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INFLUENCE OF DIFFERENT TYPES OF MILK AND STABILIZERS ON SENSORY EVALUATION AND WHEY SEPARATION OF YOGHURT

Mohammad Ayub

Department of Food Science and Technology, NWFP Agricultural University, Peshawar, Pakistan

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The influence of seven different stabilizers i.e. pectin, guargum, carboxymethylcellulose (CMC), carrageenan, sodium alginate, corn starch and gelatin was studied at 0.4% levels in buffalo milk with 16.6% total solids, cow milk with13.5% total solids and mixture (1:1) of both having 15.0% on syneresis, body/texture, flavor, acidity and color in yoghurt. Results showed that corn starch gave best results in controlling synerises in yoghurt followed by gelatin, pectin, sodium alginate, carageenan, guargum and CMC in buffalo milk as compare to mixture and cow milk. Treatment (T_{19}) having 0.4% corn starch and 16.6% total solids got maximum scores in flavor, body/texture, acidity and appearance than all other six stabilizers. This sample had firm coagulum, less separating whey, good aroma, pleasant taste and rheologically superior to all other samples. Statistical analysis showed that the treatments, storage intervals and total solids had a significant effect ($P<0.05$) on syneresis, body/texture, flavor, acidity and color of the yoghurt samples.

Key words**:** Yoghurt, Milk stabilizer, Syneresis.

Introduction

Yoghurt is defined as the product of fermented milk made from whole, low fat or skim milk. Yoghurt is so popular that it contains all the food value of the milk from which it was made (Krause and Mehan 1984). It has different forms e.g. stirred, set and frozen liquid yoghurt. Among all varieties, set yoghurt with a rather firm body is most common (Potter and Joseph 1995).

In Pakistan, yoghurt is prepared in two ways i.e. by traditional and by commercial methods. In traditional method "Dahi" is prepared at home and by shopkeepers. It is comparatively cheaper but has short shelf life with poor body characteristic and problem of syneresis. These defects yield a product of variable nature and of low quality. The commercial yoghurt manufacturing in this country is in growing stage, which mainly depends upon a high degree of mechanization and sanitation. With the development of science and technology, chemical additives are used in foods and dairy industries on commercial scales.

In the last few years, attempts have been made to improve the quality of yoghurt but further research is required in this field, particularly on milk composition and whey separation. Milk solid not fat (MSNF) play an important role in preventing whey separation in yoghurt. Richter *et al* (1979) found that MSNF was the most important component affecting the flavor, rheological properties and overall acceptability of the yoghurt.

E-mail: ayub120@yahoo.com

Whey separation or syneresis is a major problem of yoghurt which occurs when the body of yoghurt is cut and undesirable watery (whey) comes on the surface of yoghurt. Different stabilizers are used to over come this problem during processing and storage of yoghurt. Stabilizers (sometimes referred as hydrocolloids) have two types of action i.e. the binding of water and increase in the viscosity in yoghurt (Boylw 1972). The stabilizers permitted by FAO/WHO in 1976 are natural gums including plant extracts (pectin), seed flour (guar gum), cellulose derivatives (CMC), seaweed extracts (carrageenan and sodium alginates) and cereal starches (corn starch). From animal source includes gelatin (Glicksman 1979).

The most common inoculating material used by the modern dairy plants is the culture comprising of *Streptococcus thermophilus* and *Lactobacillus bulgaricus* in the ratio of 1:1, available either in powder or in tablet form. These grow together symbiotically and are responsible for the production of good taste and aroma in yoghurt. This fermentation process also causes pre-digestion of protein, carbohydrates, fats, increase in B–vitamins, enzymes and enhance the calcium bio-availability (Shahani 1983; Kaup *et al* 1987). So far little research work has been conducted on the effect of stabilizers on the physico-chemical characteristics, particularly on syneresis of yoghurt. It is the continuation of our previous study (Ayub and Siddiq 2003), which has been undertaken to improve the quality of yoghurt by controlling whey separation with added stabilizers in fresh dairy farm milk of buffalo and cow (1:1 and individual), available to common consumer in any season.

