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Formulation of Soygurt Mung Bean with Date Juice as Adjuvant Therapy for Diabetes Mellitus

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ABSTRACT

One innovative nutritional therapy approach for diabetic mellitus (DM) is modulating the gut microbiota by administering probiotics. Soygurt is a probiotic functional food made from fermenting soy milk with lactic acid bacteria (LAB), which includes bioactive peptides and antioxidants. The use of soybean, mungbean, and date juice as sweeteners is expected to increase the product's physicochemical quality as well as the presence of lactic acid bacteria, maximizing its benefits as a functional meal for DM. This study was an experiment that used a completely randomized design with three treatment formulas comparisons of soybeans and mungbean's (% : %) as follows F1 (25:75), F2 (50:50), and F3 (75:25). Protein content was determined using the biuret method, fat content was identified using the mojonieur method, the reduced sugar content was analyzed using the Nelson Smogyi method, crude fiber content was identified using the gravimetric, and LAB were determined using the Total Plate Count (TPC). The best formula was continued for clinical trials on animals. The result of F3 produced protein of 5.46%, fat of 2.36%, reduced sugar of 4.66%, crude fiber of 3.81%, and a pH of 4.139. The lactic acid bacteria (LAB) count in F1 was 1.9 x 108 CFU/mL. It concluded that soygurt mung bean with date juice can potentially control blood glucose levels due to its high protein and low-fat content.

Keywords: Soygurt, mungbean, date juice, chemical analysis, lactic acid bacteria, diabetes mellitus

Introduction

One innovative nutritional therapy approach for diabetes mellitus (DM) is modulating the gut microbiota by administering probiotics. Probiotics are known to significantly reduce fasting blood sugar, making them beneficial for those with impaired glucose metabolism (PERKENI, 2021). Probiotics are live microorganisms that are helpful to health and effective against a variety of chronic conditions. Soygurt is a probiotic functional food created by fermenting soy milk with lactic acid bacteria (LAB). Lactic acid bacteria exhibiting hypoglycemia effects also serve an important function in reducing insulin resistance by contributing to the formation of short-chain fatty acids (SCFA) and decreasing inflammation (Wang et al., 2020).

Soybeans contain bioactive peptides and antioxidants (Vitetta et al., 2023). Soy milk's antioxidant activity can be boosted through fermentation using bacterial hydrolysis, which releases antioxidant components such as flavonoids and phenols. Soybeans include isoflavones, which can improve insulin sensitivity and lower blood glucose levels (Rustanti & Prasetyo, 2019). This study also used mung beans as a substitute for milk protein sources. Oligosaccharides and polysaccharides in nuts provide energy for LAB growth (Arisanti & Islamiyah, 2020). Mung beans are an excellent source of protein, dietary

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fiber and micronutrients. Mung beans also have a low glycemic index, so they can increase glucose oxidation by increasing insulin (Hou et al., 2020).

Soygurt is sweetened with date juice, a natural source of glucose that replaces the need of sugar. Dates are the primary source of monosaccharides containing fiber (Al-Sahlany et al., 2023). Other nutrients contained in dates include riboflavin, niacin, pyridoxal, and folate. Dates provide a variety of health benefits, such as antidiabetic, antibacterial, anti-inflammatory, antioxidant, antihyperlipidemia, preventing anemia, rickets, osteomalacia, and facilitating childbirth for pregnant women (Rahmawati et al., 2021). Hariri et al. (2020) found that combining dates and milk provides functional food products with high nutritional value, good microbiological quality, and acceptability. The combination of soybeans and mung beans, as well as date juice sweeteners rich in bioactive peptides, antioxidants, fiber, oligosaccharides, and polysaccharides, can improve blood glucose homeostasis by boosting the amount of probiotic bacteria.

The combination of soybean extract, mung beans, and dates as sweeteners is expected to improve the product's physicochemical quality and the presence of lactic acid bacteria, maximizing its benefits as a functional food for diabetics.

