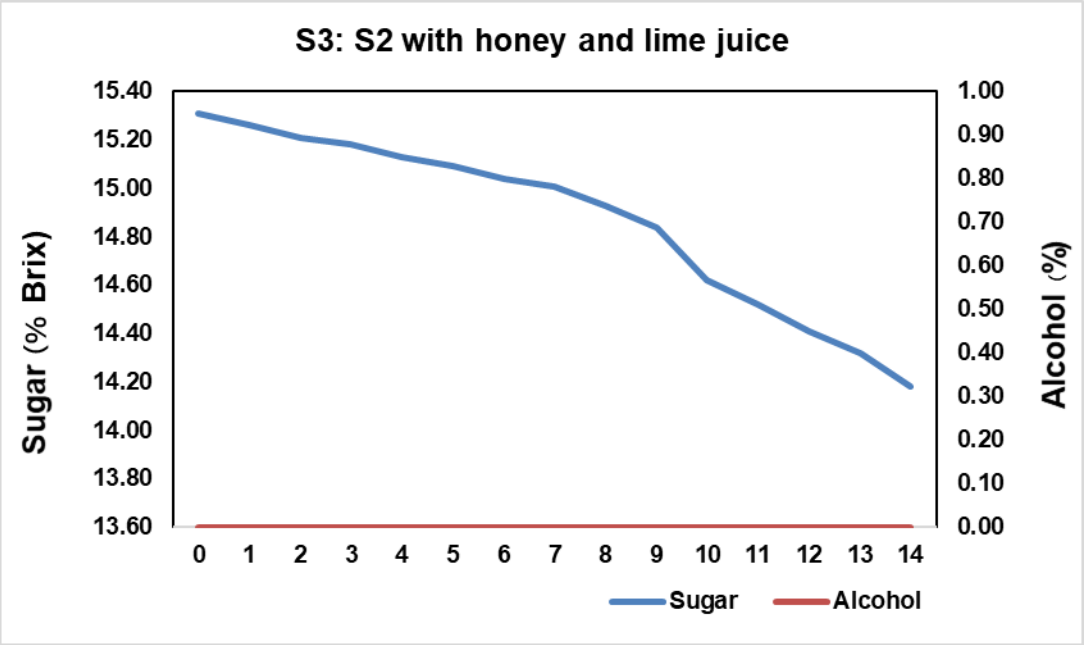
3.4 The sugar and alcohol between fermentation days of fermented broth kombucha (refer in Fig. 5).



(a)



(b)



(C)

Fig. 5. The sugar and alcohol content between fermentation days of fermented kombucha (a) S1: Lady finger banana blossom tea (b) S2: Lady finger banana pollen tea and (c) S3: S2 with honey and lime juice.

The sweetness levels of Kombucha cultures from S1: ladyfinger banana blossom tea, S2: ladyfinger banana pollen tea, and S3: ladyfinger banana pollen tea (S2) mixed with honey and lime decrease over the fermentation period. At day 0 of fermentation, the %Brix values for the Kombucha cultures from S1: ladyfinger banana blossom tea, S2: ladyfinger banana pollen tea, and S3: ladyfinger banana pollen tea (S2) mixed with honey and lime are 7.50, 7.52, and 15.31, respectively. By day 7 of fermentation, these values decrease to 7.24, 7.21, and 15.01 %Brix, respectively, and continue to decrease consistently to 6.95, 6.84, and 14.18 %Brix, respectively, by day 14 of fermentation. The decrease in sugar content during fermentation is attributed to the consumption of sugar by yeast and acetic bacteria, which utilize sugar as a carbon source for growth and produce various organic acids [7, 8]. For appropriate sugar consumption levels for each age group, it is recommended that children and adults over 60 years old consume no more than 16 grams of sugar per day, equivalent to about 4 teaspoons of sugar. Adolescents aged 14 - 25 should not exceed 24 grams of sugar per day, equivalent to about 6 teaspoons of sugar. For individuals engaging in high energy activities, sugar consumption should not exceed 32 grams per day, equivalent to about 8 teaspoons of sugar. The World Health Organization (WHO) recommends consuming no more than 6 teaspoons of sugar per day, or approximately 24 grams [9].

