Livestock and Animal Research

Accredited by Directorate General of Higher Education, Research, and Technology No. 152/E/KPT/2023

Open Access
Livest. Anim. Res., November 2024, 22(3): 156-166
p-ISSN 2721-5326 e-ISSN 2721-7086
https://doi.org/10.20961/lar.v22i3.87368

Original Article

The Quality of Yoghurt Drink with Guar Gum and Corntarch as Stabilizer

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Received: January 31th, 2024; Accepted: November 18th, 2024; Published online: November 20th, 2024

Abstract

Objective: This study aims to determine the effect of using guar gum and cornstarch as stabilizers in Yoghurt drinks and to determine the stability of Yoghurt drinks.
Methods: The method used 2 stages of research. Stage 1 of the research used a completely randomized design (CRD) with 6 treatments and 3 replicates, T0 (Control); T1 (0.4% Guar gum); T2 (0.3% Guar gum and 0.1% cornstarch), T3 (0.2% Guar gum and 0.2% cornstarch), T4 (0.1% Guar gum and 0.3% cornstarch), and T5 (0.4% Cornstarch). Stage 2 of the study used a completely randomized design (CRD) nested pattern related to different storage periods, H1 (7 days), H2 (14 days), H3 (21 days), H4 (28 days), H5 (35 days) with the same treatment and replication. Data were analyzed using the Analysis of Variance.
Results: The results of stage 1 showed that guar gum and cornstarch as stabilizers had a significant effect (P<0.01) on viscosity, syneresis, and water holding capacity, significant effect (P<0.05) on pH, protein, lactose, and showed that no significant effect (P>0.05) on fat, moisture, total titratable acidity, and LAB content. The results of stage 2 showed that different storage periods had a very significant effect (P<0.01) on viscosity and pH. There was no significant effect (P>0.01) on LAB content.
Conclusions: It was concluded that guar gum and cornstarch can maintain the quality of the Yoghurt drink for 6 weeks of storage.

Keywords: Chemical quality; Physical quality; Microbial quality; Stabilizer; Yoghurt

INTRODUCTION

Yoghurt is produced through the process of fermenting milk using lactic acid bacteria. The specific species of bacteria involved in this process are *Lactobacillus bulgaricus* and *Streptococcus thermophilus*. Both bacteria play an important role in the fermentation of milk to produce yoghurt. Yoghurt is beneficial for health and can help weight loss or diet programs, slow down aging due to the sun's UV rays, and regenerate cells [1]. The longer shelf life of fermented products is attributed to alterations in pH levels and the generation of inhibitory compounds, including bacteriocins and alcohol, which impede the growth of microorganisms and prevent spoilage [2]. The acidity level and flavor of yoghurt are influenced by Streptococcus thermophilus, which plays a role in lowering pH. The sour taste in yoghurt is caused by bacteria that convert milk sugar (lactose) into lactic acid. This process allows for the consumption of yoghurt by individuals with lactose intolerance.

Yoghurt has a longer shelf life than fresh milk because Yoghurt contains lactic acid which acts as a natural preservative. Problems that are often found in Yoghurt products are the occurrence of syneresis, and a decrease in water holding capacity [2]. One way to reduce syneresis, increase water holding capacity, and extend the shelf life is by using thickeners that function to increase viscosity, stabilize, and glue. Thickeners are gum arabic, tragacanth gum, guar gum, pectin, cornstarch, and carboxymethyl cellulose (CMC) [3]. The incorporation of one or more stabilizers is essential to ensure the quality and stability of the yoghurt drink. Hydrocolloids form gels and are viscous when dissolved in water. One hydrocolloid that is widely used in food is cornstarch [4]. Cornstarch is a corn-based flour that is a source of carbohydrates. The degree of syneresis exhibited by a given product will determine the necessity for a high concentration of cornstarch, given that cornstarch has the capacity to bind water and prevent it from leaving the starch gel. The addition of a greater quantity of starch will result in the formation of a greater number of hydrogen bonds between water molecules and amylopectin molecules, thereby reducing the extent of syneresis [5].

Guar gum is most widely produced in India, where it accounts for about 80% of the world's production. Guar gum is obtained from the *Cyamopsis tetragonolobus* plant in the endosperm of guar seeds, in the form of water-soluble galactomannan [6]. Guar gum is a natural gelling gum with good spreadability and viscosity [7]. Guar gum is more readily soluble in water due to the presence of a galactose-substituted chain, which is a distinctive feature when compared to other types of seed gum. The utilization of guar gum as a stabilizing agent is imperative due to its capacity to bind water and its hydration properties. The addition of guar gum, which has the capacity to bind water, will result in an increase in total solids, thereby producing a higher viscosity. The greater the number of particles that are bound by guar gum, the higher the total solids content will be. This can also result in a reduction in the formation of sediment. The low water content of the product is a consequence of the high total solids content. An increase in total solids within a product can result in a reduction in water content. Guar gum has the capacity to bind free water, thereby increasing viscosity and reducing water activity. This effect is achieved by preventing the interaction between the dispersing phase and the dispersed phase, which in turn inhibits flocculation, creaming, and merging. Guar gum has the capacity to diminish the surface tension of water, thereby preventing the separation or rupture of fat globules [3].