Material and Methods

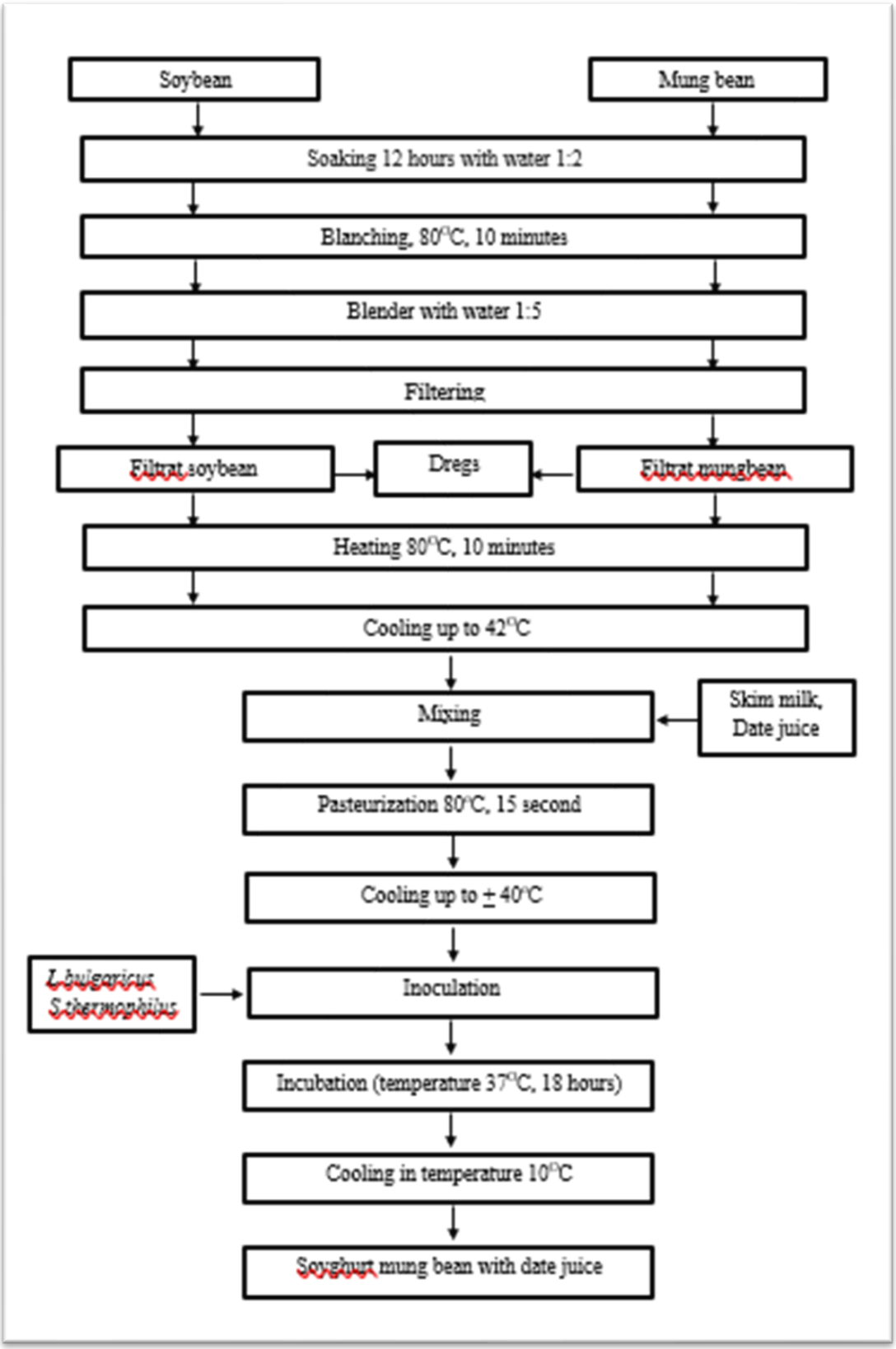
This study was an experiment that used a completely randomized design with three treatment formulas comparisons of soybeans and mungbeans (% : %) as:

