Food and Public Health 2013, 3(5): 235-239
DOI: 10.5923/j.fph.20130305.01

Production and Processing of Yoghurt Powder Using Foam-Mat Drying

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Abstract In this study, powder yoghurt was conducted using 20% maltodextrin, 1.25% tween 80 of total material using foam-mat drying based on optimized conditions. The product covered the component of its nutrition content to the effect of foam-mat drying. This condition was found that moisture, protein, fat, ash content were 10.3%, 31.2%, 36.2%, 6.7%, respectively. The pH was 6.6; the total Lactic Acid Bacteria (LAB) was 12×10^6 CFU/g and it was proven that the powder yoghurt had been organoleptically accepted by the panelist. The present findings, especially on the powder yoghurt using foam-mat drying will provide a new opportunity for application in the food indusrty.

Keywords Yoghurt Powder, Foam-mat Drying, Optimum Condition

1. Introduction

Yoghurt is a popular fermented milk products having different names and forms by a culture of lactic acid-producing bacteria, *Lactobacillus delbrueckii* subsp. *bulgaricus* and *Streptococcus thermophilus*[1]. This product is among the most common dairy products consumed around the world, and its sensory attributes have a large effect on consumer acceptability[2]. Furthemore, yoghurt has been continuously modified to obtain a product with better appeal and nutritional effects and the flavor components of yoghurt are affected because of these modifications to produce yoghurt with different parameters and modifications on form, aroma, taste and nutrients value of yoghurt[3].

The new form of yoghurt is in powder form. Drying yoghurt had been studied to preserve it in a shelf-stable powdered form of high quality without the need of refrigeration[4]. Yoghurt powder is manufactured in order to store the product in a stable and readily utilizable state. Yoghurt has been present in the human diet in many parts of the world because of acceptance of its taste[5].

In order to improved the shelf life, Narchi et al.[6] have been studied foam-mat technic for liquid food product in laminar flow conditions. This is in agreement with the findings by Ratti and Kudra[7] who reported that foam-mat drying is done at lower temperatures and shorter drying times, when compared to non-foamed material. However, there is limited information on the effect foam-mat drying on the nutrition of powder yoghurt, we became intersted in carrying out the present research in order to determine the optimum condition of powder yoghurt processing if combined with tween 80, maltodextrin and foam-mat drying on the nutrition of powder yoghurt.

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2. Materials and Methods

The work was carried out in the laboratories of the Department of Agroindustrial Technology, Faculty of Agricultural Technology, Brawijaya University, Malang, Indonesia.

2.1. Sample Preparation

Fresh milk was obtained from Jawa Timur, Indonesia. Cultures used were *Lactobacillus delbrueckii* subsp. *bulgaricus* and *Streptococcus thermophilus*.

2.2. Preparation of Powder Yoghurt

To commercial plain yoghurt was added 20% maltodextrin, 1.25% tween 80 of total material (based on optimum condition). The mixture was homogenized using a mixer at low speed for 10 minutes. The rough obtained were scattered on the baking pan with aluminium foil and dried at 52℃ and the dried rough was then blended and shifted using sieve of 100 mesh.

2.3. Analysis of Powder Yoghurt

Characteristics of powder yoghurt, as moisture, protein, fat, ash, pH content total lactic acid bacterial, were determined for optimum level of powder yoghurt

2.3.1. Moisture Content Determination

The moisture content of the yogurt products was determined according to the Association of Official Analytical Chemists method[8]. Samples (5 mL) were transferred into the plates, then placed in an oven and dried at 105℃ for 24 hours. The plates were cooled in desiccator and weighed. Moisture content was calculated as followed:

$$\frac{B-C}{B-A}\ x\ 100\%$$

where :

A = weight of plate
B = weight of sample + weight of plate before drying
C = weight of plate + weight of sample after drying

2.3.2. Protein Content Determination

Protein content was analyzed using Kjedhal method as described by AOAC[8]. Samples (0.25 g) were transferred into the Kjedhal flask containing concentrated sulphuric acid and the mixture of selenium were destructed by heating at room until the mixture become clear. The mixture was diluted. Samples were distillated and titrated with 0.1 N $KH(IO_3)_2$ until the colour of mixture was altered. The similar method was prepared to determine the blank. Protein content was calculated as followed:

$$\frac{(A-B)x\ Px\ 14\ x\ 6.38}{Weight\ of\ sample}\ x\ 100\%$$

where:

A = mL titrated of sample
B = mL titrated of blank
P = mL diluted

2.3.3. Fat Content Determination

The fat content was determined by the modified Mojonnier ether extraction method[9]. Before the solvent extraction step can begin the sample must be dried using oven and cooled using desiccator. Samples (5 g) were transferred into thimble line with a circle of filter paper and containing a small amount of sand. Mixing the sand and with the samples was done with a glass rod, wipe glass rod with filter paper strips, and place strips in thimble. Extract the sample contained in the thimble with ether for at least 80 cycles in a minimum of 5 hours in a Soxhlet extraction apparatus until most of the ether is removed.