The alcohol content of the kombucha cultures from ladyfinger banana pollen tea and ladyfinger banana blossom tea was not detected on days 0 and 1 of fermentation. Alcohol was first detected on day 2 of fermentation, with values of 0.12% and 0.07%, respectively. By day 14, the alcohol content of the kombucha cultures from ladyfinger banana flowers and ladyfinger banana shoots increased to 0.30% and 0.50%, respectively. However, no alcohol content was detected in the Kombucha culture from ladyfinger banana pollen mixed with honey and lime. This absence of alcohol may be due to acetic acid bacteria, which can convert sugar into polysaccharides or cellulose on the surface of the kombucha when oxidative alcoholysis occurs, resulting in no alcohol content in the Kombucha [10].

Observations suggest that the kombucha culture from ladyfinger banana pollen tea mixed with honey and lemon produces agar more rapidly and abundantly compared to the cultures from ladyfinger banana pollen tea and ladyfinger banana blossom. The alcohol content of Kombucha in ready-to-drink containers must comply with regulations for beverages in sealed containers, with an alcohol content not exceeding 0.5% by weight [11]. The level of alcohol in kombucha is of specific concern to industries due to regulatory requirements in several countries, mandating that the alcohol content remains below 0.5% (v/v) [12, 13, 14].

During the initial stages of fermentation, yeast plays a crucial role in breaking down sucrose into glucose and fructose using hydrolytic enzymes [15]. Glucose is then further metabolized without oxygen, a process known as alcoholic fermentation. In the early stages of fermentation, the primary products are alcohol and carbon dioxide. Acetic acid bacteria are capable of thriving in this environment and can further metabolize alcohol to produce acetic acid and water. In addition to acetic acid, kombucha also contains various other organic acids that are produced during fermentation.

Following the taste testing of kombucha cultures fermented from ladyfinger banana blossom tea, ladyfinger banana pollen tea, and ladyfinger banana pollen tea mixed with honey and lime, conducted by community stakeholders from Tha Phutsa sub-district, including the sub-district head, agricultural officer, local entrepreneurs, members of the community agricultural cooperative in Ban Pruek Makrut, and academic staff along with students (totaling 5 participants), a unanimous decision was reached. It was agreed that kombucha cultures fermented from all three types of tea, at the 14-day fermentation mark, should be diluted to achieve a taste that aligns with consumer preferences. Dilution ratios of 1:3, 1:4, and 1:5 (v/v) were suggested. Parameters such as pH, sweetness, and alcohol will be monitored throughout the dilution process (refer with: Table 1).

Table 1. The pH, sweetness, and alcohol of diluted kombucha at various ratios.

Ready-to-drink Kombucha.	Dilution ratios (v/v)	pH	Sweetness (%Brix)	Alcohol content (%)
ladyfinger banana pollen tea	1:3	3.18	12.80	0.00
	1:4	3.13	13.20	0.00
	1:5	3.04	13.50	0.00
ladyfinger banana blossom tea	:13	3.16	12.82	0.00
	1:4	3.12	13.22	0.00
	1:5	3.02	13.52	0.00
ladyfinger banana pollen tea mixed with honey and lemon	:13	2.80	20.61	0.00
	1:4	2.73	21.01	0.00
	1:5	2.63	21.31	0.00