The incorporation of stabilizing agents, such as guar gum and cornstarch, into yoghurt beverages is anticipated to diminish syneresis and enhance water-binding capacity, thereby prolonging the shelf life of yoghurt. In light of the aforementioned description, further research is required to ascertain the efficacy of a combination of guar gum and cornstarch as a stabilizing agent in yoghurt drinks, with the objective of enhancing the quality of yoghurt drinks.

MATERIAL AND METHODS

Materials

The materials utilized in this study were fresh milk procured from KUD Dau Malang, guar gum, cornstarch, and a 2% starter culture (comprising *Lactobacillus bulgaricus, Streptococcus thermophilus, and Lactobacillus acidophilus*) obtained from CV. Brawijaya Dairy Industry Batu, distilled water, 1% phenolphthalein indicator, 0.1N NaOH, buffers 4 and 7, deMan Rogosa Sharpe Agar, plate count agar, and 0.1% peptone water buffer, 250 mL plastic bottles, 100 mL glass bottles, tissues, masks, gloves, and 70% alcohol.

Methods

Research Design

The method consisted of 2 stages of research. Stage 1 was conducted using a completely randomized design (CRD) with 6 treatments and 3 replicates: T0 (Control); T1 (0.4% Guar gum); T2 (0.3% Guar gum and 0.1% cornstarch); T3 (0.2% Guar gum and 0.2% cornstarch); T4 (0.1% Guar gum and 0.3% cornstarch); and T5 (0.4% Cornstarch). Data analysis results that showed significant or highly significant differences were followed by the Duncan Multiple Range Test. Variables observed during Stage 1 included viscosity, optical microscopy, syneresis, water holding capacity, pH, fat content, protein content, moisture content, total titratable acidity, lactose content, and LAB content.

In Stage 2, a completely randomized design (CRD) with a nested pattern was applied to assess the effect of different storage periods: H1 (7 days), H2 (14 days), H3 (21 days), H4 (28 days), and H5 (35 days), using the same treatments and replications. Data analysis results were followed by the Least Significant Difference Test (LSD) if significant differences were detected. The variables observed in Stage 2 included pH, viscosity, and LAB content.

Yoghurt Drink with Guar gum and Cornstarch Stabilizer Preparation

Plain Yoghurt was made using 500 mL of fresh cow's milk pasteurized by the HTST (High Temperature Short Time) method at 72˚C for 15 seconds and starter (*Lactobacillus bulgaricus*, *Streptococcus thermophilus*, and *Lactobacillus acidophilus*). The samples were incubated at 37°C for a period of 24 hours. The yoghurt drink was prepared using a combination of plain yoghurt, a guar gum solution, cornstarch, water, and sugar, heated to a temperature of 80°C in accordance with the specified treatment. The yoghurt drink with guar gum and cornstarch as a stabilizing agent was placed into glass bottles in accordance with the dosage and stored in the refrigerator as a test sample. The concentration of guar gum and cornstarch utilized as a stabilizing agent in yoghurt is presented in Table 1.

Viscosity Determination

Viscosity determination was carried out based on protocol [8], an Electrometer 2300 RV viscometer was prepared, the L1 spindle was installed on the tool at a speed of 100 rpm, viscosity value printed on the tool was recorded. The spindle used is L1 with a speed of 100 rpm, which is used according to the viscosity of the sample.

Optical Microscopy Determination

Optical microscopy determinations were carried out based on protocol [6]. The prepared sample was taken 5 mL, one drop was placed on the object glass, covered with a cover glass, and observed using an optical microscope with 100x magnification, photos were taken as documentation of the observation results using a camera.

