FOAMING STABILITY OF YOUGURT SMOOTHIE WITH WHEY POWDER AND XANTHAN GUM

T. F. Miano[*1,2], M. Dogan[2], M. Hyata[2], T. F. Miano[3] and A. Shamim[4]

[1*]Institute of Food Sciences and Technology, Sindh Agriculture University, Tandojam, 70060, Pakistan
[2] Department of Food Engineering, Faculty of Engineering, Erciyes University, Kayseri, Turkey
[3]Department of Horticulture, Sindh Agriculture University, Tandojam70060, Pakistan
[4]Department of Pathobiology, Faculty of Veterinary and Animal Science University of Poonch Rawalakot Azad Kashmir
Correspondence author Email: tahseenfm@yahoo.com

ABSTRACT: Yogurt is made by adding the starter culture of bacteria to milk and leave it for fermentation, till it forms gel like structure. The yogurt smoothie was prepared by using fresh pasteurized milk with addition of other ingredients whey powder and xanthan gum of *Xanthomonas Campestris*. The aim of this research was to evaluate the effect of whey powder and xanthan gum on foaming capacity and foaming stability of yogurt smoothie. The samples were prepared by using Taguchi experimental model. The optimum conditions for foaming process were time, pH and concentration ratio of whey powder (0.5, 1, and 1.5 g) and xanthan gum (0.01, 0.02, and0.04 g) was used. The physico chemical characteristics of each sample was analyzed like pH, Tss(°Brix), color value *($L^*a^*b^*$)*, foam stability (FS), foam capacity (FC), syneresis (%), were recorded. The result observed shown statistically significant difference ($P< 0.05$) in each sample for °Brix, FC, FS, and syneresis % respectively. Yogurt smoothie sample observed with higher pH 4.67, Tss (°Brix) of 12.67, FC 195 – 147 % at 0 min, FS 93.49 – 85.83 % after 25 min were recorded in yogurt samples. Whereas, syneresis % and color value *($L^*a^*b^*$)* were observed non-significant. Therefore, it is concluded from this research use of whey powder and xanthan gum have the ability to make the stable formulations in yogurt smoothie. The foam as top layer remain stable after 25 min that has an appealing texture that attracts the consumer. This study is very helpful to the local and at industrial level to use the whey powder and xanthan gum s foam stabilizer.

Keywords: Yogurt smoothie, stabilizer, foam capacity, foam stability.

(Received 24.04.2021 Accepted 04.06.2021)

INTRODUCTION

Yogurt is made by adding the starter culture of bacteria to milk and leave it for fermentation, till it forms gel like structure[1]. Milk used in preparation of yogurt is composed of various types of nutrients and vitamins, that helps preparation of yogurt to produce lactic acid[2] during fermentation process. There are different types of yogurt formulations including instant, dry powdered products are commercially available that consumed by reconstitution with water to make either a yogurt meal or a yogurt drink [3]. Yogurt is a form of fermented milk beverage[3]based on different types of fruits flavors prepared with animal milk or soybean milk ingredients[4].Therefore, increasing healthy food mandate by emerging trend in food products. The food industry is also focused for food safety assurance and product quality improvement[5].

The yogurt found with syneresis properties that visually observed as the yield of whey and curd that made up of moisture, fat, protein, and total solids percentage in whey proportion [2]. However, the curd and whey samples were separated[2]to find the synergism when heating the mixture[6]. The yogurt as gel that formed from milk by process of adding enzyme or acid renneting or acidification, under inactive conditions that may subsequently show syneresis. The yogurt consumed contains two parts one liquid and the other gel as curd swollen[7], Therefore, differences observed in syneresis throughout a mass of curd cause differences in composition of yogurt[7][8]. The yogurt type beverages are usually preserved by mild pasteurization (MP), combining moderate heat (H) and pulsed electric fields (PEF)[6]. The technologically preserved yogurt observed slow level of syneresis and desirable physical-chemical characteristics[9].However, the rennet induced yogurt may show syneresis, i.e. due to fermentation process expulsion of whey protein observed [10]. The binding of yogurt gel shows endogenous force and external pressure that exerted on the liquid in the pores[10] with time [10][11].