Materials and Methods

Preparation and formulation of raw material. Buffalo milk (S_1), cow milk (S_2) and mixture of both (1:1) S_3, with total solids 16.6, 13.5 and 15.0% were used for all trails. Hydrocolloid @ 0.4% was added as a stabilizer in formulation of yoghurt mix. Samples were pasteurized at a temperature of 85°C for 15 min in water bath, and cooled to a temperature 42°C. The mixture was inoculated with already prepared starter culture (@ 2%) of *S. thermophilus* and *L. bulgaricus* having pH 4.2. After stirring for 1 min the mix was filled in polystyrene cups (125 ml) and sealed. The culture mix was incubated at a temperature of 42°C till setting of the body to pH (4.2 ± 0.05) and acidity (0.85 ± 0.05%). The yoghurt was cooled to 4°C in order to stop further fermentation. The product was stored for 15 days at 10°C for further studies. Samples prepared for this study with different milk composition and stabilizers are presented in Table 1.

Table 1
Plan of study for yoghurt samples

Code	Stabilizers	Concentration	Milk	% TS
T_1	Control	Nil	Buffalo	16.6
T_2	Control	Nil	Cow	13.5
T_3	Control	Nil	Mixture	15.0
T_4	Pectin	0.4%	Buffalo	16.6
T_5	Pectin	0.4%	Cow	13.5
T_6	Pectin	0.4%	Mixture	15.0
T_7	Guargum	0.4%	Buffalo	16.6
T_8	Guargum	0.4%	Cow	13.5
T_9	Guargum	0.4%	Mixture	15.0
T_{10}	CMC	0.4%	Buffalo	16.6
T_{11}	CMC	0.4%	Cow	13.5
T_{12}	CMC	0.4%	Mixture	15.0
T_{13}	Carrageenan	0.4%	Buffalo	16.6
T_{14}	Carrageenan	0.4%	Cow	13.5
T_{15}	Carrageenan	0.4%	Mixture	15.0
T_{16}	Sodium alginate	0.4%	Buffalo	16.6
T_{17}	Sodium alginate	0.4%	Cow	13.5
T_{18}	Sodium alginate	0.4%	Mixture	15.0
T_{19}	Corn starch	0.4%	Buffalo	16.6
T_{20}	Corn starch	0.4%	Cow	13.5
T_{21}	Corn starch	0.4%	Mixture	15.0
T_{22}	Gelatin	0.4%	Buffalo	16.6
T_{23}	Gelatin	0.4%	Cow	13.5
T_{24}	Gelatin	0.4%	Mixture	15.0

Syneresis or whey separation. Susceptibility to syneresis was determined by using the drainage test described by Molder *et al* (1983), using 120 ml container of yoghurt.

Organoleptic evaluation. Samples were evaluated for flavor, body texture, physical appearance and taste or sensory acidity by a panel of three judges using the score card as approved by American Dairy Science Association (Nelson and Trout 1964).

Statistical analysis. The data obtained was statistically analysed using three factors factorial design according to Steel and Torrie (1980).

Results and Discussion

Syneresis/whey separation. Table 2 shows the mean values of syneresis of yoghurt samples. The mean values for pectin (T_2), guargum (T_3) and CMC (T_4) treated yoghurt samples (0.9, 0.933, 1, 1.433, 1.333, 1.433, 1.933, 1.967 and 1.9 ml) in S_1, S_2 and S_3 gradually increased (8.533, 8.467, 8.767, 11.367, 11.4, 11.433, 15, 14.833 and 14.7 ml) during 15 days storage. Samples with carrageenan (T_5) and sodium alginate (T_6) showed mean values of 2.333, 2.3, 2.367, 3.2, 3.267 and 3.267 ml which was gradually increased to 18.233, 18.4, 18.567, 16.2, 16.233 and16.233 ml, respectively. The mean values of samples with added corn starch (T_7) and gelatin (T_8) (0.533, 0.467, 0.5, 0.8, 0.733 and 0.733) gradually increased (6.8, 6.867, 6.9, 8, 8 and 7.967 ml) during storage. Control samples (T_1) showed a higher increase (from 1.9, 1.867 and 2.033 to 21.333, 20.833 and 21.1 ml) in syneresis during storage (Foley and Mulchahy 1989; Rouse and Moore 1973), as compared to those samples having stabilizers. Our results showed that syneresis decreased with the increase in total solids in yoghurt samples. Among all added stabilizers corn starch gave best results in controlling syneresis in yoghurt samples.