Syneresis Determination

Syneresis determination was carried out using centrifugation based on protocol [2], weighing a centrifuge tube and a 15 gram sample, centrifuging for 20 minutes at a speed of 1535 rpm, then separating the liquid from the Yoghurt sediment, then weighing the sediment. Syneresis was calculated using Equation 1.

$$\frac{A-B}{A} \times 100\% \qquad (1)$$

Where:
A: Weight of sample before centrifugation (grams)
B: Weight of sample after centrifugation (grams)

Water Holding Capacity Determination

Water holding capacity determination was carried out using centrifugation based on protocol [9], weighing the centrifuge tube then adding 10 grams of Yoghurt, centrifuging for 10 minutes at a speed of 3000 rpm. The clear liquid is weighed and the results are recorded, then calculated using Equation 2.

$$\%WHC = 1 - \frac{A}{B} \times 100\% \qquad (2)$$

Where:
A: Weight of supernatant
B: Weight of sample

pH Determination

pH determination was carried out based on protocol [10], using a Hanna pH meter by calibrating using buffers 4 and 7 first, then testing was carried out on a 10 mL Yoghurt sample.

Fat Content Determination

Fat content determination was carried out using Soxhlet based on protocol [7], inserting the Soxhlet tube 8 ml sample, cooling carried out through the condenser. The extraction tube was installed in a Soxhlet distillation and sufficient petroleum ether was added for 4 hours. The residue was stirred in the extraction tube. Extraction is continued by transferring petroleum ether which contains fat into a clean weighing bottle and knowing the weight and then evaporating it with a water heater until concentrated. The process with drying in a 100°C oven until a constant weight is achieved. The residual weight in the weighing bottle is expressed as the weight fat.

Protein Content Determination

Protein content determination was carried out based on formol titration on protocol [11], put sample 5 ml into a 250 ml Erlenmeyer. Add 10 ml of distilled water and 0.4 ml saturated K-oxalate (± 8 drops). Add 0.5 ml of 1% phenolphthalein indicator (± 10 drops), let stand for 2 minutes. Titrate with 0.1 N NaOH until it reaches pink color. After color pink is achieved, add 0.5 ml of 40% formaldehyde (10 drops), wait for the color of the milk sample returns to its original color. Titrate again with 0.1 N NaOH until a pink color is achieved Return. Record the titration volume of NaOH. Make a blank titration, add 10 ml distilled water into Erlenmeyer. Add 0.4 ml K-oxalate (8 drops). Add 0.5 ml pp indicator 1% (10 drops). Add 0.5 ml of 40% formaldehyde. Titrate with NaOH until pink. Record the titration volume.

Moisture Content Determination

Moisture content determination was carried out using a modified gravimetric method based on protocol [12], weighing the sample before and after being oven-dried. Moisture content was calculated using Equation 3.

$$\%\,Moisture = \frac{W1-W2}{W1-W0} \times 100\% \qquad (3)$$

Where:
W0: Weight of petri dish
W1: Weight of petri dish + sample before oven
W2: Weight of petri dish + sample after oven

Total Titratable Acidity Determination

Total titratable acidity determination was carried out based on protocol [13], Total titrable acidity was carried out by taking a sample of 10 mL and then added with 3 drops of phenolphthalein indicator which was then titrated with 0.1 N NaOH solution until the color turned pink and when homogenized the color does not disappear.

Lactose Content Determination

Lactose content determination was carried out based on protocol [11], using a milk analyzer MCC lactoscanner, insert the analysis tube into a 15 mL film pot containing the Yoghurt drink sample. The results of the Lactoscan ultrasonic wave analysis will appear on the monitor and printer.

LAB Content Determination

LAB content determination was carried out based on protocol [13], Yoghurt drink samples dilutions using peptone with a ratio of 1:9, carried out from $10^{-1} – 10^{-9}$. The first dilution was carried out with a 1 mL sample into 9 mL of 0.1% peptone then homogenized using a vortex for 1 minute. Sample of 1 mL of the first dilution was taken and then added to 9 mL of 0.1% peptone. The same procedure is carried out up to 10^{-9} dilution. Take 1 mL sample from the 3 last dilution (10^{-7}, 10^{-8}, 10^{-9}). Put it in a petri dish and pour in 10-15 mL of MRSA. Homogenized by moving the petri dish to form number 8. Incubated upside down for 48 hours at 37°C.

RESULTS

Stage 1

Viscosity

The viscosity based on Table 2 ranged from 6.5±1.32 cP (T5) - 51.73±5.1 cP (T1). The use of guar gum and cornstarch as stabilizers with different concentrations of ingredients has a very significant effect (p<0.01) on the viscosity of yoghurt drink. The difference in the concentration of guar gum and cornstarch added can produce different levels of viscosity in each treatment. The higher the percentage of viscosity in a yoghurt drink, the thicker the texture and the greater the physical stability. A high viscosity level indicates a smoother texture and a more pleasant viscosity to consume. Furthermore, a high viscosity can increase the capacity of yoghurt to maintain stability during storage, as thicker mixtures tend to show less syneresis or liquefaction [8].

