

# Chemical and sensory characteristics of frozen wheygurt with the addition of taro and lesser yam flours as thickening agent

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**Abstract.** Cheese whey is a waste product from cheese processing. It has low solid contents thus required the addition of a thickening agent. Lactic acid bacteria could utilize it in the fermented drink. This research aims to study the effect of taro and lesser yam flour addition as a thickening agent on chemical and sensory characteristics of frozen wheygurt. This research used Complete Randomized Design (CRD) with one factor that is variation ratio of taro and lesser yam flour F1 (4: 0), F2 (3: 1), F3 (2: 2), F4 (1: 3), F5 (0: 4). The number of lactic acid bacteria cell determined by using hemocytometer. The lactic acid content determined by the titrimetric method by using 0.1 N NaOH and phenolphthalein as indicator. pH value measured with pH meter. Sensory characteristics evaluated using hedonic test. The result showed that the addition of taro and lesser yam flour have a significant effect on the number of lactic acid bacteria in frozen wheygurt. The higher lesser yam flour addition, the higher lactic acid bacteria count on frozen wheygurt, due to lesser yam higher glucose and fructo-oligosaccharide content than taro. The higher lesser yam addition, the higher the lactic acid produced. The higher the total bacteria and higher levels of lactic acid, the lower the pH obtained. The conclusion of this study is addition ratio of taro and lesser yam flour effect on the chemical characteristics of frozen wheygurt. There is no difference in the level of acceptance of the panelists in sensory evaluation.

Keywords: chemical, frozen, taro, wheygurt, yam

## 1. Introduction

In the manufacture of cheese will be obtained byproduct cheese way. Whey has a yellowish-green liquid form. For the manufacture of cheese as much as one kilogram will produce 9 kilos of cheese way[1]. Cheese whey still contain 0.006-0.0070% fat, 0.3% -0.9% protein, 3.04-5.00% lactose, ash 0.5-0.62%[2]. It can be processed into fermented products by the activity of lactic acid bacteria because there is lactose that can be used for growth sources [3].

Frozen yogurt is now an increasing trend among other fermented beverage products. Frozen yogurt is a dessert which combines the texture of ice cream with nutritional and yogurt health benefits[4]. The quality of the texture of frozen yogurt depends on the milk fatty bean and total milk solids. The weakness of cheese way is due to the low total solids that make the derivative products have a lower viscosity than commercial fermented products[3].



To overcome the weakness is done the addition of thickening materials that can increase the viscosity of whey-based beverage products. Commonly used thickeners are hydrocolloids. One of the most common types of hydrocolloids used is starch. Starch from tubers is suitable for acids and frozen products such as frozen wheygurt[5]. Taro (*Colocasia esculenta* L.) and lesser yam (*Dioscorea esculenta* L) have the potential to be used as a thickener because of their high content (about 51.34-70.92%), and a similar ratio of amylopectin and amylose (taro 21.44: 78.56 and lesser yam 24.30: 75.7).

However, these two materials have different gelatinization profile. Taro starch has high peak gelatinization viscosity[6] thus makes ice cream made from taro starch can melt slowly[7]. Lesser yam starch has low peak gelatinization viscosity[8] thus makes ice cream can melt in an ideal time range[9]. In this study, taro and lesser yam flour are combined to find the best chemical and sensory characteristics of frozen wheygurt. Furthermore, these two tubers have prebiotic substance which can be utilized as lactic acid bacteria (LAB) growth medium in human digestion system and metabolites formation, such as oligosaccharides in taro[10] and inulin in lesser yam[11].

This study aimed to determine the effect of taro and lesser yam flour on frozen wheygurt chemical and sensory characteristics.

## 2. Materials and Methods

### 2.1. Materials

Mozzarella cheese whey obtained from cheese industry in Boyolali (Indonesia). Lactic acid bacteria used in this study were *Lactobacillus acidophilus* FNCC 0051 and *Lactobacillus plantarum* FNCC 0027 from Food and Nutrition Culture Collection Gadjah Mada University Yogyakarta (Indonesia). Taro flour bought from Naya Tepung Bogor (Indonesia) and lesser yam flour bought from Kusuka Ubiku Bantul (Indonesia). Other materials used in frozen wheygurt preparations were egg yolk, sucrose (Gulaku®), whipping cream (Anchor®, 33.33% fat).