Statistical analysis showed that storage intervals and stabilizers had a significant effect ($P<0.05$) on syneresis of the product; the interaction between storage intervals and stabilizers was also highly significant. These results are in agreement with the findings of ealiers (Nielson 1974; Christensen and Trudsoe 1980; Anderson 1981; Porsdal and Jakobsen 1983; Anon 1993), who determined that yoghurt with increased total solids, had a resistance in developing syneresis.

Body/texture. The body/texture of the product is the next important factor in organoleptic evaluation. For body/texture excellent score was 30 and 24 for acceptable. The mean score for body/texture of samples from T_2 to T_6 (30, 24, 24, 22, 16, 10, 22, 16, 12, 16, 12, 8, 24, 20 and 12 in S_1, S_2 and S_3) decreased (28, 24, 22, 18, 12, 8, 14, 8, 8, 12, 6, 6, 22, 16 and 12)

Table 2
Effect of storage time on syneresis of different yoghurt samples

Milk	Treatments	Storage time (days)				Average (ml)
		0	5	10	15	
Buffalo (16.6% T.S)	T_1	1.900	7.967	14.100	21.333	11.325
	T_2	0.900	2.500	6.133	8.583	4.517
	T_3	1.433	2.733	6.633	11.367	5.542
	T_4	1.933	2.900	7.167	15.000	6.750
	T_5	2.333	6.067	12.433	18.233	9.767
	T_6	3.200	5.500	11.433	16.200	9.083
	T_7	0.533	1.433	5.200	6.800	3.492
	T_8	0.800	2.067	5.900	8.000	4.192
Cow (13.5% T.S)	T_1	1.867	7.733	13.500	20.833	10.933
	T_2	0.933	2.500	6.233	8.467	4.533
	T_3	1.333	2.700	6.733	11.400	5.542
	T_4	1.967	3.400	7.167	14.833	6.842
	T_5	2.300	6.100	12.467	18.00	9.817
	T_6	3.267	5.667	11.567	16.233	9.183
	T_7	0.467	1.533	5.300	6.867	3.542
	T_8	0.733	2.167	5.967	8.000	4.225
Mixture (15.0% T.S)	T_1	2.033	8.067	14.00	21.100	11.300
	T_2	1.000	2.467	6.333	8.767	4.642
	T_3	1.433	2.667	6.800	11.433	5.583
	T_4	1.900	3.167	7.233	14.700	6.750
	T_5	2.367	6.133	12.500	18.567	9.892
	T_6	3.267	4.800	11.667	16.233	8.992
	T_7	0.500	1.667	5.367	6.900	3.608
	T_8	0.733	2.267	6.033	7.907	4.250

T_1, Control; T_2, Pectin; T_3, Guargum; T_4, CMC; T_5, Carrageenan; T_6, Sodium alginate; T_7, Corn starch; T_8, Gelatin.

during storage. The mean score of samples T_7 and T_8 (30, 30, 24, 30, 24 and 24) remain same during storage, while in control samples it significantly ($P<0.01$) decreased during storage, due to weak body development and lumps production (Table 3).

Comparative study of the samples showed a significant ($P<0.01$) increase in the score of body texture of yoghurt sample, with added corn starch as compared to other stabilizers and control. Our overall results showed that body/texture consistently and gradually decreased during storage in all samples.

Statistical analysis showed that storage intervals, stabilizers and total solids had highly significant ($P<0.01$) effect on body texture of treated yoghurt samples. Interaction between storage intervals and stabilizers was also significant. These results are in accordance with the findings of (Mehanna and Gonc 1988; Rohm and Kneifel 1993), who reported a decrease in the score of texture in yoghurt samples during storage.

