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Research Article

Physical and Organoleptic Properties of Freeze-dried Local Beans and Salak Yogurt Powder

Sumarto [1,2]*, Ani Radiati [1,2], Irma Nuraeni [1]

[1] Department of Nutrition, Health Polytechnic of Tasikmalaya (Poltekkes Kemenkes Tasikmalaya)
[2] Center of Excellent (CoE) on Health and Disaster Emergency (HADE) Center, Health Polytechnic of Tasikmalaya (Poltekkes Kemenkes Tasikmalaya)

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**Corresponding author:*
E-mail: sumarto@dosen.poltekkestasikmalaya.ac.id

ABSTRACT

Yogurt is one of the most popular fermented dairy products worldwide, with huge consumer acceptance due to its health benefits. While its shelf life is still relatively low, freeze-drying could extend the shelf life of yogurt. Other non-milk raw materials that can be an alternative substrate in yogurt are local Indonesian beans, namely Mung bean and Garut red bean. Additionally, yogurt can be added to the fiber- and carbohydrate-rich Manonjaya salak flour to produce a synbiotic product. Hence, this study aimed to produce yogurt powder comprising local nuts and Manonjaya salak through a freeze-drying process, which physical properties are organoleptically acceptable and meet Indonesian standards. In this study, the yogurt powder comprising the local Garut red- and Mung beans mixed with Manonjaya salak flour was compared to fresh yogurt as the control, plus yogurt powders from milk and nuts, as well as synbiotic yogurt powder from nuts, and Manonjaya salak flour. The physical properties of the resultant yogurt were tested for pH, %brix, moisture content, and organoleptic properties with hedonic testing. The findings revealed that the freeze-dried yogurt powder comprising Garut red- and Mung beans mixed with Manonjaya salak flour exhibited acceptable water content (10.39) with a 5.57 %brix and a final pH of 5.0, and was organoleptically acceptable by panelists. The physical and organoleptic properties of the Garut red-, mung beans, and Manonjaya salak flour yogurt power met the Indonesian national standards.

Keywords: Freeze-drying, Manonjaya salak flour, Local nuts, Physical and organoleptic properties, Yogurt powder

Introduction

Yogurt is one of the most popular fermented dairy products worldwide, with broad consumer acceptance because of its health benefits and basic nutrients. Yogurt is considered a probiotic-carrying food that can deliver large amounts of probiotic bacteria into the body to improve digestion. Gastrointestinal diseases in humans have been associated with poor digestion and are thought to be the source of other diseases, too. There are also claims that consuming yogurt increases lactose tolerance and immunity while averting indigestion. Due to the multitude of health benefits of consuming yogurt, the demand for yogurt and yogurt-related products has appreciably increased. It has become a fast-growing dairy product category in the global market. There are a wide-ranging variety of yogurts, with an array of fat contents, flavors, and textures, to suit different types of meals or as a snack, dessert, sweets, or savory food [1].

Yogurt ranks among the most popular fermented dairy products worldwide including Indonesia. Nevertheless, the shelf life of this food commodity remains an issue, as it is short-lived compared to other dairy products. In this context, freeze-drying is a suitable process for extending the shelf life of yogurt. The technology dries products through sublimation at low temperatures and pressures without compromising the foods' nutritional, microbiological, and sensory characteristics. Most importantly, this approach produces

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easily rehydratable dry products [2]. Hence, the same technology would be ideal for manufacturing extending the shelf-life of yogurt by turning it into powder. Also, good bacterial cultures (probiotics, like lactic acid bacteria) are maintained at low treatment temperature applications during drying.

Research has shown that cow's milk yogurt powder has a higher nutrient concentration in its rehydrated products. This is because lower amounts of water were used for rehydration when compared to water lost during freeze-drying. Rehydration of yogurt powder typically aims to obtain more nutritious products with textures similar to traditional yogurt [2]. A previous microbiological study showed that rehydrated yogurt retains the number of lactic acid bacteria above the value required by Brazilian law [2]. Meanwhile, sensory evaluation of rehydrated yogurt revealed greater consumers' acceptance of this product over traditional yogurt. This was possibly due to the dehydration process, which concentrated the compounds that positively affected the aroma and taste of the yogurt. The dehydrated-rehydrated yogurt in their study met Brazil's statutory recommendations for fermented dairy products. The findings supported the feasibility of this treatment process to extend the shelf life of yogurt, and thus a promising marketing alternative to the dairy industry. Also, various products could be produced, exhibiting greater acceptance and nutritional value than traditional yogurt [2].