Optical Microscopy

The purpose of optical microscopy observation on the physical characteristics of Yoghurt is to observe the density of Yoghurt gel. Figure 1 shows that inulin-fortified synbiotic Yoghurt with different shelf life does not produce differences in gel density.

Syneresis

The average value of Yoghurt drink syneresis in this study was 43.03±5.84 % (T3) -64.21±1.52 % (T0). Table 2 shows that the use of guar gum and cornstarch as stabilizers with different concentrations of ingredients has a very significant effect (P<0.01) on the syneresis of Yoghurt drink, due to the different concentrations of guar gum and cornstarch, resulting in different syneresis in each treatment.

Water Holding Capacity (WHC)

The use of guar gum and cornstarch as stabilizers with different concentrations of ingredients had a very significant effect (P < 0.01) on the WHC of yoghurt drinks. Table 2 shows the average WHC between 21.92±1.85 % (T5) - 43.83±2.68 % (T1). WHC increases with increasing concentration of guar gum used as a stabilizer in preparing yoghurt drinks. The higher WHC is due to the carbohydrate content of each stabilizer.

pH

Table 2 shows that the pH with guar gum and cornstarch stabilizers has an average value between 3.67±0.06 (T1) - 3.90±0.10 (T4). The use of guar gum and cornstarch as stabilizers with different concentrations of ingredients has a significant effect (P<0.05) on the pH of the Yoghurt drink, which is due to the occurrence of some fermentation by guar gum, cornstarch, and lactose at cold temperatures.

Fat Content

The use of guar gum and cornstarch as stabilizers at different concentrations had no significant effect (P>0.05) on the fat content of Yoghurt drinks. Table 2 shows an average test fat content of 1.48±0.15 % (T2) - 2.42±0.09 % (T0).The ability of guar gum and cornstarch at different concentrations as a stabilizer in the maintenance of the balance of fat globules by lowering the surface tension on fat.

Protein Content

The use of guar gum and cornstarch as stabilizers at different concentrations had a significant effect (P<0.05) on the protein content of yoghurt drink. Table 2 shows that the average protein content ranges 0.9±0.1 % (T0) - 1.42±0.06 % (T2). The ability of guar gum and cornstarch as stabilizers at different concentrations in increasing of lactic acid bacteria (LAB) in Yoghurt drinks. Increase of LAB in Yoghurt drinks by providing an energy source for the LAB fermentation process.

Moisture Content

The use of guar gum and cornstarch as stabilizers with different concentrations of ingredients has no significant effect (P>0.05) on the moisture content of yoghurt drinks. Table 2 shows that the average moisture content 70.03±0.39% (T0) - 83.11±5.06% (T3). The ability of guar gum and cornstarch as stabilizers with different concentrations to suppress the growth of spoilage bacteria in WHC yoghurt drinks, which is a medium for bacterial growth.

Total Titratable Acidity

The use of guar gum and cornstarch as stabilizers with different concentrations of ingredients had no significant effect (P>0.05) on the Total titratable acidity yoghurt drink. Table 2 shows the average

Total titratable acidity 0.37±0.07% (T1) - 0.48±0.09% (T5). The role of guar gum and cornstarch with various concentrations as a stabilizer that binds water so that the increase in Total titratable acidity obtained from the LAB fermentation process can be controlled.

Lactose Content

The use of guar gum and cornstarch as stabilizers with different concentrations of ingredients had a significant effect (P<0.05) on the lactose content of Yoghurt drinks. Table 2 shows the average lactose content 1.35±0.15% (T0) - 2.13±0.08% (T2). The ability of guar gum and cornstarch as stabilizers with various concentrations in Yoghurt drinks to convert milk sugar (lactose) into lactic acid in the LAB fermentation process.

LAB Content

Table 2 shows the average LAB content at 9.15±0.11 CFU/mL (T0) - 10.08±1.32 CFU/mL (T4). The use of guar gum and cornstarch as stabilizers with different concentrations of ingredients had no significant effect (P>0.05) on the LAB content Yoghurt drink, because the use of guar gum and cornstarch in Yoghurt drinks is done after the fermentation process, so it does not affect the change in the number of LAB in converting lactose into lactic acid in the process of making Yoghurt drinks.

Stage 2

pH

The results of the analysis of variance showed that the treatment of stabilizers T0, T1, T2, T3, T4, and T5 in Yoghurt drink had a very significant effect on pH (P<0.01). Table 3 show that the average pH at different treatment levels and storage time ranged 3.31±0.02 - 3.36±0.12.