Table 1. Formulation of soyghurt mung bean with date juice

Ingredients	F1	F2	F3	Purpose
Soybean (%)	25	50	75	As a yoghurt base
Mung bean (%)	75	50	25	As a yoghurt base
Skim milk (%)	5	5	5	Source of lactose in LAB growth
Date juice (%)	10	10	10	As a sweetener
Streptococcus thermophilus and *Lactobacillus bulgaricus.* (%)	0.1	0.1	0.1	As a bacterial starter

(Mufidah et al., 2021; Sari et al., 2021; Al-Sahlany et al., 2023)

This study used soybean and mung bean types grown by farmers in Grobogan, Central Java. The date juice used is pure commercially packaged date juice with no other additives; "Tamr" is a brand made in Sukoharjo, Central Java. Soy milk and mung bean juice are made at Muhammadiyah University of Surakarta's Food Science Laboratory. Making and testing process of Lactic Acid Bacteria (LAB) of mung bean soygurt with date juice was done at the Microbiology Laboratory, Muhammadiyah University of Surakarta. The Food Quality Analysis Laboratory of the Muhammadiyah University of Surakarta conducted proximate testing on mung bean soy yogurt and date juice. The biuret method was used to assess protein content, the mojonieur method to identify fat content, the Nelson Smogyi method to test reduced sugar content, the gravimetric to identify crude fiber content, and the Total Plate Count (TPC) to determine LAB. The most effective formula was continued for clinical trials on animals.



(Handayani & Wulandari, 2016; Mawarni et al., 2018; Labiba et al., 2020)

Figure 1. Soygurt making flow

Results and Discussion

Table 2. Nutritional and physicochemical quality results

Parameter	SNI 2981:2009	F1	F2	F3
Protein (%)	Min 2,7	3,44	3,95	5,46
Fat (%)	0,6 – 2,9	2,05	2.21	2,36
Reduced sugar (%)	-	3,42	4,02	4,66
Crude fiber (%)	-	4,14	2,99	3,81
pH	3,8 – 4,4	4,149	4,233	4,139
Lactid Acid Bacteria (CFU/mL)	Min 10^7	1,9 x 10^8	1,0 x 10^8	1,2 x 10^8

The protein content of the resulting soygurt ranges from 3.44 to 5.46%. Based on this data, the entire formulas fulfill the SNI for yogurt, which is a minimum of 2.7% (SNI 2981:2009). The highest protein content (5.46%) was found in the F3. This result differs significantly from the F1 with the lowest protein content (3.44%). Formula F3 has the highest protein content because the percentage of soybeans used is higher than F1 and F2, with the percentage of soybeans and mung beans (75: 25). Meanwhile, F1 has the lowest protein content due to the ratio of soybeans to mung beans (25:75). This is because soybeans have a higher protein content than mung beans. A hundred gram of soybeans contain 34.9 grams of protein (Gaol et al., 2018). Meanwhile, a hundred grams of mung beans provide 22.9 grams of protein (Sari et al., 2021). The higher the percentage of soybeans, the higher the protein content in soygurt.

Fat content

The fat content of soygurt ranges from 2.05 to 2.36%. Based on these data, the entire formula satisfies the SNI for yoghurt between 0.6 and 2.9 (SNI 2981:2009). The highest fat content (2.36%) was obtained in the F3 formulation. This result is significantly different from the F1 formula with the lowest fat content (2.05%). Formula F3 has the highest fat content because the percentage of soybeans used is higher than F1 and F2, with the percentage of soybeans and mung beans (75: 25). Meanwhile, the F1 formula has the lowest protein content due to the percentage of soybeans and mung beans (25: 75). This is because the protein content in soybeans is higher than mung beans. The fat content in 100 grams of soybeans is 18.1 grams (Gaol et al., 2018). Meanwhile, the fat content in 100 grams of mung beans is 1 – 1.2 grams (Sari et al., 2021). The higher the percentage of soybeans, the higher the fat content in soygurt.