The dairy sector has introduced healthy foods, yogurt, fermented milk, cheese (processed or not), ice cream, and other milk-based formulation[12] products. Now a days, researcher and scientists are more focused to prepare new fortified product development in the field of

scientific and technological sectors [12].Therefore, the percentage of whey drained after gel setting[2]used as whey milk consumed in fluid form, in a more semi solid form [7], protein in yogurt like wise casein micelles under various conditions form gels with aggregation[7] of protein binding forces of molecules. The smoothies are blended beverages, containing fruit, fruit juice, ice, yoghurt and milk [13]. Furthermore, the xanthan gum as polysaccharide has emulsification and gelling properties that enriched with cinnamic acid [14]. Yogurt available in dry form, curdled to a smooth, creamy texture and with a custard-like consistency[15].The xanthan gum has been used to improve the texture of food product due to their binding forces towards the heterogeneous molecules[16].The food gums are added to food system for many reasons, principally adjusting the texture, improving the stability [17] of the product. Further, xanthan and carrageenan gums used as a stabilizer at concentrations of 0.01% and 0.05%/ 100mLin yogurt formation of lactic acid by certain bacteria of yogurt[16]. Yogurt composed of accumulation of casein micelles into a three-dimensional network structure of molecules[3].

MATERIAL METHODS

Sample collection: The yogurt smoothie was prepared by using fresh pasteurized milk. The milk was purchased from the dairy shop of Erciyes University, Kayseri, Turkey. Other ingredients whey powder and xanthan gum of *xanthomonascampestris* of (SIGMA, AIDORICH, USA) was used in this research experiment was conducted in to the laboratory of food rheology, department of food engineering, Erciyes University, Kayseri, Turkey. The samples were brought to the laboratory where processing operation were carried out for yogurt preparation.

Experimental design and sample preparation: The experiment was designed to evaluate the best ratio of xanthan gum and whey powder on the foaming stability, foaming capacity and synersis, properties of ayran. The samples of each experiment were prepared by using Taguchi design Minitab,2018 [18] was used to prepare the samples with the addition of different ratio of ingredients to achieve best formulation (Table. 1). The optimum conditions for foaming process were time, pH and concentration ratio of whey powder 0.5, 1, and 1.5 g and xanthan gum 0.01, 0.02, and0.04 g was used. Taguchi Method was used to optimize the method constraints and improve the quality signal-to-noise (S/N) ratio. Performance characteristics to analyze the S/N ratio were larger-the-better is observed.

Table. 1: The preparation of ayran formulations with addition of different types of ingredients.

Experiment A	Treatments	Yogurt	Milk	Water	Xanthan gum	Whey powder
	S1	50	50	0	0	0
	S2	50	0	50	0	0
	S3	50	25	25	0	0
Experiment B						
	S4	50	50	0	0.01	0
	S5	50	0	50	0.01	0
	S6	50	25	25	0.01	0
	S7	50	50	0	0.02	0
	S8	50	0	50	0.02	0
	S9	50	25	25	0.02	0
	S10	50	50	0	0.04	0
	S11	50	0	50	0.04	0
	S12	50	25	25	0.04	0
Experiment C						
	S13	50	50	0	0	0.5
	S14	50	0	50	0	0.5
	S15	50	25	25	0	0.5
	S16	50	50	0	0	1
	S17	50	0	50	0	1
	S18	50	25	25	0	1
	S19	50	50	0	0	1.5
	S20	50	0	50	0	1.5
	S21	50	25	25	0	1.5

Experiment AXBXC						
	S22	50	25	25	0.02	1.5
	S23	50	25	25	0.04	1.5
	S24	50	25	25	0.02	1
	S25	50	25	25	0.04	1

Flow process sheet of yoghurt preparation at ambient temperature.

