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Performance Improvement of Microbial and Rheological Characteristics of Dehydrated Cow-goat Yogurt Powder Based on Their Combination and Drying Methods

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Abstract

Yogurt powder is dehydrated products producing by one of drying methods based on removal moisture or reduces water activity of finally product, which increase the shelf life of food. Rehydration is an importance part in viability of bacteria cells (lactic acid bacteria) in the product of powder fermented. This study is aimed to treatment cow and goat yogurt powder with rehydrate processing to provide suitable rehydration method. Methods of Ibrahim and Pestana were employed to make yogurt and drying by freeze-dryer and spry-dryer, whilst Indonesia National Standards (SNI) with Association of Official Analytical Chemistry International (A O A C), used to analyzed the parameters of rehydrated yogurt. T-test were performed to evaluate the difference between data by Microsoft Excel Version 13, and separate between means used Multiple Duncan Test. The rehydration conditions consider was; powder to water ratio (1:3, 1:4, and 1:5), respectively. These results shown there was significant different between rehydrated freeze-dried and spray-dried yogurt on viscosity, pH, titratable acidity and survival bacteria cells, whilst the water to powder ratio had significant effect on features properties of rehydrated yogurt. The study results established that the rehydration water ratio 1:3 by freeze-dryer gave generally better quality compared to fresh yogurt.

Keywords: *Yogurt, Dehydration, Rehydration, Physicochemical Properties*

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INTRODUCTION

Fresh yogurt is a functional ingredient and good source of nutrition, but can spoil if not maintained properly [1], [2]. Reasons for concentrating yogurt into powders include to decrease the costs for storing and transporting and to reduction water activity to increasing the stabilities of chemical and microbial [3]. Moreover, yogurt powder functionality is essential in many applications for cosmetics and nutrition supplementation, flavour development, viscosity modification, and texture [4], [5]. However, poor rehydration properties can impact process efficiency of yogurt powder application. Thus, it is important to understand and optimize rehydration properties for processing efficiency and for functionality in finished product application [6].

Rehydration is an importance part in viability of bacteria cells (lactic acid bacteria) in the product of powder fermented. Besides that, there are several factors, effecting in increase the bacteria cells rate, including the time, hydration rate, temperature and solution used to rehydration [7].

The reconstitution the powder of dairy a successful that are requesting four characteristics, included immerse ability, solubility, dispersibility and wettability. The control of hydration rate is depending by essential on the wettability of particles. The rapid dehydration is providing increased in a count of pores, decreasing the touching angle between the rehydration medium and powder surface, therefore simplification the rehydration operation. The emulsifier adding can contributing the processing efficiency, in the state of powder is rich in fats and the media of rehydration is hydrophilic [8].

The rehydration medium temperatures can influence on recovery of cells after dehydration. When increasing the temperature between 4 to 50oC, that increase the viability of lactic acid bacteria cells that prone to spray-drying, besides the rehydration medium temperatures can influence on recovery of cells after dehydration [9]. Also, the rehydration has two types, are rapid for two mints and slow for thirty mints, thus the time of rehydration has very importance in affect the viability of bacteria cells. Moreover, the slow rehydration led to increase cell activity, may be immersion method restricts osmotic chock [10], [11].

According to [12], who noted that the mechanical energy needed for join water for rehydration may affect the consistency of re-formed dried yogurt, or probably affected due to the weak gel network structure. Also, investigated that moisture reducing in the rehydration treatment as a method of rewarding or recommencing the lower motorized power. The products that were rehydrate at 70% with initial water gave the better rheological properties than rehydrated with 60percent and 100%. In the other side, the moisture content of final product depending on consumers acceptability. The objective of this study to investigated affect the drying method and water ratio to yogurt powder on sensory, rheological features and lactic acid bacteria amount of rehydrated yogurt.

METHODOLOGY

2.1. Manufacturing yogurt

The samples were prepared that are; mixed goat milk with cow's milk at size 75:25 (v/v), and then heated the mixed of milk at 85oC for 15s according to [28] and cooling between 42-45oC, in order was inoculating the culture with milk (culture size concentration 15%), and was incubation at 46oC to 8h. After that according to method [27]; [30], the yogurt samples were refrigerated at 50C to overnight.