Alternative raw materials other than milk that can be used as substrate in the manufacture of yogurt are nuts. This is because nuts have nutritional characteristics similar to milk, especially the composition of proteins, fats, and carbohydrates. Similar and widely consumed food processed products are soy juice, namely, soy milk. The same goes for the local nuts, namely Garut red beans and Mung beans, which have appreciable nutritional content. These nuts can potentially be used as a substitute for cow's milk-based yogurt.

Some researchers also explored new approaches to produce synbiotic foods (prebiotics and probiotics). For instance, the integration of yogurt and sweet potatoes significantly increased the number of lactic acid bacteria [3], as similarly observed for another synbiotic yogurt with the added inulin from Gembili. This novel combination significantly reduced low-density lipid (LDL) levels in the blood of experimental mice [4].

Another high-fiber food that could be added to synbiotic foods is the Manonjaya salak. The Manonjaya salak flour was shown to be high in fiber and carbohydrate content [5][6]. Hence, mixing this flour with local Garut red- and Mung Beans would yield a synbiotic yogurt powder product. In addition, Manonjaya salak flour is a food derived from the widely available local raw materials typical of Tasikmalaya regency, West Java, Indonesia. Thus, the synbiotic yogurt powder proposed in this study may prove useful in elevating the added value of local food.

Hence, this study aimed to prepare the Garut red- and Mung bean with Manonjaya salak flour yogurt powder and analyze its physical properties and organoleptic properties in comparison to individual components in the Garut red- and Mung bean with Manonjaya salak flour yogurt powder. The physical properties that analyzed were acidity, viscosity, and moisture content. The physical properties of yogurt powder compared to Indonesian national standards (SNI) and other research, too. The organoleptic properties that analyzed were color, aroma, taste, and texture properties.

Material and Methods

This study was an exploratory, experimental study in which the product(s) were analyzed descriptively and analytically, as it was a part of a research and development (R&D) project. This study performed several trials of processing and making the yogurt powder from local nuts (Garut Red Beans and Mung Beans) before subjecting to the organoleptic acceptance test by several panelists. The number of panelists were 36 untrained panelists. A scale used in the study was a hedonic scale of 1 to 5. The panelist rated their degree of liking of the powder yogurt on a five-point hedonic scale (1 = unsatisfactory; 3 = good; and 5 = excellent). The parameter of the yogurt product with hedonic assessment was a likely scale of color, aroma, taste, and texture.

This study also monitored the physical properties of the yogurt powder of local nuts and Manonjaya salak. The measured properties were the acidity, viscosity, and the pH of the final product. The raw materials to make the yogurt powder were sourced from local markets in the Tasikmalaya, West Java, Indonesia. The raw materials used were flours of Garut Red Beans (*Phaseolus vulgaris L.*), Mung Beans (*Vigna radiata*), and

Table 1. Trial Plan

Repeat/ Panelist	Treatment/ Sample Order	
	A	B
1	1	2
Code	382	198
2	2	3
Code	777	255
Etc.	-	-

Manonjaya snake-fruit (*Salacca zalacca*). The experimental design schemes in this study are as described in Table 1.

In the repeated experiment, the powder was prepared according to the formula: (t-1) (r-1) $\geq$ 15 [7]. Where "t" was the number of treatments, namely 5, while "r" was the number of repeats of at least 5, so the value (t-1) (r-1) was 16 (more than 15]. This study used a completely randomized design to prepare the instant yogurt powder product while the organoleptic tests used the group randomized design.

This research was carried out by the Food Processing Laboratory of the Department of Nutrition of Health Polytechnic of Tasikmalaya, which prepared the freeze-dried yogurt powder products. Meanwhile, the Sensory Evaluation laboratory of the Department of Nutrition of The Health Polytechnic of Tasikmalaya tested the organoleptic properties of the product(s). Physical property tests measured the acidity (pH) using the universal indicator of pH meter, water content using the drying oven with others equipments, and viscosity based on the percentage brix (%Brix) using the refractometer of the freshly prepared yogurt and the dehydrated-rehydrated yogurt products. The gravimetry method was used to determine the moisture content of each yogurt powder [8].