### 2.2. Starter preparation

The production of frozen yogurt starter is done by using [34] method with modification. Both *L. acidophilus* FNCC 0051 and *L. plantarum* FNCC 0027 were inoculated in separate sterile deMan Rogosa Sharpe (MRS) broth medium and incubated at 37°C for 24 hours. 2% (v/v) of each culture of MRS broth were inoculated to 100 ml pasteurized skim milk and incubated at 37°C for 24 hours. The cultured skim milk contains 10<sup>8</sup> cells/ml of bacterial cells.

### 2.3. Frozen wheygurt preparation

The process of frozen wheygurt making was done by using [35] method with modification. Frozen wheygurt was prepared by mixing the materials (cheese whey, 12% (w/v) sucrose, 13% (w/v) whipping cream, 2% (w/v) egg yolk and 2,5% (w/v) thickener) for 10 minutes. The mixtures were pasteurized at 75°C for 30 min and cooled until 45°C. 2% (v/v) of each *L. acidophilus* and *L. plantarum* culture starters were inoculated into pasteurized mixtures and incubated at 37°C for 18 hours. Frozen wheygurt then refrigerated for 5 hours, frozen for 30 minutes at -18°C for 30 minutes, mixed using a mixer for 20 minutes and frozen for 24 hours.

### 2.4. Chemical characteristics analysis

The lactic acid bacterial cell was determined by using hemocytometer[12]. Lactic acid was determined by the titrimetric method by using NaOH 0.1 N and phenolphthalein as indicator<sup>13</sup>. pH value was measured with pH meter<sup>14</sup> Oakton PCS\_Tester 35.

### 2.5. Sensory characteristics

Sensory characteristics were evaluated using hedonic test[5] for color, flavor, mouthfeel, viscosity and overall parameters.

### 3. Results and Discussion

#### 3.1. Chemical characteristics of frozen wheygurt

3.1.1. *Lactic acid bacteria count.* The standard of viable lactic acid bacteria (LAB) to be consumed is  $10^8$  viable cells[16]. Results obtained have met the standard of LAB (Table 1). The results showed that addition ratio of taro and lesser yam flour have a significant effect on the number of LAB in frozen wheygurt. The higher lesser yam flour addition, the higher LAB count on frozen wheygurt, due to lesser yam higher glucose and FOS content than taro[17]. *Lactobacillus* does fermentation selectively, where short oligosaccharides preferred over oligosaccharides with long chains. When fermentation media are simple sugars such as sucrose and glucose in small quantities, the *Lactobacillus* bacteria group would prefer to conduct the fermentation of simple sugars[18]. LAB viability of the final product is influenced by several factors, such as bacteria strain used, the interaction between the bacteria strains, the composition of fermentation medium and inoculum size<sup>16</sup>.

*Lactobacillus acidophilus* is a bacteria which grows optimally at 37-42°C. This bacteria had the highest growth rate at pH 5.5-6.0 and began to decline in pH 4.0. *L. acidophilus* is an obligate homofermentative bacteria[19]. *L. plantarum* is a facultative anaerobe heterofermentative bacteria. Mesophilic bacteria is classified as a bacteria which can grow at 15-45°C and pH 4.0-9.0[20]. *L. acidophilus* and *L. plantarum* inoculum size in their pure state have a higher number of cell density compared to the combination of both. However, combination cell density number still met the recommended standard of the viable LAB in a product[21]. The combination of *L. plantarum* and *L. acidophilus* did not affect the viability of bacteria in the final product[22]. The amount of inoculum is a key factor to ensure an adequate number of living cells in the final product. The use of high inoculum concentrations will guarantee the number of bacteria cells at the end of the incubation and maintain the viability of LAB during storage to consumption[16].