Color and flavor. For color maximum score (excellent) was 10 and 7, for minimum. The mean values for color of samples T_2 to T_6 (8.66, 32.66, 6, 5.33, 2.66, 2, 6, 4.66, 2.66, 5.33, 4, 2, 6.66, 5.33 and 3.33) decreased (8, 6.66, 4, 3.33, 2.66, 2.66, 4, 2.66, 2, 4, 2.66, 2, 6, 4, and 2) during storage. The initial mean scores of samples T_7 and T_8 were 10, 9.33, 7.33, 10, 8 and 6.66. In control samples the mean score (7.33, 5.33 and 3.33) decreased (7.33, 4.66 and 2.66) during storage. Among all yoghurt samples treatment (T_{19}) with added corn starch obtained maximum score, while samples with added guargum got minimum score, which developed a velvety and gummy appearance. Sample T_1 also showed same results. The results showed that samples with added corn starch gave best results for color than other six stabilizers and control samples.

Statistical analysis showed that storage intervals, stabilizers and total solids had highly significant ($P<0.01$) effect on appearance of treated yoghurt samples. These results are in agreement with the results of ealiers (Radha Krishna 1972;

Table 3
Mean score of judges for the body/texture of different yoghurt samples

Milk	Treatments	Storage time (days)			Average
		5	10	15	
Buffalo					
(16.6% T.S)	T_1	28.0	22.0	26.0	25.33
	T_2	30.0	28.0	28.0	28.66
	T_3	22.0	14.0	18.0	18.00
	T_4	22.0	10.0	14.0	15.33
	T_5	16.0	8.0	12.0	12.00
	T_6	24.0	18.0	22.0	21.33
	T_7	30.0	28.0	30.0	29.33
	T_8	30.0	28.0	30.0	29.33
Cow					
(13.5% T.S)	T_1	22.0	18.0	20.0	20.00
	T_2	24.0	24.0	24.0	20.00
	T_3	16.0	8.0	12.0	12.00
	T_4	16.0	6.0	8.0	10.00
	T_5	12.0	6.0	6.0	8.00
	T_6	20.0	14.0	16.0	16.66
	T_7	30.0	24.0	28.0	27.33
	T_8	24.0	24.0	28.0	24.00
Mixture					
(15.0% T.S)	T_1	18.0	14.0	14.0	15.33
	T_2	24.0	18.0	22.0	21.33
	T_3	10.0	6.0	8.0	8.00
	T_4	12.0	6.0	8.0	8.00
	T_5	8.0	6.0	6.0	6.66
	T_6	12.0	6.0	12.0	10.00
	T_7	24.0	22.0	24.0	23.33
	T_8	24.0	18.0	20.0	20.66

T_1, Control; T_2, Pectin; T_3, Guargum; T_4, CMC; T_5, Carrageenan; T_6, Sodium alginate; T_7, Corn starch; T_8, Gelatin.

Table 4
Mean score of judges for the acidity of different yoghurt samples

Milk	Treatments	Storage time (days)			Average
		5	10	15	
Buffalo					
(16.6% T.S)	T_1	14.67	14.67	13.33	14.22
	T_2	13.33	14.67	16.00	14.67
	T_3	14.67	18.67	13.33	15.57
	T_4	12.00	13.33	17.33	14.22
	T_5	16.00	16.00	12.00	14.67
	T_6	13.33	12.00	16.00	13.78
	T_7	20.00	17.33	20.00	19.11
	T_8	16.00	20.00	13.33	16.44
Cow					
(13.5% T.S)	T_1	10.67	12.00	12.00	11.67
	T_2	9.33	12.00	12.00	11.57
	T_3	10.67	13.33	10.67	11.57
	T_4	8.00	8.00	10.67	8.89
	T_5	12.00	12.00	9.33	11.11
	T_6	8.00	8.00	12.00	9.33
	T_7	16.00	16.00	16.00	16.00
	T_8	12.00	17.33	8.00	12.44
Mixture					
(15.0% T.S)	T_1	6.67	8.00	8.00	7.56
	T_2	5.33	9.33	6.67	7.11
	T_3	6.67	8.00	6.67	7.11
	T_4	4.00	4.00	4.00	4.00
	T_5	5.33	10.67	5.33	7.11
	T_6	4.00	5.33	8.00	5.78
	T_7	14.67	12.00	12.00	12.89
	T_8	8.00	12.00	4.00	8.00