The organoleptic test used a randomized block design, as shown in Table 1 [9]. The organoleptic properties of the products were measured using the hedonic test method, involving 36 panelists, comprising untrained or consumer panelists [9]. Organoleptic tests were conducted to elicit a favored response to color, aroma, taste, and texture by panelists to probiotic-synbiotics of the produced yogurt powder products. Organoleptic tests were performed on the following products: 1. Plain yogurt products purchased from the retail market (Control – C), 2. Rehydration products of Garut red bean yogurt powder (YP-GB), 3. Rehydration products of Mung bean yogurt powder (YP-MB), 4. Rehydration products of Garut bean yogurt powder – Manonjaya salak flour (YP-GB-MS), and 5. Rehydration products of Mung bean yogurt powder-Manonjaya salak flour (YP-MB-MS).

The subjective tests comprised physical and organoleptic tests on yogurt powder using descriptive analysis. Conversely, analysis of the organoleptic and physical properties of yogurt powder used univariable and bivariable analysis, using the Analysis of Variance (ANOVA). The normality test was first done before the Anova test, which used the Kolmogorov Smirnov for parametric or normally distributed data. The ANOVA was also preceded by homogeneity testing as a prerequisite for analysis. The homogeneity test was based on the probability of the F test on the Levene Test calculation using a computer software, the SPSS [10]. Pertinently, it is worth mentioning here that the Indonesian Standard (SNI) for yogurt in viscosity is minimum 8,2 [11].

Results and Discussion

Technology to make powder or yogurt powder typically uses a spray dryer tool [12]. Literature has shown that yogurt from the study using skim milk reportedly showed a total of dissolved solids (TDS) of 17-25%. In addition, the raw materials used in yogurt include sodium alginate, maltodextrin, and tricalcium phosphate as fillers and anticlot, all of which yield yogurt powders with water contents between 4−5% [12]. In contrast to the results of this study showed an interestingly higher water content in yogurt powders produced using nuts and Manonjaya salak, which ranges between 12 to 17% (Table 2). Notably, fillers and anti-clot agents were not added to the peanut- and Manonjaya salak yogurt powders prepared in this study.

Water contents of nuts and Manonjaya salak yogurt powder from this study were indicated the relatively low. Water content is a key that influence the shelf life of food and beverage product [13]. The lower the water content of a food product, the longer its shelf life. One of the methods to extended shelf life of yogurt beverage was freeze drying. Freeze-dried yogurt can be stored at 4 ºC for up to 1-2 years [14].

In this study, drying the Garut red- and mung bean yogurt and Manonjaya salak flour yogurt by freeze-drying was adapted from the traditional way of Brazilian yogurt-making [12]. The freeze-drying process only changes the moisture content of yogurt from 82.77% in traditional yogurt to

Table 2. The Water Content of Yogurt Powder with Various Treatments

Treatment – Yogurt Powder	Water Content (%)
Control (Milk Yogurt Powder)	5.47
Mung Bean Nutgurt Powder	12.56
Garut Red Bean Nutgurt Powder	14.97
Nutghurt Powder Synbiotic Mung Beans + Manonjaya Salak	10.39
Nutghurt Synbiotic Powder Garut Red Beans + Manonjaya Salak	17.00

Table 3. The Viscosity of Juice, Yogurt, and Synbiotic Yogurt based on Treatments

Type of Product/ Treatment	Viscosity (% Brix)
Milk/Juice (M)	
Milk (Control)	13.40
Mung Bean Juice	3.47
Garut Red Bean Juice	4.23
Milk (Juice + Sugar) Mung Beans	4.43
Milk (Juice + Sugar) Garut Red Beans	5.43
Yogurt (Y)	
Yoghurt ready to drink from the market Brand 1 (Control 1)	19.20
Yogurt *ready to drink* from the market Brand 2 (Control 2)	18.20
Yogurt from Control milk	18.57
Nutgurt Mung Beans	9.70
Nutgurt Garut Red Beans	9.87
Yogurt Sinbiotik	
Nutgurt Mung Beans + Manonjaya Salak Flour	5.57
Nutgurt Garut Red Beans + Manonjaya Salak Flour	7.96

74.09% in the freeze-dried product [12]. This moisture content was much higher in freeze-dried yogurt powders prepared from nuts (12.56-14.97%) and Manonjaya yogurt powder (10.39-17.00%) produced in this study which ranged between 5.47 to 17.00%. Hence, the moisture content becomes one factor in the quality of the drying process in yogurt.