**Table 1.** Effect of taro and lesser yam flour as thickener agent on chemical characteristics of frozen wheygurt\*

Formulation Taro: Lesser Yam	Lactic acid bacteria number (log cell/ml)	Lactic acid (%)	pH
4:0	8,916 <sup>c</sup> ± 0,207	0,405 <sup>d</sup> ± 0,023	4,48 <sup>c</sup> ± 0,023
3:1	9,284 <sup>b</sup> ± 0,086	0,470 <sup>c</sup> ± 0,020	4,64 <sup>e</sup> ± 0,013
2:2	9,366 <sup>b</sup> ± 0,049	0,542 <sup>b</sup> ± 0,016	4,55 <sup>d</sup> ± 0,024
1:3	9,536 <sup>a</sup> ± 0,064	0,566 <sup>ab</sup> ± 0,020	4,33 <sup>b</sup> ± 0,021
0:4	9,647 <sup>a</sup> ± 0,095	0,588 <sup>a</sup> ± 0,283	4,22 <sup>a</sup> ± 0,028

\*Notation different letters in the same column indicate significantly the difference at a significance level of 5%

3.1.2. *Lactic acid.* The main role of lactic acid bacteria is to convert lactose into lactic acid during the fermentation of milk[16]. Total lactic acid showed concentrations of lactic acid as a result of metabolism of milk lactose into galactose and glucose[23]. The results showed the addition ratio of taro and yam flours have a significant effect on the lactic acid level in frozen whey yogurt. The higher lesser yam addition, the higher the lactic acid produced. Lactic acid was found to correlate positively with total lactic acid bacteria produced where the higher the number the higher the lactic acid bacteria produced. Lesser yam addition can produce higher levels of lactic acid as lesser yam contains FOS and glucose higher than taro[17]. FOS and inulin in can also be an addition to increasing the growth of lactic acid bacteria also produce short-chain fatty acids or short chain fatty acid (SCFA). Propionic acid is one result of fermentation of prebiotics by lactic acid bacteria. The addition of flour in the manufacture of wheygurt can increase the levels of propionic acid produced[24]. The propionic acid produced is calculated as a lactic acid because the testing method used is a total titrated acid[13].

**3.1.3. pH.** The results showed the addition ratio of taro and lesser yam flours have a significant influence on the pH value of frozen yogurt. Due to lesser yam higher glucose and FOS contents than taro[17], thus LAB growth, metabolism, and lactic acid formation are higher in the sample higher addition of lesser yam. pH is obtained in accordance with the levels of lactic acid and total bacteria. The higher the total bacteria and higher levels of lactic acid, the lower the pH obtained.

The growth of bacterial cells followed by the formation of primary metabolites such as lactic acid derived from the change of the sugar content in the medium. The accumulation of lactic acid resulted in a decrease in pH[25]. A decrease in the degree of acidity (pH) caused by H<sup>+</sup> ions derived from acidic compounds overhauled from lactic acid metabolism. Lactic acid is produced as the main product will dissociate producing H<sup>+</sup> and CH<sub>3</sub>CHOHCOO<sup>-</sup>, so the increase of lactic acid allows more H<sup>+</sup> to be liberated in the medium and pH can decrease further[26]. However, in this study the decrease in acidity that is not proportional to the increase in total lactic acid. This can be caused by propionic acid produced by both bacteria strain used[24] as a result of metabolism FOS and inulin from lesser yam. *L. plantarum* is a strain of bacteria which can produce metabolites other than lactic acids, such as acetic acid to lower the pH. Lactic acid is the main organic acid produced by *L. plantarum*, but acetic acid is also produced in smaller quantities[27]. In addition, the acid measured by pH meter is a concentration of H<sup>+</sup> ions which indicate the amount of dissociated acid, while the total titrated acid shows measurements for all the components of acid, either dissociated or not[28].

### 3.2. Sensory characteristic of frozen wheygurt

**3.2.1. Color.** Color is one of the first aspects which affect consumer acceptance of a product. Color is the most important quality attributes[29]. The results showed the addition ratio lesser yam and taro flours have a significant influence on the color parameters frozen wheygurt. Based on Table 2 it can be seen that in the color parameter, the sample of frozen wheygurt with the addition ratio of 4: 0 and 3: 1 is preferred by the panelist. This is due to frozen wheygurt with the addition of more taro flour ratio will have a whiter color compared to frozen wheygurt with the addition of lesser yam flour.