2.2. Dehydration yogurt samples

Goat and cow yogurt samples were Prepared to dehydrating by spray-dryer and freeze-dryer (makes two samples). In the other side, the first samples were coded (SDY) and drying by spray-dryer based on checked the fresh yogurt total solids by refractometer, after that was added to yogurt sample maltodextrin material with level size (1:1) for facilitate of drying, and was dehydrated at inlet temperature 1600C, outlet temperature 86oC, and feeding temperatures at 15oC). Besides, the second samples were coded (FDY), and putted on the small plastics containers 24/litter, then was frozen between 80-82oC before dehydration, then drying at -71oC to 19h, according to method of [13], [3].

2.3. Rehydration of powder yogurt

The yogurt powder samples were coded RFD (rehydrating freeze-dried yogurt) and RSD (rehydrating spray-dried yogurt). Then both yogurt powder samples were rehydrated at water temperature 40°C for 30 minutes with water ratio to yogurt powder (1:3, 1:4, 1:5).

2.4. Determination physicochemical and microbiological parameters

The physicochemical parameter analysis (viscosity, total solids, pH, titratable acidity) of both rehydrated yogurt samples were determination according to methods recommended by [14], [15] and descriptive by [16]. The microbiology (TLAB) was analysed by the procedures recommended by [14], method of [17].

2.5. Sensory evaluation of rehydrated yogurt

The sensory assessment tests were determined according to 9-point hedonic scale, were using twenty participants from students of Food Science. The acceptability of taste, aroma, colour, texture and overall acceptance. method of [3].

2.6. Statistical analysis

The Completely Randomize Design (CRD) was employed to discuss the results. T-test was performed to evaluate the difference between data by SPSS Version (25) and Microsoft Excel (16). Was separating the means by Duncan test (P≥0,05). The analysis was carried out in triplicates. Method of [18].

RESULT AND DISCUSSION

3.1. Effect of water to powder ratio on rheological features and pH of rehydrated yogurt

Table 1. Viscosity of rehydrated freeze-dried and spray-dried yogurt

Samples	Viscosity (mm^2/s)		
	(P: W) 1:3	(P: W) 1:4	(P: W) 1:5
Freeze-dried yogurt	62^a	51^a	42^a
Spray-dried yogurt	45^b	33.5^b	26.3^b

P: w; water to powder ratio

The viscosity results of rehydrated freeze-dried and spray-dried yogurt showed in Table 1. These results shown that the viscosity values of rehydrated freeze-dried and spray-dried with water ratio 1:3 is upper value, and with water ratio 1:5 is lower value in both samples. there were significant differences P≥0.05 between both samples in viscosities values of three treatments. From this result the water ratio has a significant effect on decreased viscosity of rehydrated yogurt with increasing water ratio of rehydration. Also there were significant differences P≥0.05 between viscosities values of rehydrated freeze-dried and spray-dried on the all treatments of water ratio, this different in viscosities values of both sample due to powder structure and shape, water content in powder, weakening of the gel network structure and different drying method, because spray-dryer had effect on composition of final products by high temperature, that agrees

with [19], who reported the powder solubility is main measure of overall the quality of the reconfiguration, it represents the whole phenomenon of milk powder reconstitution, which consists of soluble components for example lactose, unchanged whey protein, as well as dispersible components as casein, [20], [21], who noted the amount of unsolvable ingredients construction in dairy products largely depends on the temperature of any heat application prior to drying as well as drying temperature. The poorer wettability, as reflected by lower dissolution rates, may be related to the decreased solubility of the denatured protein, and [12], who noted that the mechanical energy needed for join water for rehydration may affect the consistency of re-formed dried yogurt, or probable affected due to the weak gel network structure? Also, investigated that moisture reducing in the rehydration treatment as a method of rewarding or recommencing the lower motorized power. Moreover, rheological features were significantly affected by the quantity of water used for reconstitution of the freeze-dried sample, as shown in Table 1. Therefore, rehydrating powder of spray-dried has lowest viscosity and somewhat gelation than rehydrated yoghurt of freeze-dried. Therefore, this value is suitable for product, comparable to viscosity of fresh yogurt.

Table 2. The pH of rehydrated freeze-dried and spray-dried yogurt

Samples	Ph		
	(w: p) 1:3	(w: p) 1:4	(w: p) 1:5
Freeze-dried yogurt	5.16^{a}	5.43^{a}	5.40^{a}
Spray-dried yogurt	5.80^{b}	5.83^{b}	5.86^{b}