The nuts yogurt powder and Manonjaya salak produced in this study also had a low TDS of viscosity of 5.57−9.87% brix (Table 3). The TDS of peanut yogurt (9.70-9.87 %Brix) and Manonjaya salak flour yogurt powder (5.57-7.96 %Brix) prepared in this study were comparable to earlier reported studies, which range from 7.70 to 8.13 for a yogurt prepared from a mixture of adding beet extract [16]. Another yogurt enrich papaya have range from 7.00 to 10.80 °Brix [17]. For example, yogurt enriched with coconut cake gave TDS values between 8.26−10.47% with a pH value of 4.42−4.50 [18].

Lactic acid bacteria (LAB) in the yogurt convert lactose to lactic acid as a metabolite. The metabolite is excreted out of the cells and is accumulated in the fermenting liquid. The remaining products in the form of total sugar, lactic acid, organic acid, and protein are counted as total dissolved solids (TDS) [16]. TDS especially total sugar is a substrate for probiotics to grow.

The next evaluation found that panelists organoleptically preferred the nuts (3.0-3.7) and Manonjaya salak flour yogurt powders (2.7-3.3) (Table 4). The avarage of acceptance level for organoleptic properties of nuts and Manonjaya salak were relatively liked by all of the panelist, especially on parameter of color, aroma, and taste. The acceptance level of nuts and Manonjaya salak were comparable to earlier reported studies, which range 1.5 to 3.0 with 5 scale [17]. The individual yogurt powder product is illustrated in Figure 1.

The results are in line with several other studies that made yogurt from a mixture of skim milk and kidney beans, in comparison to pure skim milk and kidney beans yogurt. They found that panelists yogurt with a ratio of skim milk and kidney beans of 1:0.5 [19].

In this study, the nuts pH 5.0 and Manonjaya salak flour yogurts pH 5.0 (Table 5) showed pH values that corresponded well with earlier research. For instance, a study by Kumalasari, et al. [19] produced a yogurt drink with added star fruit

Table 4. Mean values of Measured Organoleptic Properties of Yogurt (Scale 1-5)

Factor	F0	F1	F2	F3	F4
Color	4.3^{c}	$3.5^{a,b}$	3.7^{b}	3.3^{a}	3.2^{a}
Aroma	3.9^{b}	3.2^{a}	3.2^{a}	3.1^{a}	3.1^{a}
Taste	3.9^{b}	3.4^{a}	3.1^{a}	3.2^{a}	3.1^{a}
Texture	3.8^{c}	$3.0^{a,b}$	3.3^{b}	$3.0^{a,b}$	2.7^{a}

Notes: F0: Control – Milk Yogurt, **F1**: Garut Red Beans, **F2**: Mung Beans, **F3**: Garut Red Beans+ Salak Flour 2%, and **F4**: Mung Beans + Salak Flour 2%. *Mean values with different superscripts within a column are significantly different (p < .05)

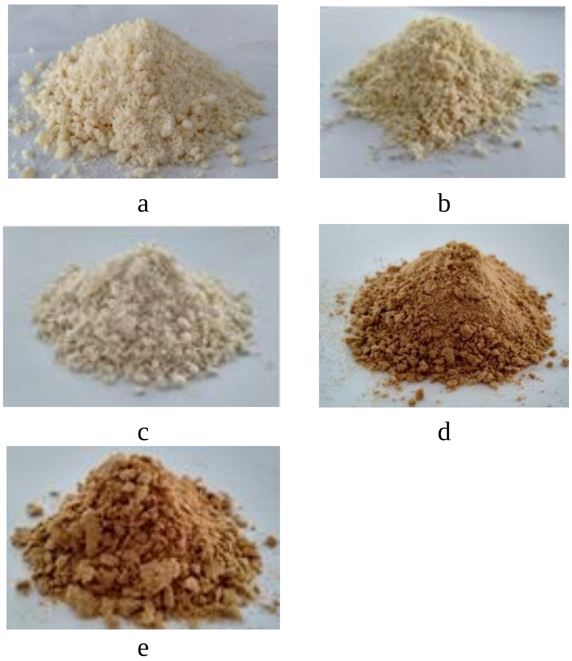

Figure 1. Appearance of yogurt powder in some treatments, (a) control, (b) Mung bean yogurt, (c) Garut bean yogurt, (d) Mung bean – Salak Manonjaya yogurt, and (e) Garut Red bean yogurt.