Take apart the Soxhlet unit and place flask on a steam bath to evaporate the remaining petroleum ether. Swirl flask initially to avoid boil over. Dry flask and its contents in a mechanical convection oven at 105℃ to obtain constant weight and cooled it to room temperature. Fat content was calculated as followed:

$$\frac{Weight\ of\ Fat}{Weight\ of\ Sample}\ x\ 100$$

2.3.4. Ash Content Determination

The ash content of each of dry yoghurt samples was determined at 550℃ for 6 hours according to AOAC[8]. The samples were cooled using dessicator and weighed as d g. Ash content was calculated as followed:

$$\frac{d-a}{b-a}\ x\ 100\ \%$$

where:

a = dried test specimen (g)
b = oven
d = sample (g)

2.3.5. pH Measurement

The pH was determined at room temperature (27℃) and was calibrated with bufer standards of pH 4 and pH 10 prior to use. 50 mL of powder yoghurt was placed in a beaker, the probe of the pH meter was inserted and pH value was recorded. This measurement was done on opening of the powder yoghurt.

2.3.6. Total Lactic Acid Bacteria (LAB)

Serial dilutions of the powder yogurt was elaborated using sterile distilled water. One mL of the samples were inoculated in MRS (de Man Rogosa and Sharpe) and incubated at 37℃ for 48 hours. The total counts were enumerated and results expressed as colony forming units (CFU) per grams.

2.4. Sensory Evaluation

Staff and students (15 panelists) of the Department Agroindustrial Technology, Faculty of Agricultural Technology, Brawijaya University, used to consuming powder yoghurt, were asked to assess both commercial product and powder yoghurt samples for aroma, taste, and colour by hedonic scale scoring of 1-9.

3. Results and Discussion

3.1. Moisture Content

The optimum condition moisture content of powder yoghurt was 10.3%. This result is similar to the value reported by Krasaekoopt and Bhatia[5] who found the moisture content of powder yoghurt dried at 50-70℃ was 8.5-8.6%; and Kiiru and Ojijo[9] reported that the moisture content was 11%. Whilst Childs and Drake[10] reported that the moisture content of commercial product was 3.0-5.0%.

The greater the temperature and the air flow speed of dryer could lead drying process faster. The greater the temperature difference between the particle and the drying air, the greater the heat transfer into the particle and thus, the greater the evaporation rate[9]. During drying of yoghurt foam, the water was removed from the three dimension structure of yoghurt, resulting in amorphous structure of yoghurt powder. Thus, water could be removed and evaporated from the material issue[5]. The next factor that affects moisture content decrease in processing yoghurt powder is the use of maltodextrin. Rahyuni et al.[11] noted that maltodextrin has a molecular mass less than 4000 and has a simple molecular structure, therefore water could be removed in drying processing. On the other hand, they also used tween 80 as foaming agent which increased the drying rate.

3.2. Protein Content

The optimum condition protein content of powder yoghurt was 31.2%. This value is smaller than that reported by Childs and Drake[10] who reported that the protein content of commercial product was 36%.

Heat may lead destruction on protein of food product as heat could destroy hydrogen bond and the non-polar hydrophobic interactions. The high temperature could increase the kinetic energy and lead the molecules of protein moving or vibrating faster, hence lead damage the molecule bond and protein of milk occured denaturation and coagulation during drying process[12]. Denaturation of proteins involves the disruption and possible destruction of both the secondary and tertiary structures. In tertiary structure there are four types of bonding interactions between "side chains" including: hydrogen bonding, salt bridges, disulfide bonds, and non-polar hydrophobic interactions, which may be disrupted[13].

Although protein content was decreased, however, protein of powder yoghurt in this study is still high as one of raw material used was skim milk, as noted by Hattingh and Viljoen[14]. Whilst Codex[15] noted that the protein of skim milk was 34%. Endang et al.[16] also noted the addition of maltodextrin and tween 80 during drying temperature could covered protein.

3.3. Fat Content

The optimum condition fat content of powder yoghurt was 36.2%. This present study is less than that reported by Childs and Drake[10] who reported that the protein content of commercial product was about 33-36%.