Viscosity

The results of the analysis of variance showed that the treatment of stabilizers T0, T1, T2, T3, T4, and T5 in Yoghurt drinks had a very significant effect on viscosity (P<0.01). Table 4 show that the average viscosity at various levels of Yoghurt drink treatment and storage time ranged results ranged from 3.07±1.69 cP - 11.26±2.74 cP.

LAB Content

The results of the analysis of variance showed that the treatment of stabilizers T0, T1, T2, T3, T4, and T5 in Yoghurt drinks did not have a significant effect on LAB content (P>0.05). The average LAB content at various treatment levels and shelf life results ranged from 9.41±0.92 CFU/mL - 10.02±0.46 CFU/mL as shown in Table 5.

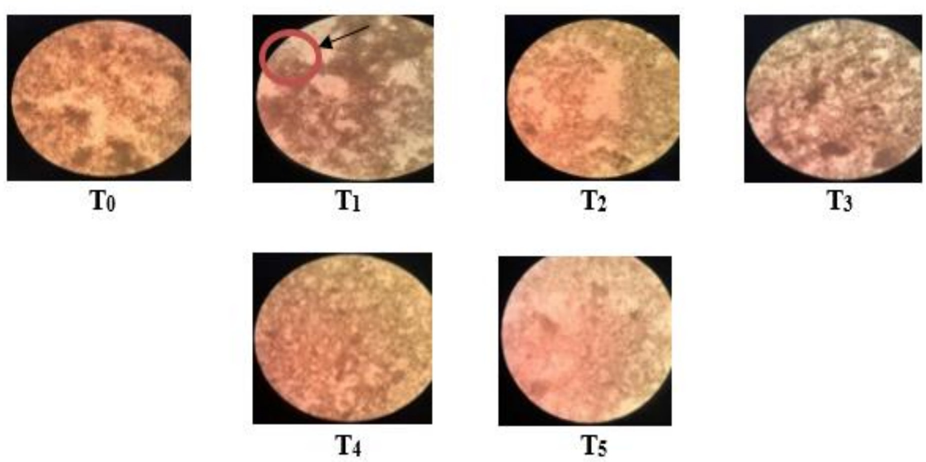

Figure 1. Observation of Yoghurt Drink with Optical Microscopy

Description: Arrows and circles indicate the density of the gel observed by the microscope at 100x magnification

Table 1. Compositon of Yoghurt Drink

Component	Treatment					
	T0	T1	T2	T3	T4	T5
Plain Yoghurt (%)	50	50	50	50	50	50
Water (%)	35.75	35.55	35.55	35.55	35.55	35.55
Sugar (%)	14.25	14.25	14.25	14.25	14.25	14.25
Guar gum (%)	0	0.4	0.3	0.2	0.1	0
Cornstarch (%)	0	0	0.1	0.2	0.3	0.4
Total (%)	100					

Note: (T0: Control; T1: 0.4% Guar gum; T2: 0.3% Guar gum and 0.1% Cornstarch; T3: 0.2% Guar gum and 0.2% Cornstarch; T4: 0.1% Guar gum and 0.3% Cornstarch; T5: 0.4% Cornstarch)

Table 2. Research Result of Stage 1

Variables	Stabilizer Treatment (mean ± SD)					
	T0	T1	T2	T3	T4	T5
Viscosity (cP)**	6.83±0.86[a]	51.73±5.1[d]	29.77±0.8[c]	14.93±2.72[b]	12.13±1.63[ab]	6.5±1.32[a]
Syneresis (%)**	64.21±1.52[b]	47.74±1.93[a]	43.03±5.84[a]	43.03±5.84[a]	58.89±0.68[b]	59.68±1.21[b]
Water Holding Capacity (%)**	24.00±2.48[a]	43.83±2.68[d]	35.72±0.62[c]	29.96±1.88[b]	24.84±0.78[a]	21.92±1.85[a]
pH*	3.77±0.06[abc]	3.67±0.06[a]	3.77±0.06[abc]	3.73±0.06[ab]	3.90±0.10[c]	3.83±0.12[bc]
Fat Content (%)	2.42±0.09	2.01±0.08	1.48±0.15	1.9±0.23	2.07±0.09	2.18±0.08
Protein Content (%)*	0.9±0.1[a]	1.4±0.24[c]	1.42±0.06[c]	1.06±0.14[ab]	1.41±0.14[c]	1.31±0.3[bc]
Moisture Content (%)	70.03±0.39	79.45±0.69	79.33±0.12	83.11±5.06	79.19±0.25	79.34±0.43
Total titratable acidity (%)	0.41±0.07	0.37±0.07	0.43±0.06	0.38±0.07	0.46±0.02	0.48±0.09
Lactose Content (%)*	1.35±0.15[a]	2.1±0.36[c]	2.13±0.08[c]	1.59±0.21[ab]	2.12±0.2[c]	1.97±0.45[bc]
LAB content (Log CFU/mL)	9.15±0.11	9.22±0.36	9.27±0.15	9.32±0.27	10.08±1.32	9.33±0.02