**Table 2.** Sensory characteristic of frozen wheygurt\*

Formulation	Color	Taste	Mouthfeel	Viscosity	Overall
Taro: Lesser Yam					
4:0	2,04±0,89 <sup>a</sup>	2,92±0,86 <sup>a</sup>	2,72±0,74 <sup>a</sup>	2,92±0,86 <sup>a</sup>	2,60±0,71 <sup>a</sup>
3:1	2,28±0,68 <sup>a</sup>	2,92±1,12 <sup>a</sup>	2,72±0,79 <sup>a</sup>	2,84±0,62 <sup>a</sup>	2,96±0,68 <sup>a</sup>
2:2	2,92±0,76 <sup>b</sup>	2,76±0,83 <sup>a</sup>	2,76±0,66 <sup>a</sup>	2,80±0,71 <sup>a</sup>	2,84±0,90 <sup>a</sup>
1:3	3,08±1,15 <sup>b</sup>	2,48±0,77 <sup>a</sup>	2,68±0,80 <sup>a</sup>	2,92±0,81 <sup>a</sup>	2,72±0,79 <sup>a</sup>
0:4	2,84±1,07 <sup>b</sup>	3,04±1,10 <sup>a</sup>	3,04±0,84 <sup>a</sup>	2,88±0,78 <sup>a</sup>	3,04±0,89 <sup>a</sup>

\*Notation different letters in the same column indicate significant difference at a significance level of 5%

Score 1: extremely dislike, 2: dislike, 3: neutral, 4: like, 5: extremely like

**3.2.2. Taste.** Taste is a very important factor in determining consumers final decision to accept or reject a food product[30]. Taste is an important attribute in the reception of ice cream. Balance in sweetness levels needs to be maintained to produce an acceptable taste[31]. The results showed that addition ratio of taro and lesser yam flours do not affect frozen wheygurt flavors parameter. Based on the data in Table 2 on taste parameters panelists showed preference level ranged from 2.48 to 3.04 (criteria like to neutral). Sample with the highest panelist acceptance response samples with taro and lesser yam flour addition ratio 1: 3. While the sample with the lowest acceptance level is a sample with taro and lesser yam flour addition ratio 0: 4.

**3.2.3. Mouthfeel.** Mouthfeel parameter is a response to the texture and body of frozen yogurt in the oral cavity[32]. Body is defined as the overall quality perceived by the mouth, while the texture is

defined as partial qualities that makeup as a whole[33]. The texture of the ice cream related directly to the structure. The structure depends on the size, number and arrangement of the trapped air, ice crystals, crystal lactose and fat globules[31].

The results showed that the addition ratio of taro and lesser yam flour and has no significant effect on the mouthfeel parameters of frozen wheygurt. Based on data in Table 2 on mouthfeel panelists showed preference level ranged from 2.68 to 3.04 (criteria like to neutral). Sample with the highest panelist acceptance response is a sample with taro and lesser yam addition ratio of 1: 3. While the sample with the lowest acceptance level is a sample with taro and lesser yam addition ratio of 0: 4.

**3.2.4. Viscosity.** The results showed taro and lesser yam ratio addition does not have a significant effect on the viscosity parameter frozen wheygurt. Table 2 on the viscosity parameter indicates the level of preference panelists ranged from 2.80 to 2.92 (criteria like to neutral). Sample with the highest panelist acceptance response is a sample with the taro and lesser yam addition ratio of 2: 2. While the samples with the lowest acceptance level are a sample with taro and lesser yam addition ratio of 4: 0 and 1: 3.

**3.2.5. Overall.** The overall parameter is a response which includes a general assessment results panelists that include color, aroma, texture, and taste of a sample[30]. The results showed that taro and lesser yam flours addition ratio have no significant effect on the overall parameters of frozen wheygurt. Table 2 on overall parameter indicates the level of preference panelists ranged from 2.60 to 3.04 (criteria like to neutral). Sample with the highest panelist acceptance response is a sample with taro and lesser yam flours addition ratio of 4: 0. While the sample with the lowest acceptance level is a sample with the taro and lesser yam addition ratio 0: 4.

#### **4. Conclusions**

Addition ratio of taro and lesser yam flour effect on the chemical characteristics of frozen wheygurt. Sample with higher lesser yam addition has better chemical characteristic compared to sample with higher taro addition. Addition of taro and lesser yam flour do not affect frozen wheygurt sensory evaluation.

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