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Original Research Article

EFFECTS OF VARIOUS STABILIZERS ON SENSORIAL QUALITY OF YOGHURT

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Abstract

This research was aimed to preserve the yoghurts using stabilizers without refrigeration in terms of syneresis and sensory analysis. Yoghurts were prepared using three stabilizers viz., gelatin, carboxymethylcellulose and sodium alginate and a control (without stabilizer). For which set type yoghurt was prepared with 2% starter culture inoculation and was incubated at 43^0C for 3 hours and was stored at 5-7^0C. Statistical analysis of all the treatments showed that 0.2 % stabilizer containing samples were significantly superior ($p<0.05$). The best samples with stabilizers containing 0.2% were again compared with control. From this, 0.2% gelatin added sample had significantly superior ($p<0.05$) scores. Shelf life of the sample was observed and it was compared with control at refrigerated condition. Sensorial gelatin added sample was best up to eleventh days while the control was best up to seventh days. Gelatin added sample showed less syneresis compared to control and adding stabilizer seems slower the acid development and syneresis of yoghurt in terms of storage time.

Keywords: yoghurt, syneresis, stabilizers, fermentation

INTRODUCTION

Yoghurt is an acidified coagulated dairy product obtained by controlled fermentation of milk by selected thermophilic lactic acid bacteria such as *Lactobacillus bulgaricus* and *Streptococcus thermophillus*. These organisms are used as yoghurt cultures to produce a characteristic mild clean lactic flavor and typical aroma[1]. Yoghurt is a source of highly nutritive protein, energy from added cane sugar, milk fat, vitamins and unfermented lactose. Other dairy ingredients are allowed in yoghurt to adjust the composition, such as cream to adjust the fat content, and nonfat dry milk to adjust the solids content. Stabilizers may also be used in yoghurt to improve the body and texture by increasing firmness, preventing separation of the whey (syneresis), and helping to keep the fruit uniformly mixed. Stabilizers used in yoghurt are alginates (carageenan), gelatins, gums (locust bean, guar), pectins, and starch[2].

Gelatin has been extensively used as a stabilizer in various styles of yoghurt. It is used at a level of 0.1–0.5%, depending on the firmness desired in refrigerated yoghurt .Carboxymethyl cellulose used in yogurt mix preparations is generally a combination of various vegetable stabilizers. Their ratios as well as the final concentration (generally 0.5–2.0%) in the product are carefully controlled to get desirable effects[3]. The optimum concentration of stabilizer(s) to be used in yoghurt is sometimes governed by legislation and/or side effects. The majority of stabilizers used in the production of yoghurt will exhibit solidification characteristics at ordinary refrigeration temperature, with the exception of gelatin which solidify at 25°C. Some recommended levels of stabilizer for the manufacture of yoghurt are in table 1:[4]

Table 1. Common stabilizer for yoghurt and yoghurt drinks

Stabilizer	Concentration in Yoghurt Mix (%)
Gelatin (225/250 Bloom)	0.1-0.5
Pectin (Low Methoxy for Yoghurt)	0.08-0.20
Caarboxymethyl Cellulose	0.1-0.2

The normal yoghurt is very perisable food product and has short shelf-life even at refrigerated temperature. The major constraint hampering large-scale production is quality changes during storage at room and refrigerated temperature. The bacteria present in yoghurt increase the acidity during storage at chilling temperature[5]. But whey separation or syneresis is a big problem of yoghurt.

Different stabilizers are used to overcome the problem of syneresis and to create desired texture and stability during processing and storage[6]. The only technique applied by most of the dairies to extend the shelf life is the chilling storage. The frequent shortage of electricity in countries like Nepal may limit the shelf-life due to the growth of culture contaminating microorganisms and syeneresis. The product may deteriorate during distribution due to other various reasons like shaking, jerk on the product due to transportation through vehicles. The main aim of the research has been undertaken to extend the shelf-life of yoghurt. Stabilizernot only extends the shelf-life of yoghurt but also prevents the product from becoming deteriorated in case of electricity shortage and in terms of sensory attributes. Stabilizers enhance the viscosity, influence texture, creaminess and mouth feel as well as help to prevent separation of whey from yoghurt and ultimately extend the shelf life of yoghurt [1].

MATERIALS AND METHODS

Milk, Sugar, Skim Milk Powder (SMP) (Good quality yoghurt has been produced by fortification of the yoghurt mix with 2% SMP) [7], Stabilizers (Commercial grades gelatin, sodium alginate and carboxymethyl cellulose (CMC) and Starter culture (yoghurt culture) was used.

Analytical methods

Proximate analysis of milk and yogurt such as fat content by Gerber method, titrable acidity, Protein content by Formol titration, Lactose content,Ashcontent according to NDDB,(2001).[8] Sensory evaluation of the product wascarried out using9 point hedonic rating scale and total solid content of yoghurt was determined by hot air oven method. Similarly the moisture content was determined by difference method[9]. The experimental data were analyzed by using the analysis of variance (two ways ANOVA) at 5 % level of significance using GenStat 3 Discovery edition. Testing of syneresis was determined by using the drainage method[10] with slight modifications.