The pH values of the ladyfinger banana blossom kombucha at ratios of 1:3, 1:4, and 1:5 (v/v) were 3.18, 3.13, and 3.04, respectively. For the ladyfinger banana pollen kombucha, the pH values at the same ratios were 3.16, 3.12, and 3.02. The pH values of the ladyfinger banana pollen tea mixed with honey and lime kombucha at ratios of 1:3, 1:4, and 1:5 (v/v) were 2.80, 2.73, and 2.63. Regarding sweetness, the ladyfinger banana blossom kombucha at ratios of 1: 3, 1: 4, and 1: 5 (v/v) had %Brix values of 12.80, 13.20, and 13.50, respectively. For the ladyfinger banana pollen kombucha, the %Brix values at the same ratios were 12.82, 13.22, and 13.52. Meanwhile, the %Brix

values of the ladyfinger banana pollen tea mixed with honey and lime kombucha at ratios of 1:3, 1:4, and 1:5 (v/v) were 20.61, 21.01, and 21.31. No alcohol content was detected in any of the 9 samples.

The increase in sweetness of the kombucha from all three types at ratios of 1:3, 1:4, and 1:5 (v/v) is attributed to the addition of kombucha culture mixed with the ladyfinger banana pollen honey lemon tea, aiming to achieve the desired aroma and taste preferred by consumers. The ladyfinger banana pollen honey lemon tea has a sweetness level of 14.90 % Brix and a pH value of 3.45. Consequently, the sweetness level of the composite banana blossom tea blends increases proportionally, with the sweetness level of the 1:3 ratios being lower than that of the 1:4 ratios, and the sweetness level of the 1:4 ratios being lower than that of the 1:5 ratios.

The sensory evaluation of the kombucha brewed from ladyfinger banana blossom, ladyfinger banana peel, and ladyfinger banana blossom honey lemon, diluted at a 1:4 (v/v) ratio, was conducted by community stakeholders from Tha Phutsa sub-district. This group comprised the village headman, agricultural officer, local entrepreneur, members of the Pruek Makrut agricultural community enterprise, teachers, and students, totaling 5 individuals. They collectively agreed that the kombucha prepared from all three variants at a 1:4 (v/v) dilution ratio received the highest satisfaction rating.

To assess the sensory attributes of the kombucha products, the participants utilized a scale ranging from 1 to 9 to evaluate six aspects: color, clarity, aroma, taste, ease of swallowing, and overall preference. A total of 30 individuals, who attended the Thai Banana Blossom Festival in Kamphaeng Phet from October 5th to 15th, 2023, participated in the sensory evaluation (refer with: Fig.6).

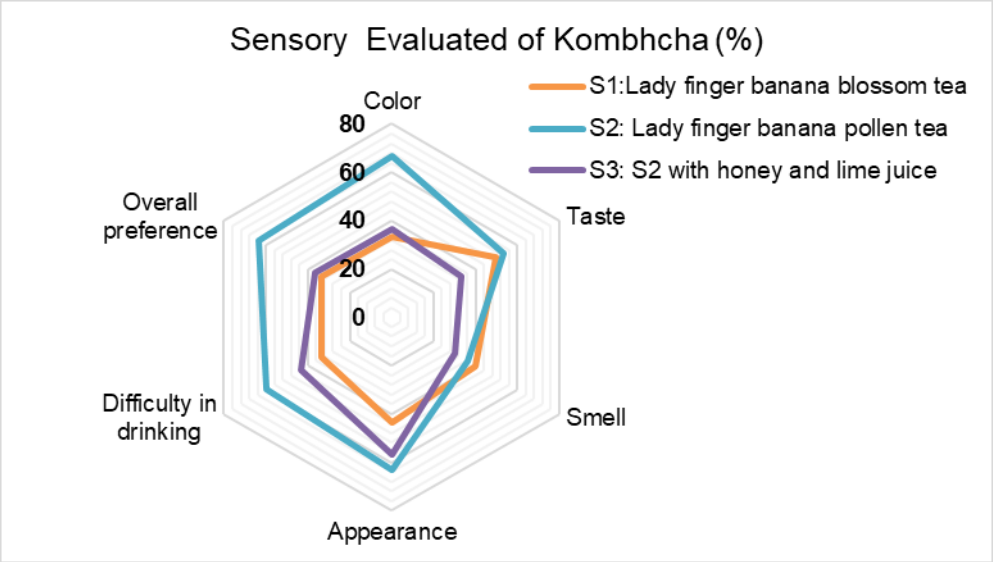


Fig. 6. The sensory evaluated of kombhcha (%) (a) S1:Lady finger banana blossom tea (b) S2: Lady finger banana pollen tea and (c) S3: S2 with honey and lime juice.