Notes: **a, b, c, d Superscript gives a very significant effect ($P<0.01$) on viscosity, syneresis and water holding capacity.
*a, b, c Superscript gives a significant effect ($P<0.05$) on, pH, protein content, and lactose content (T0: Control; T1: 0.4% Guar gum; T2: 0.3% Guar gum and 0.1% Cornstarch; T3: 0.2% Guar gum and 0.2% Cornstarch; T4: 0.1% Guar gum and 0.3% Cornstarch; T5: 0.4% Cornstarch).

Table 3. Average pH at different treatment levels and storage times

Treatment	Storage Times					Mean±SD
	7 day	14 day	21 day	28 day	35 day	
T0	3.57	3.33	3.30	3.30	3.30	3.36±0.12[b]
T1	3.53	3.30	3.30	3.30	3.30	3.35±0.10[b]
T2	3.30	3.30	3.30	3.30	3.30	3.31±0.02[a]
T3	3.30	3.33	3.30	3.30	3.30	3.31±0.02[a]
T4	3.30	3.33	3.30	3.30	3.30	3.31±0.02[a]
T5	3.30	3.33	3.30	3.30	3.30	3.31±0.02[a]

Notes: [a, b] superscripts in the same column indicate highly significant differences ($P<0.01$) between treatments.
(T0: Control; T1: 0.4% Guar gum; T2: 0.3% Guar gum and 0.1% Cornstarch; T3: 0.2% Guar gum and 0.2% Cornstarch; T4: 0.1% Guar gum and 0.3% Cornstarch; T5: 0.4% Cornstarch)

Table 4. Average viscosity at various levels of Yoghurt drink treatment with addition of stabilizer

Treatment	Storage Times					Mean±SD
	7 day	14 day	21 day	28 day	35 day	
T0	0.67	2.40	3.40	2.27	3.60	3.07±1.69[a]
T1	6.57	13.87	9.87	11.33	14.67	11.26±2.74[b]
T2	5.93	9.47	8.67	7.87	10.20	8.43±2.98[b]
T3	2.00	4.67	4.87	6.53	6.00	4.81±1.75[ab]
T4	1.33	4.80	4.27	5.53	5.07	4.20±1.67[a]
T5	0.60	4.07	4.27	6.33	4.53	3.96±2.08[a]

Notes: [a, b] superscripts in the same column indicate very significant differences (P<0.01) between treatments.
(T0: Control; T1: 0.4% Guar gum; T2: 0.3% Guar gum and 0.1% Cornstarch; T3: 0.2% Guar gum and 0.2% Cornstarch; T4: 0.1% Guar gum and 0.3% Cornstarch; T5: 0.4% Cornstarch).

Table 5. Average LAB content at various treatment levels and shelf life

Treatment	Storage Times					Mean±SD
	7 day	14 day	21 day	28 day	35 day	
T0	9.67	10.62	9.67	9.13	8.02	9.42±0.95
T1	10.62	9.67	9.13	8.02	9.72	9.43±0.95
T2	9.67	9.13	8.02	9.72	10.52	9.41±0.92
T3	9.13	8.02	9.72	10.52	10.27	9.53±0.99
T4	8.02	9.72	10.52	10.27	10.23	9.75±1.01
T5	9.72	10.52	10.27	10.23	9.38	10.02±0.46

Note: (T0: Control; T1: 0.4% Guar gum; T2: 0.3% Guar gum and 0.1% Cornstarch; T3: 0.2% Guar gum and 0.2% Cornstarch; T4: 0.1% Guar gum and 0.3% Cornstarch; T5: 0.4% Cornstarch.

DISCUSSION

Stage 1

Guar gum and cornstarch added can produce different levels of viscosity in each treatment. The higher total soluble solids in yoghurt drinks will produce yoghurt drinks with high viscosity. Yoghurt drink with the addition of stabilizer has a viscosity value in the range of 12 - 55.6 cP, with an increase in viscosity value along with the addition of stabilizer concentration [14]. The addition of guar gum will result in an increase in viscosity and the binding of free water, which will in turn reduce the water activity and the interaction between the dispersed particles. The viscosity of yoghurt products is subject to influence by a number of factors, including the type of milk, the type of lactic acid bacteria, the protein content, the fat content, the pH, the incubation time, and the total milk solids [6].