Reduced Sugar Content

The decreased sugar level indicates how much simple sugar has been digested and consumed by LAB for metabolic processes. Lactose, lactulose, maltulose, and melibiose are examples of reducing sugars (Laksito et al., 2020). The study's findings indicated that F3 had the largest reducing sugar concentration, at 4.66%, followed by F2 (4.02%) and F1 (3.42%). This is due to the fact that F3 (25:75) has a larger ratio of mung beans to soybeans than F2 (50:50) and F1 (75:25). This is consistent with a study by Khusniati et al. (2023) that found that yoghurt prepared from soybean paste flour extract and amyloproteolytic enzymes (amyloproteolytic soygurt) had a higher concentration of reducing sugar (0.0062%) than yoghurt created from flour juice. Amyloproteolic mung bean yogurt, or mung bean paste, had a 0.0049% ($p<0.05$) value. Because soybeans have a higher carbohydrate content than mung beans, they have a higher concentration of reducing sugars in paste flour than mung beans (Zhang et al., 2017).

Crude fiber content

Crude fiber or crude fiber is a carbohydrate fraction that cannot be digested by the body, consisting of cellulose, lignin, hemicellulose, and other components that are very important for facilitating the digestive process (Tuapattinaya, 2017). Crude fiber contained in food ingredients or products can be used as an index of fiber content because crude fiber generally has around 0.2 – 0.5 part of the total amount of food fiber (Dahlan, 2020). The soygurt produced contains crude fiber ranging from 2.99 – 4.14%. The highest crude fiber content (4.14%) was obtained in the F1 formulation. Formula F1 has the highest crude fiber content considering that the percentage of mung beans used is higher than F2 and F3, with the percentage of mung beans and soybeans (75: 25). The analysis results show that the higher percentage of mung beans and the lower the percentage of soybeans used, the higher the crude fiber content of the soygurt. This is in line with research by Yusya et al., (2023) which shows that the highest average crude fiber content in vegetable drinks was obtained at P5 (1:3) with a combination of 37.5 g sweet corn: 112.5 g mung beans for 3 .80%. Meanwhile, the lowest fiber content was treatment P1 (3:1) with a combination of 112.5 g sweet corn: and 37.5 g mung beans at 1.42%.

pH

The level of acidity that can create the ideal conditions for LAB growth is indicated by the degree of acidity (pH) (Hasna et al., 2023). The pH of soygurt ranges from 4.139 – 4.233. From this data, the overall formula satisfies SNI for yoghurt, it between 3.8 – 4.4 (SNI 2981:2009). In this study, date juice was utilized in place of sugar as a natural supply of glucose. The primary source of fiber-containing monosaccharides is dates (Al-Sahlany et al., 2023). One of the nutrients that LAB will use as an energy source is a glucose, which also creates lactic acid metabolites, which lowers the pH of yoghurt (Hasna et al., 2023).

Lactic acid bacteria

The quantity of lactic acid bacteria in soy yogurt serves as a gauge for the quality of the microbiome. Yogurt contains at least 107 lactic acid bacteria, according to SNI 2981:2009. According to research, the overall LAB findings range between $1,0 \times 10^8 – 1,9 \times 10^8$, F1 ($1,9 \times 10^8$) has the highest results, followed by F3 ($1,2 \times 10^8$) and F2($1,0 \times 10^8$). For yogurt, these three outcomes satisfy SNI. Lactic acid bacteria can proliferate when 5% skim milk is added. Because skim milk adds more protein to the medium, it can break down peptides and proteins and promote the growth of lactic acid bacteria. Moreover, lactose is produced by skim milk, whose carbohydrates serve as substrates for LAB fermentation (Guntiyastutik et al., 2020).

Conclusion

Based on the research that has been carried out, all soygurt formulas meet the Indonesian National Standard (SNI) 2981:2009. F3 (5.46%) has the highest protein content, fat content, and reducing sugar content followed by F2 (3.95%) and F1 (3.44%). F1 has the highest total LAB (1.9 x 108) and crude fiber content (4.14%), followed by F3 (total LAB 1.2 x 108 and crude fiber 3.81%) and F2 (total LAB 1.0 x 108 and crude fiber 2.99%). The formula that will be continued for clinical trials on animals is F3, because of its high protein content, which can potentially control blood glucose levels.

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