T_1, Control; T_2, Pectin; T_3, Guargum; T_4, CMC; T_5, Carrageenan; T_6, Sodium alginate; T_7, Corn starch; T_8, Gelatin.

Mehanna and Gonc 1988). In a similar study, Varbioff (1979) determined that yeast and molds mainly affect the appearance of yogurts during storage.

Flavor of the product is one of the most important factor for determining the consumer's response. The flavor score for excellent was 45 and for acceptable 36. The mean values for flavor of samples T_2 - T_6 (42, 36, 36, 24, 24, 15, 21, 15, 12, 24, 18,12, 33, 24 and 21 in S_1, S_2 and S_3) decreased (39, 36, 33, 21, 21, 15, 18, 12, 9,15, 9, 9, 30, 27 and 21) during storage. The mean score of samples T_7 and T_8 (45, 45, 42, 45, 39 and 36) showed no changes in flavor during storage. Our results showed that samples with added corn starch (T_7) obtained maximum scores; compare to other samples (T_2 - T_8). The data showed that fresh samples got an acceptable range for flavour both for treated and untreated samples, which was significantly ($P<0.01$) decreased during storage. The flavor retention in corn starch samples (T_{19}) was comparatively higher than other samples during storage.

Statistical analysis showed that storage intervals, stabilizers and total solids had highly significant ($P<0.01$) effect on the flavor of treated yoghurt samples. Interaction between storage intervals and stabilizers was also significant. Our results are in agreement with the findings of (Abrahamsen 1978; Resubal *et al* 1987; Rehman 1987).

Acidity. The mean score for acidity (excellent) was 20 and for acceptance was 14. The mean score for acidity of samples T_2 to T_6 (13.33, 9.33, 5.33, 14.67, 10.67, 6.67, 12, 8, 4, 16, 12, 5.33, 13.33, 8 and 4) increased (16, 12, 6.66, 13.33, 10.67, 6.67, 17.33, 10.67, 4, 12, 9.33, 5.33, 16, 12 and 8) during storage. The mean values of samples T_7 and T_8 (20, 16, 14.67, 16, 12 and 8) slightly decreased (20, 16, 12, 13.33, 8 and 4) during storage. The mean values of sample T_1 also (14.67, 10.67 and 6.67) decreased (13.33, 12 and 8) during storage (Table 4).

Our results showed that the mean score for acidity decreased (due to increase in acidity) during storage. Among all the yoghurt samples, treatment with added corn starch obtained maximum mean score for acidity followed by samples with added gelaton.

Statistical analysis showed that storage time, stabilizer and total solids had a highly significant ($P< 0.01$) effect on acidity of treated yoghurt samples. Interaction between storage intervals and stabilizers is also highly significant. The results are in agreement with the findings of previous (Salji and Ismail 1983; Rehman 1987; Mehanna and Gone 1988; Shin *et al* 1991).

References

Abrahamsen R K 1978 The content of lactic acid and acid aldehyde in yoghurt stored at different temperature. *Inter Dairy Cong* **1** 829-830.

Anderson K G 1981 The technology of clear pickles. I. F. S. T. *Matership in Food Control Dissertation.* Serial No 34.

Anonymous 1993 Functional ingredients for food. *Grindsted Products*. Edwin Rahrs. Vej 38, DK-8220, Brabrand Denmark.

Ayub M, Siddiq M 2003 Effect of different types of milk and stabilizers on the chemical composition of quality yoghurt. *Sarhad J Agric* **19** (2) 271-278.

