



Comparative Study on the Starter Cultures as Influence on Yogurt Fortified with Hemp Seeds Protein

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ABSTRACT

The purpose of this study was to compare three different types of starter cultures: natural yogurt, coconut yogurt, and soy yogurt, in order to develop appropriate formulas to be used as an ingredient in yogurt fortified with hemp seed protein. The developed yogurts were tested for chemical and physical properties, as well as sensory analysis. Consumer acceptance of drink yogurt products was tested by 30 panellists using the 9-Point Hedonic Scale for sensory ranking. Sensory analysis was evaluated for appearance, color appearance, aroma, taste, and overall acceptability. The pH and degree of sweetness of fortified yogurts were in the range of 4.10 – 4.28 and 8.33 – 8.67 °Brix, respectively. The color values of coconut yogurt were $L^* = 42.41 \pm 3.52$, $a^* = -0.78 \pm 0.30$, $b^* = 6.45 \pm 0.18$, soy yogurt at $L^* = 44.78 \pm 8.50$, $a^* = -0.67 \pm 0.17$, $a^* = 5.32 \pm 0.44$, and natural yogurt at $L^* = 40.43 \pm 3.70$, $a^* = 0.02 \pm 0.37$, $b^* = 5.08 \pm 0.32$. The results of the sensory analysis found that yogurt produced from coconut starter was the most appropriate product of the three inoculums.

Keywords: *hemp seeds protein, starter cultures, fortified yogurt, sensory*

INTRODUCTION

Yogurt is a product derived from milk that has been fermented under certain conditions and is edible by people of any age. It contains various types of healthy bacteria that provide rich sources of nutrients such as protein, calcium, vitamins, and probiotics. It populates the intestines with microorganisms that facilitate digestion, bowel movements, and prevent irritable bowel syndrome, making it very popular in the healthy food market for health-conscious consumers, people who are on their weight loss journey, and athletes (Megan, 2021). Currently, Thailand's health-conscious consumers are on the rise, as people's purchasing and consuming behavior is different from that of the past. The Thailand domestic yogurt market is seeing healthy growth in the foreseeable future. In 2017, the market was valued at 30 billion Baht, a 7.5% increase from 2016, and is expected to be over 35 billion Baht in 2020. However, compared to other markets such as those in Japan, the United States, and the European Union (Chuchom, 2020), Thailand's yogurt consumption per capita is considerably low, meaning the market still has a lot of growth potential. A new generation of consumers is educated and well-informed and more critical when it comes time to select products; they prefer more natural ingredients with no sugar or other unnatural additives.

According to current statistics, there are at least 47 countries growing industrial hemp for commercial and research purposes (Cannabis Business Plan, 2021). As a result of legalization by authorities, the industrial hemp market is seeing a continuing growth. The hemp market is expected to reach 26.6 million USD in the year 2025 (Markets and Markets, 2019). However, an ACS Laboratory study (2020) found that growing hemp without accurate market usage data is affecting its selling price by 60% in the latter half of 2019 due to oversupply. At the same time, the price of hemp and hemp oil extract are falling 18% and 68% consecutively. Nevertheless, there are still many other applications such as foods and beverages, textiles, paper industry, cosmetics, and self-care. This makes industrial hemp one of the commodities to keep an eye on, as its market potential is still large. The market is still expected to grow from 4.6 billion USD in 2019 to 9.4 billion USD in 2025 at a 12.8% annual growth rate (Whitney Economics, 2019).

Industrial hemp has gained popularity in Thailand since it was legalized on June 9, 2022. People can now apply for permits that allow them to plant, process, import seeds, and engage in sales and distribution. Besides its many applications and growing demand, hemp is on its way to becoming what is considered Thailand's new "economic plant" with its endless high-value industrial applications that could provide a substantial economic gain under the green economy principle (BCG; Bio-Circular-Green) (Sowcharoensuk, 2564). Many consumers are becoming interested in products derived from hemp due to its popularity, leading to further and numerous researches, and evidence of its nutritional benefits such as hemp seed containing Arginine, which aids in the production of nitric acid for cardiovascular health. Hemp seeds also contain nutritional fiber, helping the digestion process and reducing the risk of diabetes (Mahammad, 2022).

Therefore, the purpose of this research is to study consumer behavior toward yogurt made with hemp, to serve as a basic guideline for further development of hemp seed extract for yogurt beverages with protein from hemp seed. This value-adding process could be considered a "super food," answering the demand for health-conscious consumers.