The observation of yoghurt by optical microscopy there is a darker color area, this indicates that the area has a higher gel density compared to areas that have a lighter color [15]. The observed increase in gel density can be attributed to the functional properties of guar gum, which has been incorporated into the treatment. It has been demonstrated that the gel density of the yoghurt drink is directly proportional to the percentage of guar gum added. The microstructure of the yoghurt exhibited an increase in the concentration of guar gum, which resulted in the formation of small serum pores and large interconnections between casein micelles within the yoghurt gel. An increase in guar gum concentration can facilitate greater chain interactions between molecules, thereby enhancing the visual density of the resulting yoghurt [16].

The syneresis in yoghurt drinks without stabilizer is around 65.71% [2]. The highest average syneresis was found in T0 (control) at 64.21%. The highest interest is found in yoghurt that does not add stabilizing ingredients and vice versa [14]. Arab *et al*. [17] the incorporation of stabilizers can mitigate the occurrence of syneresis, which is a phenomenon associated with high total solids. The quality of yoghurt drinks can be maintained by the use of stabilizing agents, as the addition of such agents has been demonstrated to result in a reduction in syneresis. The stabilizer will have a diminishing effect on the appeal of yoghurt drinks, as the stabilizer can bind water and produce yoghurt that is thicker, more homogeneous, and with a distinctive taste [18].

The water holding capacity (WHC) of yoghurt drinks increases with the concentration of guar gum used as a stabilizer. The elevated WHC is attributable to the carbohydrate composition of each stabilizer. Guar gum contains 86% carbohydrates, while corn starch contains 76.89% carbohydrates [19]. In this study, the lower level of syneresis and the higher WHC indicate that the yoghurt can be considered of good quality. A reduction in

WHC is believed to be attributable to the pH being at the isoelectric point, which is characterized by a neutral charge. This is attributable to an increase in protons or a loss of charge through acid-base reactions. The elevated acidity of the yoghurt beverage will result in an augmented syneresis and a diminished WHC.

The decrease in pH of yoghurt drinks is influenced by the activity of lactic acid bacteria in breaking down lactose into lactic acid. The formation of lactic acid during fermentation leads to an increase in acidity, lowering pH. Guar gum pH was 4.0 while cornstarch pH was 4.2. The pH with the use of stabilizers guar gum and cornstarch is still in the range of yoghurt with a good pH. Rossi *et al*. [20] that a good pH for yoghurt products is below 4,5.

The ability of guar gum and cornstarch at different concentrations as a stabilizer in the maintenance of the balance of fat globules by lowering the surface tension on fat. The stabilizer will work to form a protective microlayer that acts to protect the fat globules in the yoghurt drink so that it is stable. The value of fat content in the range of 0.6-2.9% [21]. The use of guar gum and cornstarch as a stabilizer in yoghurt can increase the number of lactic acid bacteria (LAB) and is used as a medium for bacterial growth and development. This is because cornstarch contains high enough carbohydrates that can be used in the fermentation process. The incorporation of stabilizing agents, such as guar gum, can influence the interaction between carbohydrates and fats in the final product during the process of yoghurt production. Guar gum is a stabilizing agent that can emulate the function of fat in providing viscosity and stability due to its carbohydrate composition, which enables the formation of a viscoelastic matrix in yoghurt. This results in a product with a softer and thicker consistency, despite the low fat content [4].

The value of protein content of good quality plain yoghurt is at least 2.7% [21]. Nuraeni *et al.* [22] the main component of LAB is protein. The amount of protein in yoghurt depends on the amount of LAB in the ingredients used. LAB due to the presence of a stabilizer that can bind water in the yoghurt, allowing it to serve as a growth medium for LAB. Increasing of protein content can increase the LAB. The explained that this happens because the protein in milk is broken down into amino acids by protease enzymes from LAB [23]. The use of the stabilizer guar gum and cornstarch increased the protein levels. This process can due to the catabolic activity of LAB, the breakdown of protein into polypeptides. The protein in yoghurt is more easily digested due to the fermentation activity [20].

Wang *et al*. [14] the increase in acidity which means the casein in yoghurt is too low. That casein in yoghurt is not constant and coagulation occurs to form a gel in yoghurt. The elevated acidity and coagulation levels observed in yoghurt beverages have the potential to reduce the water content. High moisture content may influence the shelf life of the product, affecting both microbiological and chemical processes. The fermentation process in making yoghurt does not significantly reduce moisture content, because the protein in milk clotting after the formation of lactic acid, so it can be interpreted that moisture content in yoghurt drink is still high [10].