The evaluation of sensory perception for all three examples of kombucha can be divided into 6 aspects: color, clarity, aroma, taste, ease of swallowing, and overall preference. After analyzing the data, it was found that the testers showed the highest preference for kombucha made from ladyfinger banana blossom tea in every aspect of sensory evaluation. This includes color, clarity, aroma, taste, ease of swallowing, and overall preference. Following this, kombucha made from ladyfinger banana pollen tea ranked second, and kombucha made from ladyfinger banana pollen tea mixed with honey lemon ranked third in terms of overall preference, except for ease of swallowing, where kombucha made from ladyfinger banana blossom tea received the lowest score.

The kombucha drink from ladyfinger banana blossom tea with honey lemon product (refer with Fig. 7).

(a) (b)

Fig. 7 The kombucha drink from ladyfinger banana blossom tea with honey lemon (a) product label (b) kombucha drink product.

The market testing was conducted by participating in collaborative booth setups with other entrepreneurs at an event of the Thai Banana Blossom Festival in Kamphaeng Phet from October 5th to 15th, 2023 found that customers have expressed high satisfaction with kombucha products made from ladyfinger banana pollen tea, which influences their decision to purchase kombucha products overall. When considering various aspects, it was found that 11 returning customers, accounting for 10%, showed favorable behavior post-purchase. Following this group, the majority of customers are middle-aged, around 40 years old or older, who are health-conscious working professionals. They prioritize the shelf life of the product, preferring a delicious, slightly sweet and sour taste, fizziness, and refreshing sensation upon consumption. They appreciate the variety of products available, including kombucha made from l ladyfinger banana blossom tea, ladyfinger banana pollen tea, and ladyfinger banana pollen tea mixed with honey lemon. Additionally, they value attractive packaging designs with clear and accurate pricing. The products are packaged appropriately according to their quality, and there is interest in distribution channels, particularly online platforms such as the official Line account and Facebook page of the community enterprise "Pruek Makrut Village" (refer in Fig 9). Moreover, customers note that the products are clean and neatly displayed, with an emphasis on informative documents detailing the benefits of kombucha.

4. Conclusion

Utilizing ladyfinger banana blossoms for kombucha production in Tha Phutsa Subdistrict, Kamphaeng Phet, offers waste management and value addition, reducing greenhouse gas emissions by 1,760.20 KgCO2/MJ and generating additional value of 6,600 to 82,000 baht annually. The study examined fermentation of three kombucha variants over 14 days: ladyfinger banana blossom tea, ladyfinger banana pollen tea, and ladyfinger banana pollen tea with honey lemon. pH levels decreased during fermentation, meeting standards. Decreased sweetness suggests sugar consumption, needing age-based monitoring. Alcohol content variations were attributed to microbial activity. Sensory evaluations showed high satisfaction for kombucha from ladyfinger banana blossom tea, then ladyfinger banana pollen tea, and ladyfinger banana pollen tea with honey lemon. Market testing at the Thai Banana Blossom Festival indicated strong satisfaction, particularly among health-conscious middle-aged professionals, with potential for online distribution channel growth. In conclusion, kombucha made from ladyfinger banana pollen tea shows potential for commercialization and market expansion, addressing consumer demand for healthy beverage options

through sustainable agricultural waste utilization. Further research and development can enhance its viability in meeting consumer preferences.