MATERIAL AND METHODS

Sample preparation

Hemp seed protein was purchased from Bob's Red Mill (Oregon, U.S.). The coconut starter (Agrilift, Bangkok, Thailand), soy starter (Rivon, Bangkok, Thailand), and natural starter (Meiji Bulgaria, Bangkok, Thailand) were purchased from Tops supermarket, Chiang Mai, Thailand. The fortified yogurt with 10% hemp seed protein was prepared using the modified formula of Xu et al. (2022), as presented in Table 1. The procedures for making protein-fortified yogurt from hemp seeds are shown in Figure 1.

Table 1 the receipt for making protein-fortified yogurt from hems seeds.

Composition	Concentration % (w/v)
Milk	89
Hemp seeds protein	10
Starter culture	1

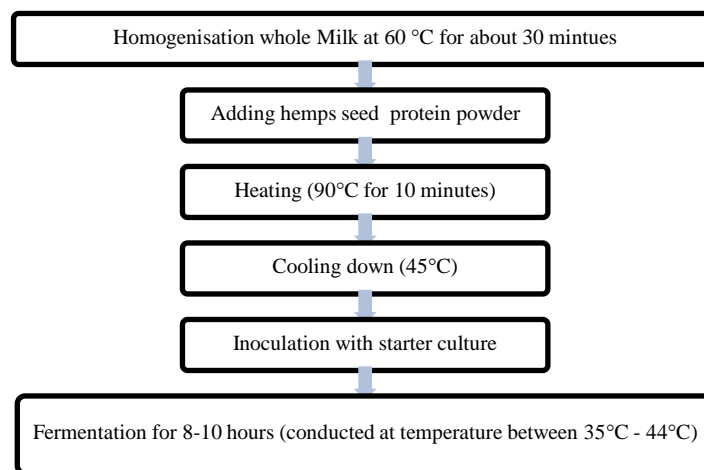


Figure 1 Procedures for making protein-fortified yogurt from hems seeds.

2.2 pH measurement

The pH of the fortified yogurts was measured by pH 700-Eutech, German. All samples were measured in triplicates.

2.3 Degree of sweetness

The determination of the sweetness was tested by hand refractometer (Atago, Japan).

2.4 Color measurement

The A*, B*, and L* values of yogurt fortified with hemp seed protein were measured by the CR-400. In the CIELAB color space system, the L* value corresponds to the brightness and the values range from 0 (black) to 100 (white); the A* value indicates the degree of redness (positive) or greenness (negative); and the B* value indicates the degree of yellowness (positive) or blueness (negative).

2.3 Sensory evaluation

The study was reviewed and approved by Payap University's IRB and informed consent was obtained from each subject prior to their participation in the study. We convened 30 members of the Chiang Mai Badminton Club aged over 20 years old (untrained panelists). The evaluation form included five aspects (appearance, color appearance, aroma, taste, and overall acceptability). The test method used was a 9-point hedonic scale to measure the level of acceptance of respondents, where scores ranged from 1 point (very much disliked) to 9 points (very much liked).

2.4 Statistical analysis

Each group of experiments duplicated three times unless stated otherwise. The results are reported as means \pm standard deviation.

Results and Discussions

The results of a comparative study on pH values of protein-fortified yogurt from hemp seed starter culture from three sources prove that the pH values do not differ significantly (Table 2). The highest pH was found in soybeans with a mean of 4.28 ± 2.14 , followed by coconut with a mean of 4.14 ± 2.07 , and lastly natural milk with a mean of 4.10 ± 2.05 .

Furthermore, the results of a comparative study on the sweetness of protein-fortified yogurt from hemp seed starter culture from three sources prove that the sweetness values do not differ significantly. The highest sweetness value was natural milk with a mean of 8.63 ± 0.55 , followed by coconut with a mean of 8.47 ± 0.03 , and lastly natural milk with a mean of 8.33 ± 0.11 .

The color value of coconut yogurt was $L^* = 42.41 \pm 3.52$, $a^* = -0.78 \pm 0.30$, $b^* = 6.45 \pm 0.18$, soy yogurt at $L^* = 44.78 \pm 8.50$, $a^* = -0.67 \pm 0.17$, $b^* = 5.32 \pm 0.44$, and natural milk at $L^* = 40.43 \pm 3.70$, $a^* = 0.02 \pm 0.37$, $b^* = 5.08 \pm 0.32$.

Table 2 The physical and chemical properties of each type of yogurt.