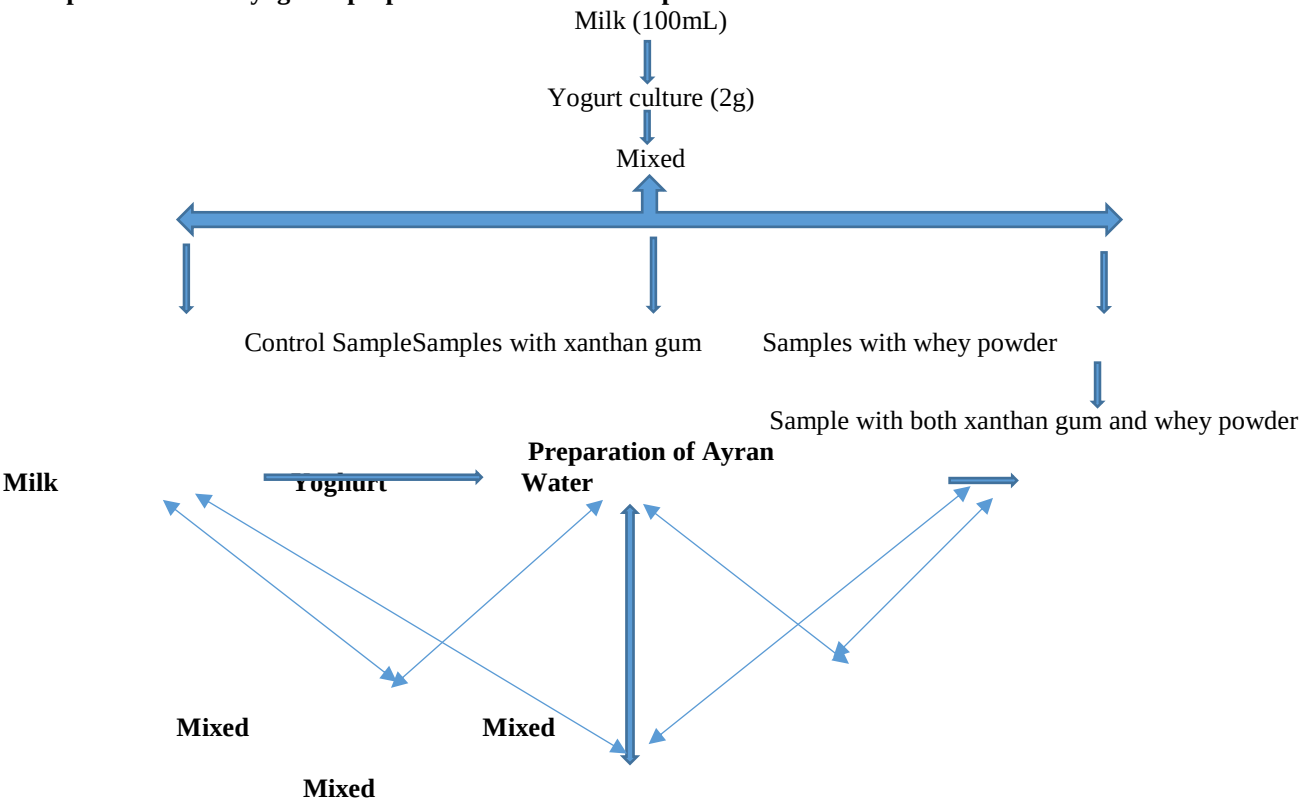

Figure 1: The flow process sheet of ayran preparation at ambient temperature.

Proximate analysis of ayran: Chemical characteristics of each sample was analyzed like pH values,Tss%, color value*($L^*a^*b^*$)*,foam stability (FS), foam capacity(FC), moisture %, ash% and protein %, were recorded. In order to observe the significant variation in trail, the experiment was replicated in duplicate.

Each sample 50mLwere taken in beaker to measure the pH value using pH meter model HI 2211pH/ORP meter.Total soluble solids of samples were measured by using digital refractometer model no. Reichert meter AR 700. Before sample analysis the refractometer was calibrated with distilled water for getting accurate reading of samples. The color of the each yogurt smoothies samples were evaluated using a colorimeter or Chroma meter (model CR-5, Konica monitor), and reported as CIE L^*-value (lightness), a^*-value (redness), and b^*-value (yellowness). Measurements were repeated three times, and mean values were compared. Foaming capacity of each sample were determined under the ambient conditions (25 °C), as reported by Patel *et al*. (1988). 50 mL of sample was transferred in to a beaker and mixed at 3,000 rpm for 2 min, 30 °C, using an UltraturraxT25 homogenizer, the foaming capacity (FC) were determined by using following equation.

$$Foaming\ capacity\ \% = \frac{Vf - Vi}{Vi} X100$$

Final volume of foam= Vf
Initial volume of foam= Vi

Foaming stability was determined by transferring the sample in to graduated cylinder.Where,Vf is the volume of foam after mixing, Vi the initial liquid volume, and Vr the volume of liquid retained in foam after 30 min, were recorded. The effect on stability of foam properties were observed by using following formula

$$Foaming\ stabilty\ \% = \frac{Vr}{Vi} X100$$

Syneresiswas observed in yogurt samples by taking 30 g of each samples, was centrifuged at 222 g for 10min at 4ºC using a centrifuge (30k-300, Sigma Laborzen- trifugen GmbH, Germany). After

centrifugation, the clear supernatant was poured off [19], weighed and recorded as percentage of syneresis (Keogh and O'Kennedy, 1998).