In the metabolic process of LAB fermentation, lactic acid is produced which is calculated as Total titratable acidity, because the LAB has not maximized energy from the stabilizer guar gum and cornstarch. The energy source of LAB is only obtained from carbohydrates in milk, this is lactose [24]. The elevated Total titratable acidityof yoghurt is attributable to the utilization of a substantial quantity of sugar by lactic acid bacteria (LAB) throughout the fermentation process, whereby lactic acid is produced. The activity of lactic acid bacteria (LAB) in the digestion of sugar results in the production of lactic acid, which has an impact on the reduction of lactose and pH levels, thus increasing the acidity value of yoghurt [25].

The breakdown of sugar in lactic acid bacteria will produce energy for the formation of probiotic activity. This probiotic activity will form lactic acid the pH value decreases and a sour taste appears in the product. The ability of guar gum and cornstarch as stabilizers to bind water inhibits LAB activity so that the breakdown of lactose and sucrose as LAB energy sources into lactic acid is also inhibited. The maximum value of good-quality lactose content is 3.5% [26]. The lactose content in fresh milk or whole milk used as raw material in making yoghurt will all be broken down into pyruvic acid and processed into lactic acid [27]. During the fermentation process, the lactose content in yoghurt will decrease, so that yoghurt drinks with guar gum stabilizer and cornstarch can be enjoyed by people with milk allergies and the elderly.

LAB content with a minimum standard in good yoghurt contains of 7 CFU/mL [13]. Bacteria utilize lactose as an energy source and carbon source during the growth process. Lactose is a form of carbohydrate found in milk, lactose can only be found in milk because lactose is not found in other food stuffs. LAB activity in milk lactose fermentation and simple sugars will be converted into lactic acid, so the more sugar utilized in LAB activity, the more lactic acid produced [27]. During the fermentation process, lactic acid bacteria (LAB) will metabolize carbohydrates into lactic acid. An increase in the quantity of LAB results in a proportional increase in the production of metabolites, particularly lactic acid, which is decomposed into H+ ions. This results in a reduction in the pH of the yoghurt.

Stage 2

Additionally, guar gum and cornstarch can facilitate the proliferation of lactic acid bacteria (LAB) due to their complex carbohydrate composition, which can serve as an energy source for these bacteria, leading to an increase in LAB within the yoghurt. The conversion of lactose into lactic acid provides a source of energy and carbon for bacterial growth during the fermentation process. This results in a decrease in pH, which can inhibit the growth of harmful microbes in fermented products. A reduction in pH can result in a sour taste due to the formation of lactic acid as a consequence of lactic acid bacteria metabolism [28]. During refrigerated storage, the microorganisms present in the yoghurt can continue to proliferate and engage in fermentation, converting lactose into lactic acid. The accumulation of lactic acid during the shelf life results in a decrease in the pH of the yoghurt.

Yoghurt viscosity increases with the addition of guar gum and cornstarch as stabilizer. The addition of guar gum is also very helpful in reducing whey separation and improving the texture and rheology of yoghurt. The manufacturing process also influences the viscosity of Yoghurt. Yoghurt produced at 42ºC has a higher viscosity value than yoghurt produced at 30ºC [29]. In the final product, the storage process at a temperature of <10ºC can maintain the viscosity of yoghurt especially if there is the addition of a stabilizer. If above that temperature there can be a decrease in viscosity, due to the continued activity of the starter hydrolyzing the protein or due to the activity of microbial contaminants. The transportation process can also reduce the viscosity of yoghurt due to the shaking of the product [17].

Lactobacillus bulgaricus and *Streptococcus thermophiles* and probiotic bacteria support each other and synergize in cell multiplication, because bacterial cells can grow to the maximum number in the media which is influenced by the availability of nutrients in the media. This addition of guar gum and cornstarch provides excess nutrients for LAB growth. The greatest ability of LAB can degrade various types of sugar into various components, especially lactic acid [30].

CONCLUSION

The conclusion of this study shows that the addition of 0.4% guar gum (T1) as a stabilizer in yoghurt beverages succeeded in maintaining product quality significantly until the 6th week of storage. The addition of guar gum was demonstrated to preserve the stability of yoghurt through the assessment of quality parameters, including viscosity, pH, water binding capacity, and density. These findings suggest that the incorporation of guar gum can enhance the physical stability of yoghurt during storage, thereby making it an effective ingredient in maintaining product consistency and quality over an extended period.

CONFLICT OF INTEREST

We certify that there is no conflict of interest with any financial, personal, or other relationships with other people or organization related to the material discussed in the manuscript.

ACKNOWLEDGMENTS

We acknowledge the Faculty of Animal Science, Universitas Brawijaya for funding this research. The work is supported by the Hibah Research Group Faculty of Animal Science, Universitas Brawijaya Contract Number 2466/UN.10.F05/PN/2022.

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