Physical and chemical properties	Type of starter culture		
	Coconut (Means \pm S.D.)	Soybeans (Means \pm S.D.)	Natural milk (Means \pm S.D.)
pH values	4.14 \pm 2.07	4.28 \pm 2.14	4.10 \pm 2.05
Sweetness values) $^{\circ}$ Brix(8.47 \pm 0.03	8.33 \pm 0.11	8.63 \pm 0.55
Color parameters			
- L*	42.41 \pm 3.52	44.78 \pm 8.50	40.43 \pm 3.70
- a*	-0.78 \pm 0.30	-0.67 \pm 0.17	0.02 \pm 0.37
- b*	6.45 \pm 0.18	5.32 \pm 0.44	5.08 \pm 0.32

The pH of all 3 yogurt formulas was between 4.0 - 4.6, which was in line with the standards of laws and business promotion organizations (Dairy Cow of Thailand, Industrial Standards for Fermented Milk, 2004). The sediment was formed from the protein powder extracted from the hemp seeds during the Upon completion of the process of making yogurt. process, the sediment from the protein powder extracted from the hemp seeds was found over time. The texture was smooth, but the stability of the yogurt remains an issue.

Table 3 The results of sensory analysis of coconut yogurt.

Attributes	Acceptance rating scale	
	Means \pm S.D.	Evaluation
Appearance	6.53 \pm 1.16	Like Slightly
Color appearance	6.73 \pm 1.14	Like Slightly
Aroma	7.06 \pm 1.08	Like Moderately
Taste	6.50 \pm 1.22	Like Slightly
Overall acceptability	6.60 \pm 1.27	Like Slightly

Table 4 The results of sensory analysis of soybeans yogurt.

Attribute	Acceptance rating scale	
	Means \pm S.D.	Evaluation
Appearance	6.43 \pm 1.33	Like Slightly
Color appearance	6.53 \pm 1.16	Like Slightly
Aroma	6.20 \pm 1.09	Like Slightly
Taste	6.33 \pm 1.44	Like Slightly
Overall acceptability	6.36 \pm 1.21	Like Slightly

Table 5 The results of sensory analysis of natural milk yogurt.

Attribute	Acceptance rating scale	
	Means \pm S.D.	Evaluation
Appearance	6.43 \pm 1.69	Like Slightly
Color appearance	6.26 \pm 1.38	Like Slightly
Aroma	6.03 \pm 1.35	Like Slightly
Taste	5.96 \pm 1.29	Neither Like nor Dislike
Overall acceptability	6.10 \pm 1.32	Like Slightly

The results of the sensory analysis found that yogurt produced from coconut starter was more appropriate than that of the other two inoculums, which the volunteers gave the most importance to in terms of aroma. Overall, there was no significant difference in each formulation. The results of the sensory analysis of the coconut yogurt attribute were the appearance rating scale with a mean of 6.53 ± 1.16 , color appearance with a mean of 6.73 ± 1.14 , aroma

with a mean of 7.06 ± 1.08 , taste with a mean of 6.50 ± 1.22 , and overall acceptability with a mean of 6.60 ± 1.27 . Followed by the soybeans yogurt, appearance with a mean of 6.43 ± 1.33 , color appearance with a mean of 6.53 ± 1.16 , aroma with a mean of 6.20 ± 1.09 , taste with a mean of 6.33 ± 1.44 , and overall acceptability with a mean of 6.36 ± 1.21 . Lastly, natural milk had an appearance with a mean of 6.43 ± 1.69 , color appearance with a mean of 6.26 ± 1.38 , aroma with a mean of 6.03 ± 1.35 , taste with a mean of 5.96 ± 1.29 , and overall acceptability with a mean of 6.10 ± 1.32 .

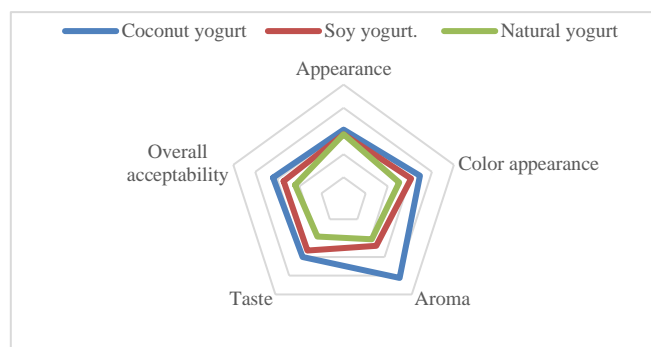


Figure 2 Spider web analysis of the consumers' preference and acceptability of yogurt samples.

4. Conclusion

In this study, the aim was to compare three different types of starter cultures: natural yogurt, coconut yogurt, and soy yogurt. According to the results of the sensory analysis, it was found that yogurt produced from coconut starter was a more appropriate product than the other two inoculums, and there was no significant difference in the physical and chemical properties of each type of yogurt. Therefore, the development of yogurt formulas fortified with coconut protein from hemp seeds is another option for health-loving consumers in the future.

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