Table 2 exposed the pH values of rehydrated spray-dried, freeze-dried yogurt samples with three ratio waters for rehydration 1:3, 1:4, 1:5 was determined as 5.16, 5.43, 5.40 and 5.80, 5.83, 5.86 respectively. The pH values of rehydrated freeze-dried and spray-dried yogurt varied between 5.16 - 5.40, and 5.80 - 5.86 respectively. The pH values of rehydrated freeze-dried yogurt are lower than rehydrated spray-dried. From these results there were significant differences $P \geq 0.05$ between rehydrated yogurt of both samples in pH values. This different may due to powder structure and shape, water content in powder yogurt sample, different drying method, protein content, water ratio for rehydration and weakened of the gel network structure. Moreover, these variations in the pH-value may due to the presence of deformed or denatured whey proteins that interact with themselves in a hot system. In fact, it is well-known that unheated milk is governed by casein build-up. In the hot milk, the complex mutilated whey protein forms with itself and with K casein and precipitates at highest pH value before true casein precipitation and coagulation [22]. Also, this result displays the effect of water rehydration ratio on increased pH values of rehydrated yogurt when increase water ratio for rehydration and vice versa, that agrees with [12], they mentioned that the product rehydrated with 70% of initial water gave the better rheological properties than rehydrated with 60 and 100 percent. In the other side, the moisture content of final product depending on consumers acceptability. Moreover, the chemical and physical analysis were significantly influenced by the sued size of water to reconstitute the freeze dried and spray- dried samples, that exposed on Table 2. Consequently, the recycled milk had a higher pH and was slightly acidic than conventional milk. In addition, those values are appropriate for the product, because according to traditional yogurt; [11], who noted that value of pH lower than 4,00 could lead to rejected by consumers.

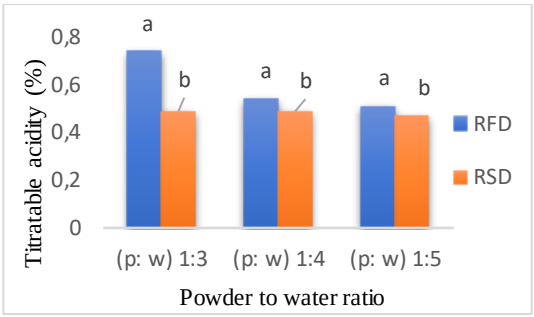

Figure 1. Titratable Acidity of freeze-dried and spray-dried rehydrated yogurt.
* RFD; Freeze-dried rehydrated yogurt, RSD; spray-dried rehydrated yogurt.

Figure 1 shown acidity values of freeze-dried and spray-dried rehydrated yogurt. The acidity values of both freeze-dried and spray-dried rehydrated yogurts with three water ratio 1:3, 1:4, 1:5 respectively was among the recommended by the Identity and Quality Standards of Fermented Milk, because the values of acidity were 0.74, 0.54, 051 to 0.49, 0.49, 0.47 % lactic acid. From those results obtained there was significant differences P≥0.05 between both rehydrated yogurt in each treatment of water ratio for rehydration. These results in range of fresh yogurt acidity. Although [23] who recommended the suitable acidity ranging from 0,7-0,9 percent, besides (Santos et al., 2018) they obtained values of acidity varying between 0,9-1,5 percent.

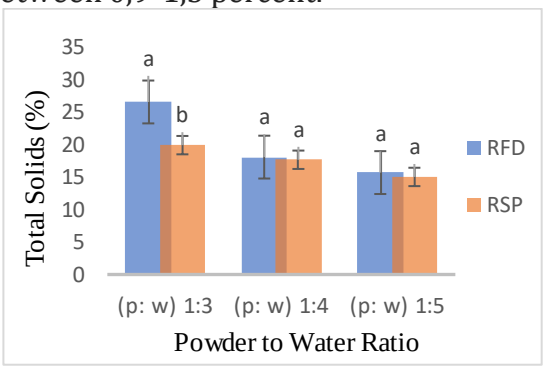

Figure 2. Total solids of freeze-dried and spray-dried rehydration yogurt
*RFD; freeze-dried rehydrated yogurt, RSD; spray-dried rehydrated yogurt.

The total solids values of freeze-dried and spray-dried rehydrated yogurt by three level of water ratio extended in Figure 2, respectively. since the total solid values were 26.54, 18.06, 15.68 and 19. 90, 17.65, 15.10%, correspondingly. The consistency of yogurt is an importance to consumers choosing, and this result allow determining the size of water that can be adding to rehydrate yogurt to get a reconfigured product with a texture coil that resembles the fresh yogurt. In this research, yogurt has a 1:3 ratio of water of both samples showed texture profile close to fresh yogurt. Moreover, the rehydrate ed yogurt with 1:3 water ratio of freeze-dried exposed beat in texture profile than rehydrated spray-dried yogurt. Moreover, the availability of product in the market, the size of water using to reconfiguration depending on the decision of the consumers. Large quantities of water reduce viscosity and increase the productivity of the reconstituted product.