RESULTS AND DISCUSSION

The results regarding physico chemical properties of each ayran formulationsfor pH, Tss (°Brix)foaming capapcity (FC %) and moisture (%)indicated significant difference at p<0.05probability level.The results presented for each treatment in Table2and Table3 showed the significant difference observed in Tss(°Brix),syneresis (%) and FC (%).The data regarding pH of each samples indicated in Table 2, it showed thelowest pH of sample 3.14, was obtained in S11 followed by maximum increase 4.67 in S13. The data obtained for ayran was with the study done by [20] they worked by the addition of salt in Turkish ayran. The Tss (°Brix) indicated a significant difference between the each sample formulations lowest was observed 6.61 in S9 and 12.67 in S19 % were recorded at p<0.05probability level. The results of Tss(°Brix) are supported by the work done [21] on conventional ayran to improve yogurt drink quality.

Table 2.Physical and chemical characteristics of yogurt smoothie formulations.

Samples	pH	TSS%	FC % after 0 min	FS % after 25 min
S1	3.86 ± 0.33	10.56 ± 0.29	115.5±0.71	20.5±0.71
S2	4.52 ± 0.33	7.22 ±0.22	115.5±0.71	21±1.42
S3	4.18 + 0.33	9.04±0.64	116.5±0.71	29.5±0.71
S4	3.83 ± 0.34	10.92±0.33	115±1.42	23.5±2.12
S5	4.25 ± 0.33	10.515±0.09	115.5±2.12	24.5±2.12
S6	4.31 ± 0.34	10.79±0.04	119±1.42	36.5±2.12
S7	3.84 ± 0.35	9.47±0.14	115±1.42	25±1.41
S8	4.29 ± 0.35	9.6±0.03	117±1.42	31±1.41
S9	4.31 ± 0.35	6.61 ± 0.19	118.5±0.71	42.78±3.64
S10	3.94 ± 0.36	11.77±0.14	117±1.41	42.43±0.25
S11	3.14 ± 0.37	7.67±0.45	116.5±2.12	39.35±1.27
S12	4.25 ± 0.21	7.495±1.30	119.5±0.70	46.295±1.49
S13	4.67 ± 0.22	8.805±0.26	115±1.41	24.91±0.98
S14	3.97 ± 0.21	10.515±0.51	116±1.41	28.08±1.17
S15	4.27 ± 0.19	6.775 ± 0.20	118±1.41	28.08±1.17
S16	4.28 ± 0.20	10.04 ± 0.43	147.5±10.60	30.71±0.56
S17	4.21 ± 0.21	7.22 ± 0.04	195±7.071	93.485±1.88
S18	4.14 ± 0.21	8.755 ± 0.81	192.5±10.60	47.71±10.32
S19	4.75 ± 0.21	12.67 ± 0.98	112.5±3.53	80.59±0.50
S20	4.60 ± 0.16	9.995 ± 0.02	152.5±3.53	90.735±2.62
S21	4.40 ± 0.11	9.985 ± 0.79	152.5±3.53	65.835±3.07
S22	4.41± 0.11	12.88 ± 0.01	122.5±3.53	57.605±1.49
S23	4.22 ± 0.07	13.09 ± 0.02	137.5±3.53	85.35±1.20
S24	4.29 ± 0.10	9.59 ± 0.03	112.5±3.53	85.825±0.16
S25	4.14 ± 0.21	10.78 ± 0.09	122.5±3.53	83.895±1.01

*Tss: Total soluble solids, FC: Foam capacity, FS: Foam stability

The FC% indicated a significant difference between the yogurt smoothie sample formulations. The initial volume of FC in control sample was recorded 115.5 % at 0 min, the significant increase was observed in foaming volume in samples of yogurt smoothie 195 – 147 % were observed at p<0.05probability level.

The FS % indicated a significant difference between the yogurt smoothie sample formulations. The foam volume as foaming stability after 25 min, in control sample S1 was recorded 20.5 %. The highest value of FS was observed in S17 and S24 were 93.49 – 85.83 % after 25 min of foaming stability, that were recorded at p<0.05probability level. Investigation done by Ertugy et al., [18] prepared yogurt smoothie with various formulation to improve the energy level of smoothie and rheological properties. They also found serum loss during storage of conventional ayran[18].