Boylw J L 1972 The stabilization of cultured milk products by alginates. Paper presented at the symposium on: *New Technological Development in Milk Industries, Vratney Doline,* Czechoslovakia.

Christensen O, Trudsoe J 1980 Effect of other hydrocolloids on the texture of kappa carrageenan gels. *J Texture Studies Food* **11**(2) 137-147.

Foley J, Mulchahy A J 1989 Hydrocolloid stabilization and heat treatment for prolonging shelf life of drinking yoghurt. *Irish J Food Sci Tech* **13**(1) 43-50.

Glicksman M 1979 Gelling hydrocolloids in food product application. In: *Polysaccharides in Food*, eds Bllanchard J M V & J R Mitchell, Butterworth, London, UK.

Kaup S M, Shahani K M, Amer M A, Peo E R J 1987 Bioavailability of calcium in yoghurt. *Milchwissenschaft* **42**(8) 513-516.

Kraus M V, Mehan L K 1984 Choosing food for nutrition and health. *Food, Nutrition and Diet Therapy*. 7th ed, pp 830-848.

Mehanna N M, Gonc S 1988 Manufacture of yoghurt from milk fortified with whey powder. *Egypt J Dairy Sci* **16**(2) 239-248.

Molder H W, Larmand M E, Lin G, Frochilch D, Emmons D B 1983 Physical and chemical properties of yoghurt stabilized with milk protein. *J Dairy Sci* **66**(3) 422-429.

Nelson J A, Trout G M 1964 *Judging Dairy Products*. The Olsen Pub. Co. Milwaukee Wis, USA, 4th ed.

Nielson J P 1974 The influence of cooling and storage temperature on the quality of yoghurt in relation to the content of solid not fat in the milk. In: *19th Int Dairy Congress*, pp 737.

Potter N N, Joseph H H 1995 Milk and milk products. *Food Sci*, 5th ed, pp 279-315.

Porsdal P K, Jakobsen O P 1983 Freeze thaw stability of gels. In: *16th Int Congress on Refrigeration, Pairs, 1983* **3** 713-716.

Radha K N 1972. MSc. Thesis, Andhra Pradesh Agric. University Hyderabad, India.

Rehman A 1987 Some microbiological aspects in relation to quality control of yoghurt. MSc. Thesis, Deptt. of Food Technology, University of Agric. Faisalabad, Pakistan.

Resubal L E, Collado E R, Emata O C, Lapiz E S 1987 Quality of yoghurt made from fresh skim milk and fortified with skim milk powder. *Philippine Agriculturist* **70**(3 & 4) 171-177.

Richter R L, Watts C W, Gehring T C, Cheshier K, Dill C W 1979 The relationship of milk fat, milk solid not fat and sugar to consumer acceptance of plain yoghurt. *J Dairy Sci* **62** 205-206.

Rohm H, Kneifel W 1993 Physical properties of set yoghurt enriched with various substrates, *DMZ, Lebensmitel lindustrie and Milchwirtschaft* **144**(11) 272-276.

Rouse A H, Moore E L 1973 All purpose gel blend or preparing citrus gels. *Proceedings of Florida State Hort Soc* **85** 229-232.

Salji J P, Ismail A A 1983 Effect of initial acidity of plain yogurt on acidity changes during refrigeration storage. *J Food Sci* **48**(1) 258-259.

Shahani K M 1983 Nutritional impact of *Lactobacilli* fermented foods. *Symposia of Swedish Nutrition Foundation* **15** 103-111.

Shin J G, Lee J J, Kim H Y, Beak Y J 1991 Studies on the change in quality and sensory evaluation of stirred yoghurt stored at different temperature. *Korean J Dairy Sci* **13**(12) 148-155.

Steel R G D, Torrie J H 1980 Analysis of variance II multiway classification. *Principles and Procedure of Statistics*, Mc Graw Hill, Book Co. NY, USA, 2nd ed, pp 195-238.

Varbioff Y 1979 Spoilage and keeping quality of yoghurt. *Dairy Production* **7**(2) 7-8.