3.2. Effect of rehydration on survival of yogurt powder bacteria cells

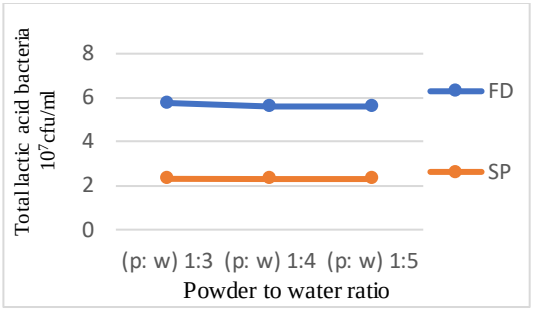

Figure 3. Viable bacteria cells of rehydrated yogurt
*FD; freeze-dried rehydrated yogurt, SD; spray-dried rehydrated yogurt

Total bacterial cells in samples rehydrated freeze-dried and spray-dried yogurt that treated with different levels of water 1:3, 1:4, and 1:5 shown in Figure 3. The total lactic acid bacteria result for all rehydrated yogurt samples were 5.76, 5.6, 5.6, 2.31, 2.3 and 2.3 x 107cfu / ml, respectively. From this result, there was a significant effect on the viable cells of bacteria in rehydrated freeze-dried and spray-dried. The bacteria cells remaining in the rehydrated freeze-dried yogurt are higher than the rehydrated spray-dried yogurt. These may due to the drying method, drying temperature and the drying conditions. [11], [6], whey noted that freeze-drying could be preserving microbial, nutritive value, and organoleptic properties of yogurt [24], who stated that the survival of yogurt bacteria was also influenced by the temperature in Spray drying. According to Standards National Indonesia [14], [25], a minimum of 107cfu / ml viable bacteria cells in milk is required until feeding. In the line with these requirements, the number of bacteria in all samples of rehydrated yogurt (Figure 3) was greater than that required by legislation for both samples. This has proven that freeze drying is an excellent way to preserve the desired microbiological properties of yogurt. As [26] ; [27] have reported, fermented lactic acid in fermented milk helps keep bacteria stuck during the freezing stage, once low pH values lead to changes in bacteria membranes that help resist low temperatures. A study of the survival of probiotic lactic acid bacteria in freeze-dried fermented soy milk [3] shown the freeze-drying preserves a greater quantity of feasible bacterial cells with compared to spray drying.

3.3. Sensory profile of rehydrated freeze-dried and spray-dried yogurt

Table 3. Sensory Evaluation of Rehydrated Yogurt Samples

Samples	Color			Texture			Aroma			Taste			Overall accebtability		
	1:3	1:4	1:5	1:3	1:4	1:5	1:3	1:4	1:5	1:3	1:4	1:5	1:3	1:4	1:5
A	7.88	5.88	5.12	6.12	5.44	4.80	6.04	6.2	5.92	5.24	4.88	4.12	5.68	5.28	4.32
B	6.44	7.94	7.94	7.94	7.0	6.82	7.47	6.94	7.11	7.05	6.7	6.76	7.88	7.7	7.76

*A; rehydrated spray-dried yogurt, B; rehydrated freeze-dried yogurt

Table 3 displays the mean acceptance scores of the freeze-dried and spray-dried yogurt rehydration at 1:3, 1:4 and 1:4 powder to water ratio. The rehydrated freeze-dried yogurt was significant better accepted than reconstituted spray-dried yogurt for the all attributes. No significant variances were observed for the attributes colour, smell, taste

between samples of yogurt treated at different water ratio, whilst slightly significant effect of water ratio on decreased were observed for the attribute texture between all rehydrated yogurt samples. The mean acceptance scores correspond to the term liked so much representative high acceptance scores of the rehydrated freeze-dried yogurt at all water ratio for rehydration. this is indicating that the rehydrating freeze-dried yogurt at water ratio1:3 and 1:4 is similar slightly to traditional yogurt.

CONCLUSION

This study established that the rehydration of yogurt powder based on water to powder ratio had significant effect on viscosity, pH, titratable acidity, and survival bacteria cells of freeze-dried and spray-dried yogurt. Moreover, when decrease water ratio of rehydrating obtained the best quality of final product in both samples. The rehydration water ratio 1:3 by freeze-dryer gave generally better quality compared to traditional yogurt.

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CONFLICT OF INTEREST

The authors need to declare that there is no conflict of interest related to the writing or publication of this article.

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