The data regarding synresis % indicated a significant difference between the yogurt smoothie sample formulations. The syneresis observed in control sample S1 was recorded 0.62 %. The lowest results found for S4 0.46 %, the highest results of syneresis % were observed in S21 and S19 were 0.98 – 0.89 % were recorded at p<0.05 probability level. The previous work

done by [16] they use various gums to reduce the syneresis % in yogurt. The findings are more or less are similar with the work done by [8] found syneresis properties. The data regarding color determination of yogurt formulation presented in Table 3. The result obtained for S2 color value L^*90.505, a^* -0.68 followed by value of a^*1.51. Furthermore, the result found for S8 color value L^*91.42, a^* -0.67followed by value of a^*1.71, followed by other samples presented in Table 2 observed non-significant at $p<0.05$ probability level.

Table 3.Syneresis % and color values*($L^* a^* b^*$)* of ayran formulations.

Samples	Syneresis %	L^*	a^*	b^*
S1	0.62 ± 0.11	91.47 ± 0	0.65 ± 0	1.76 ± 0
S2	0.72 ± 0	90.51 ± 0.71	-0.68 ± 0.01	1.51 ± 0
S3	0.76 ± 0.02	91.31 ± 0.01	-0.66 ± 0	1.66 ± 0.01
S4	0.46 ± 0.12	91.45 ± 0.01	-0.62 ± 0.01	1.9 ± 0
S5	0.70± 0.01	91.37 ± 0.01	-0.71± 0.01	1.51 ± 0
S6	0.70 ± 0.01	91.42 ± 0.05	-0.67 ± 0.05	1.71± 0.27
S7	0.72 ± 0.01	91.07 ± 0.01	-0.65 ± 0	1.51 ± 0
S8	0.63 ± 0.01	91.42 ± 0.05	-0.67 ± 0.06	1.70± 0.27
S9	0.72 ± 0.01	91.15 ± 0.21	-0.67 ± 0.02	1.59 ± 0.09
S10	0.72 ± 0.03	91.38± 0.01	-0.715 ± 0.01	1.52 ± 0.01
S11	0.73 ± 0.01	91.13± 0.01	-0.62 ± 0.01	1.71 ± 0.01
S12	0.74± 0.01	91.24 ± 0.12	-0.4 ± 0.30	1.71 ± 0.01
S13	0.73± 0.01	91.46 ± 0.01	-0.65 ± 0	1.76 ± 0
S14	0.87± 0.06	91.01± 0.01	-0.68 ± 0	1.51 ± 0
S15	0.85± 0.02	91.3 ± 0	-0.66 ± 0	1.66± 0.01
S16	0.76± 0.01	91.43 ± 0.01	-0.63 ± 0.01	1.85 ± 0
S17	0.91± 0.06	91.16 ± 0.01	-0.66 ± 0	1.72 ± 0.01
S18	0.83 ± 0.03	91.31± 0.01	-0.65± 0.01	1.78 ± 0.01
S19	0.89± 0.03	91.43± 0.01	-0.66 ± 0	1.88 ± 0
S20	0.81± 0.01	90.98± 0.01	-0.72 ± 0	1.61 ± 0
S21	0.99 ± 0.01	91.26 ± 0	-0.7 ± 0	1.86 ± 0
S22	0.98± 0.01	91.44± 0.01	-0.67 ± 0	1.88 ± 0
S23	0.81 ± 0.01	91.51 ± 0.01	-0.665 ± 0.01	1.955 ± 0.01
S24	0.85± 0.04	91.30± 0.01	-0.69 ± 0	1.61 ± 0
S25	0.86± 0.06	91.44± 0.01	-0.63 ± 0.01	1.98 ± 0.01

L^*: Lightness a^*: red or green b^*: Yellowness

Conclusion: It is concluded from the present study that use of whey powder and xanthan gum showed a significant effect on physicochemical properties of yogurt smoothies. The foam observed stable by the use of whey powder and xanthan gum texture was improved foam was stable after time lapse of 25 min. This research is helpful for the local and industrial level that use of stabilizer in low quantity can enhance the foaming properties of yogurt smoothie. As yogurt smoothie is liked and attractive by consumer having foaming layer on the top surface.

Conflict of interest: The author declares no any conflict of research.

REFERENCES

I. Milk, "Encyclopedia of Foods," *Encycl. Foods*, pp. 344–361, 2002.

M. J. Mateo, D. J. O'Callaghan, C. D. Everard, M. Castillo, F. A. Payne, and C. P. O'Donnell, "Validation of a curd-syneresis sensor over a range of milk composition and process parameters," *J. Dairy Sci.*, vol. 92, no. 11, pp. 5386–5395, 2009.