Drying processing could decreased fat content due to the oxidation to the fat. Oxidation is an interaction process between oxygen molecules and all of different substance. Or in other words, oxidation is the released of electron by a molecule, atom, or ion that leads to damage and alteration of certain compounds[17].

3.4. Ash Content

The optimum condition ash content of powder yoghurt was 6.7%. Mineral cannot contribute significantly to the physico-chemical treatment during processing and the presence of oxygen. However, several mineral may oxidized and become minerals of higher valence and do not affect its nutritional value. Although several component of food suffers destruction by thermal proces, this processing did not affect the mineral content. The minerals contained in yoghurt were sodium, potassium, calsium, magnesium, potassium and iron ions. Magnesium is able to prevent the formation of histamine from amino acid and histidin. Due to the presence of minerals such as magnesium, histamine is released in allergic reactions and cause itching and pain on the skin, hence powder yoghurt could hold the production of histamine[18]. Other mineral such as sodium and potassium are electrolytes that maintain normal fluid balance inside and outside of cells and a proper balance of acid and bases in the body and deficiency of these elements may result in muscle cramp and hypertension and also iron takes part for haemoglobin formation, normal functioning of the central nervous system and in the oxidation of carbohydrates, proteins and fats[19].

3.5. pH

The optimum condition of pH for the powder yoghurt was 4.6. It is similar to the value reported by Davis[20], he found that the pH of powder yoghurt was about 4.14-4.26 and 3.69-4.62.

Lactid Acid Bacteria found in powder yoghurt could produce a large number of lactic acid as end product of carbohydrate metabolism. This lactic acid will affect the pH values and produce sour taste[20]. Similarly, pH value is decreased as produce acidification condition by bacterial activity, and not because of heating materials[14].

3.6. Total Lactic Acid Bacteria (LAB)

The optimum condition total LAB of powder yoghurt was 12×10^6 CFU/g. This is smaller than the values reported by Krasaekoopt and Bhatia[5] who found that total LAB of powder yoghurt was 5.6×10^7 CFU/ml and Kiiru and Ojijo[10] who found total LAB was 1.4×10^7 CFU/ml. It should be noted that the LAB in powder yoghurt should meet the criteria of suggested minimum number of 10^7 CFU/ml. From above results it can be noted that this study did not meet the suggested minimum value, probably because of the drying temperature, which is the most important factor affecting the process.

Temperatures is the most important factor affecting the survival of yoghurt cultures as for each 10℃ rise in temperature will affected the survival of lactid acid bacteria[21]. There are reports in literature that the survival of lactid acid bacteria in powder yoghurt dried at 70-80℃ was 45%[22].

The level of viability of bacterial were considered sensitive to oxygen and heat[23] and caused destruction of cell bacterial[24]. Corcoran et al.[22] and Bielecka and Majkowska[21] reported that the drying temperature and less moisture content were the most important factor affecting theo viability of lactid acid bacterial.

3.7. Sensory Properties

Organoleptic profiles of powder yoghurt containing flavour, taste and colour. Aroma of powder yoghurt obtained was normal (typical of yoghurt) when compared to commercial product. This flavour was produced by *L. bulgaricus* which resulted in acethyldehyd as reported by Olugbuyiro and Oseh[25]. Powder yoghurt possessed sour taste similar to commercial powder yoghurt. The tasted of soured powder yoghurt are characterized by lactid acid fermentation such as *Streptococcus thermophilus*, which are able to fermentlactose, sucrose, glucose, fructose. Lactid acid itself is suggested to be one of the major compounds significantly contributing to yoghurt taste[26].

The optimum condition of powder yoghurt colour which was similar to commercial powder yoghurt was yelow to brownish. Ginting and Pasaribu[27] noted that the powder colour can vary depending on the feed and the amount of carotenoids contained in milk fat of fresh milk. While Harrison and Dake[28] noted that the colour of the powder alterated from yellownish to brownish due to the dry temperature, concentration of sugar and amino and also pH as the non-enzymatic reaction between an amino acid and reducing sugar, usually called maillard reaction.

4. Conclusions

At relatively high concentration, powder yoghurt had good nutrition content based on optimum condition. It is concluded that yoghurt is synergistically able to combine with tween 80, maltodextrin and foam-mat drying to produce powder yoghurt which could maintain the nutrition under such conditions.

ACKNOWLEDGEMENTS

The authors expresses their gratitude to the Department Agroindustrial Technology, Faculty of Agricultural Technology, Brawijaya University for facilitate this research.

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