Table 5. The Acidity Values (pH) of Juice, Yogurt, and Synbiotic Yogurt on Various Treatments

Type of Product/ Treatment	Indicator pH value
Milk/ Juice (M)	
Milk (Control)	6
Mung Bean Juice	6
Garut Red Bean Juice	5
Milk (Juice + Sugar) Mung Beans	6
Milk (Juice + Sugar) Garut Red Beans	6
Yogurt (Y)	
Yogurt *ready to drink* from the market Brand 1 (Control 1)	5
Yogurt *ready to drink* from the market Brand 2 (Control 2)	5
Yogurt from Control milk	5
Nutgurt Mung Beans	5
Nutgurt Garut Red Beans	5
Yogurt Synbiotic	
Nutgurt Mung Beans + Manonjaya Salak Flour	5
Nutgurt Garut Red Beans + Manonjaya Salak Flour	5

extract [21]. The final product registered a pH of 4.16-4.21. Conversely, when cane fruit extract was added, the product showed a final pH of 4.16-4.20 [22]. Another study produced a yogurt enrich papaya have a pH of 5,66-5.82 [17]. Other study was reported the yogurt from pineapple, corn, banana, pumpkin, and sweet potato have pH between 3.92 to 4.66 [23].

Researchers utilizing local raw materials have comprehensively explored the various synbiotic yogurt products. One of the studies was conducted by adding filtrate of the Dahlia tuber flour (3%) to manufacture synbiotic yogurt. The resultant synbiotic yogurt has a total Lactic Acid Bacteria (LAB) of 2.4 x 10^8 cfu/ml and pH 4.2, which meets the required benchmark for SNI of Lactic Acid Bacteria population in yogurt (write the benchmark here) [24]. Yogurt supplemented with jam and persimmon puree as much as 10% and 12% produces a pH value of 4.59-4.65 [25]. Conversely, adding the fiber of passion fruit produces a pH of 4.42-4.47 [26], while adding cashew nuts yields a pH of 4.40-5.45 [27].

Likewise, red bean yogurt supplemented with the prebiotic banana flour [28] gave a product with a total of LAB of 3.00 x 10^6 cfu/ml. The improved LAB population can be ascribed to banana flour containing 1% inulin. The presence of 1-3% inulin represents a good physiological property of synbiotic products. A similar study also prepared banana flour yogurt that gave a higher total LAB of 6.9 x 10^8 cfu/ml, with a final pH of 4.87 [29].

The nutritional content, especially carbohydrate and fiber, found in the Manonjaya salak flour from this study [5], can be a source of energy for LAB. The increase in the energy sources can stimulate the growth of LAB in producing lactic acid so that it affects the pH value [30]. The high LAB population and relatively low final pH of the yogurt can be good to human health [31–34]**.** Having banana as a component of yogurt imparts the benefit of its cholesterol-lowering property. Pertinently, their prepared yogurt offers a healthy food alternative is due to the yogurt's low-fat levels, combined with the high total LAB and propionic acid levels, and its pH is closest to optimal pH of human gut [29].

In this study, adding Manonjaya salak with high fiber content in yogurt from nuts was intended as a prebiotic for its antimicrobial property due to its high sugar content. Previously, it was shown that supplementing with date flour with a high sugar content could extend the shelf life of the yogurt and effectively eliminate the presence of total and fecal coliform, *Staphylococcus aureus*, *faecal streptococci* and *Salmonella* [35]. Also, non-fat synbiotic yogurts supplemented with inulin from Yam flour exhibited LDL cholesterol-lowering properties in hypercholesterolemia mice [4]. The product form this research must be down-streamed to the micro, small, and medium enterprises (MSME) as an activity was done by the researcher [36-38].

Conclusion

Based on the findings, the freeze-dried yogurt powders comprising the combination of Garut red- and mung beans and Manonjaya salak powder components appear to meet Indonesian national standards (SNI). The results showed that the freeze-dried yogurt powder from nuts and Manonjaya salak flour has a better moisture content than other yogurt powder. Total factors of % brix and pH of yogurt powder were similar to other studies, in which the viscosity of the prepared yogurt varieties in this study showed viscosities ranging between 5.57 to 9.87 %Brix, pH values between 5.0 to 6.0 and Moisture content between 10.39 to 17.00%. Panelists could accept organoleptic yogurt nuts and Manonjaya salak, based on their high scores for color (3.2-3.7).

Based on the currently results, future studies would encompass testing on the efficacy of this product *in-vivo* for improving gut health. Further analysis of the nutritional properties of the prepared Garut red- and mung beans and Manonjaya salak flour yogurt powder is also required to support its feasibility as a functional food.

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