R. B. Penland, "Instant yogurt composition and process," no. 19, 1991.

V. Andrés, M. D. Tenorio, and M. J. Villanueva, "Sensory profile, soluble sugars, organic acids, and mineral content in milk- and soy-juice based beverages," *Food Chem.*, vol. 173, pp. 1100–1106, 2015.

Y. Pan, D. W. Sun, and Z. Han, "Applications of electromagnetic fields for nonthermal inactivation of microorganisms in foods: An overview," *Trends Food Sci. Technol.*, vol. 64, pp. 13–22, 2017.

M. Walkling-Ribeiro, F. Noci, D. A. Cronin, J. G. Lyng, and D. J. Morgan, "Shelf life and sensory attributes of a fruit smoothie-type

beverage processed with moderate heat and pulsed electric fields," *LWT - Food Sci. Technol.*, vol. 43, no. 7, pp. 1067–1073, 2010.

P. Walstra, "The Syneresis of," vol. 1, pp. 141–142, 2004.

M. O. Ramírez-Sucre and J. F. Vélez-Ruiz, "Effect of formulation and storage on physicochemical and flow properties of custard flavored with caramel jam," *J. Food Eng.*, vol. 142, pp. 221–227, 2014.

K. K. F. D. Costa, P. B. Pertuzatti, T. F. De Oliveira, M. Caliari, and M. SOARES SOARES Júnior, "Syneresis and chemical characteristics of fermented rice extract with probiotic bacteria and waxy maize starch," *Food Sci. Technol.*, vol. 37, no. 4, pp. 640–646, 2017.

H. J. C. M. van den Bijgaart, "Syneresis of rennet-induced milk gels as influenced by cheesemaking parameters," pp. 1–247, 1988.

D. Ma, Z. C. Tu, H. Wang, Z. Zhang, and D. J. McClements, "Fabrication and characterization of nanoemulsion-coated microgels: Electrostatic deposition of lipid droplets on alginate beads," *Food Hydrocoll.*, vol. 71, pp. 149–157, 2017.

D. Granato, J. S. Santos, R. D. Salem, A. M. Mortazavian, R. S. Rocha, and A. G. Cruz, "Effects of herbal extracts on quality traits of yogurts, cheeses, fermented milks, and ice creams: a technological perspective," *Curr. Opin. Food Sci.*, vol. 19, pp. 1–7, 2018.

D. F. Keenan, C. Rößle, R. Gormley, F. Butler, and N. P. Brunton, "Effect of high hydrostatic pressure and thermal processing on the nutritional quality and enzyme activity of fruit smoothies," *LWT - Food Sci. Technol.*, vol. 45, no. 1, pp. 50–57, 2012.

K. Hecht, "Editorial," *LWT - Food Sci. Technol.*, vol. 62, no. 1, pp. 373–375, 2015.

"Synersis foaming capapcity and foaming stability properties of yougurt smoothie." .

N. Hematyar, A. M. Samarin, H. Poorazarang, and A. H. Elhamirad, "Effect of gums on yogurt characteristics," *World Appl. Sci. J.*, vol. 20, no. 5, pp. 661–665, 2012.

A. H. Abdelmoneim and A. M. Sherif, "Rheological Properties of Yoghurt Manufactured by using Different Types of Hydrocolloids," *Austin J. Nutr. Food Sci.*, vol. 4, no. 2, pp. 1082–1088, 2016.

M. F. Ertugay, M. Başlar, M. Şengül, and S. Sallan, "The Effect of Acoustic Energy on Viscosity and Serum Separation of Traditional Ayran, a Turkish Yogurt Drink," *Gida*, vol. 37, no. 5, pp. 253–257, 2012.

M. Bahrami, D. Ahmadi, M. Alizadeh, and F. Hosseini, "Physicochemical and sensorial properties of probiotic yogurt as affected by additions of different types of hydrocolloid," *Korean J. Food Sci. Anim. Resour.*, vol. 33, no. 3, pp. 363–368, 2013.

A. Köksoy and M. Kiliç, "Effects of water and salt level on rheological properties of ayran, a Turkish yoghurt drink," *Int. Dairy J.*, vol. 13, no. 10, pp. 835–839, 2003.

T. Petreska Ivanovska, Z. Zhivikj, L. Bogdanovska, K. Mladenovska, and L. Petrushevska-Tozi, "Application of Lactobacillus casei 01 and oligofructose-enriched inulin in ayran," *Maced. J. Chem. Chem. Eng.*, vol. 37, no. 1, p. 43, 2018.