Acknowledgements

Grateful acknowledgements to Faculty of Education, and Research and Development Institute, Kamphaeng Phet Rajabhat University, Thailand for the grant.

References

[1] Alam, P. and Ahmade, K. (2013). Impact of solid waste on health and the environment. Special Issue of International Journal of Sustainable Development and Green Economics (IJSDGE), (Special issue), Vol. 2 No. I, pp. 165-168.

[2] PCD—Pollution Control Department, "Thailand State of Pollution Report 2016", PCD—Pollution Control Department, Ministry of Natural Resources and Environment: Bangkok, Thailand, 2016. network: http://infofile.pcd.go.th/mgt/Pollution%20Report%202016%20.pdf?CFID= 2513660 &CFTOKEN=16816152.

[3] Kamphaeng Phet Provincial Agriculture and Cooperatives Office, "Agricultural statistics report economic crops of Kamphaeng Phet province in cultivation year 2023/2024", 2024, network: https://www.opsmoac.go.th/kamphaengphetdwl-preview-431091791819. (in Thai).

[4] B. Thanomnim, S. Papong, and R. Onbhuddha, "The methodology to evaluate food Waste generation with existing data in Thailand" *Thai Environ. Eng. J.*, Vol. 36, 2022, pp.1–9. network: https://so05.tci-thaijo.org/index.php/teej/article/view/255003/174182.

[5] W. Surivong, S. Jaturonglamlert, C. Thinan, and T. Somwang, "The role of ultrasonic waves in enhancing the efficiency of black kombucha tea production", *Burapa Science Journal*. Vol.28, No. 1, pp. 343-363, 2023.

[6] Nutrition Division, "Department of Health, Ministry of Public Health. (2003). Recommended daily nutrient intake for Thai people", *Bangkok: Organization for Printing and Distribution of Goods and Packaging (RSP),* 2003.

[7] G.W. Frank, "Kombucha: Healthy Beverage and Natural Remedy from the Far East" *Wilhelm Ennsthaler*, Austria, 1995.

[8] C.Hobbs, "Kombucha Manchurian Tea Mushroom: The Essential Guide". *Botanica Press*, *Santa Cruz*, 1995.

[9] World Health Organization, "Reducing free sugars intake in adults to reduce the risk of noncommunicable diseases", 2019. network: http://www.who.int/elena/titles/ free-sugars-adults-ncds/en/.

[10] W. F. Gunther, "Kombucha healthy beverage and natural remedy from the far east", *Printed in Austria*, 1995.

[11] Department of Health, Good health starts with food: Reduce sugar, fat, salt, and fill up with vegetables and fruits, (2019). network: http://nutrition.anamai.moph.go.th.

[12] M. Talebi, L.A. Frink, R.A. Patil, D.W. Armstrong, "Examination of the varied and changing ethanol content of commercial kombucha products", *Food Anal. Methods.* Vol. 10, No. 12, pp. 4062–4067. 2017. network: https://doi.org/10.1007/s12161-017-0980-5.

[13] S.S. Jang, L. McIntyre, M. Chan, P.N. Brown, J. Finley, and S.X. Chen, "Ethanol concentration of kombucha teas in British columbia, Canada", *J. Food Protect.* Vol. 84, No. 11, pp. 1878–1883, 2021. network: https://doi.org/10.4315/JFP-21-130.

[14] T. Suhre, M.B. Mann, C.I. Kothe, A.L.G. Rocha, P.G. Celso, A.P.M. Varela, A. P.G. Frazzon, J. Frazzon, "Microbial community and physicochemical characterization of kombuchas produced and marketed in Brazil", *J Food Sci. Nutr. Res*. Vol. 4, pp. 302–316. network: https://doi.org/10.26502/jfsnr.2642-11000082, 2021.

[15] C. Dufresne and E. Farnworth, Tea, Kombucha, and health: a review. Food Research International, Vol. 33, 2000, pp. 409-421.