Preparation of yoghurt

Milk was preheated to 45°C and skim milk powder was added at the rate of 2% and was again heated to 65-70°C and sugar was added at the rate of 4% and stirred well. Stabilizer such as gelatin, carboxymethylcellulose and sodium alginate were added at the rate of 0.2, 0.4 and 0.6% each. After that pasteurization was done at 85-90°C for 30 minutes. The yoghurt milk does receive a severe heat treatment (e.g. 85°C for 30min or equivalent) and hence some latitude with respect to the microbiological quality of the milk powder can be tolerated.[11]The pasteurized milk was cooled to 43°C and 2% starter culture (DDC yoghurt) was inoculated, then incubated at 43°C for 3-4 hours. Set type yoghurt thus obtained was cold stored at 5-8°C. Control was prepared without addition of stabilizer by following similar steps.

Optimization of Gelatin, sodium alginate and Carboxymethylcellulose (CMC)

Nine samples of Yoghurt were prepared by using the 4% sugar, 2% skim milk powder[7] and stabilizers (0.2%, 0.4% and 0.6%) like gelatin samples coded as A, B and C; sodium alginate samples coded as D, E and F;carboxymethylcellulose samples coded as G, H and I. These samples were subjected to sensory evaluation in terms of appearance/ color, Flavor, texture and overall acceptability and the scores so obtained were subjected to statistical analysis to get optimum level of stabilizer for preparation of yoghurt.

Comparison between the yoghurt using different optimized stabilizers

Four samples of yoghurt were prepared by using 4% sugar, 2% skim milk powder (Good quality yoghurt has been produced by fortification of the yoghurt mix with 2% SMP)[7]andoptimized amount of stabilizer (0.2%) such as gelatin, sodium alginate, carboxymetylcellulose and another one without stabilizer. These samples were coded as yoghurt G for yoghurt containing gelatin, yoghurt SA for yoghurt containing sodium alginate, yoghurt CMC for yoghurt containing carboxymethylcellulose and yoghurt C for yoghurt without stabilizer. These coded samples were subjected to sensory evaluation and the scores obtained were subjected to statistical analysis and best yoghurt in terms of sensory score in comparison to control was taken.

Comparison between the best yoghurt using stabilizer and control

Yoghurt was prepared by using 4% sugar, 2% skim milk powder[7] and optimized amount of gelatin (0.2%) and coded as yoghurt G and control was prepared without addition of stabilizer while other proportion remained constant and coded as yoghurt C. Both samples of yoghurt were stored in refrigeration and subjected to physicochemical analysis and sensory evaluation in every two days interval till products were acceptable for sensory evaluation upto 11 days to compare the shelf life of yoghurt with or without stabilizer.

RESULTS AND DISCUSSION

The milk from buffalo and cow has certain range of proximate composition like fat 8% and 3.9%, protein 4.2% and 3.3%, lactose 4.9% and 4.7% and ash content 0.8 and 0.7% respectively.[4] The proximate composition of milk used for the preparation of yoghurt is given in table 2. The milk used is the mixture of buffalo and cow milk available.

Table 2. Proximate composition of milk

Parameters	Value*
Total soluble solids	12.8(0.2)
Acidity as lactic acid (%)	0.15(0.01)
pH	6.6(0.1)
Lactose (%)	4.29(0.46)
Protein (%)	3.4(0.09)
Fat (%)	4.66(0.11)
Ash (%)	0.74(0.02)

* The values in the Table 2 are the means of triplicates. Figures in the parentheses are the standard deviation.

Optimization of gelatin for preparation of yoghurt

The mean sensory score of the yoghurt is shown in Table 3.

Table 3. Optimization of gelatin for preparation of yoghurt*

Parameter	Sample A	Sample B	Sample C	LSD
Appearance/ color	7.5[a](0.84)	7.2[a](1.22)	6.8[b](1.03)	0.659
Flavor	7.5[a](0.52)	6.9[b](0.87)	6.9[b](0.87)	0.583
Texture/mouthfeel	7.4[a](0.69)	7.2[a](0.63)	7.1[a](1.10)	0.659
Overall acceptability	7.6[a](0.69)	7.2[a](0.63)	6.9[b](0.99)	0.608

* The values in the table are the means of triplicates. Figures in the parentheses are the standard deviation. Values on row bearing similar superscript are not significantly different at 5% level of significance.

In terms of superiority (at 5% level of significance) of the formulations based on the frequency of occurrence as 'best' in each attribute type Sample A appears to be the best formulation. In the present study, the texture of yoghurt prepared from gelatin was significantly superior to others at 0.2%.

Too high concentration of a stabilizer, such as gelatin (0.6%, w/v) can impair the palatability of a natural yogurt gel[10]. Therefore, a medium concentration 0.2% (w/v) of gelatin could be appropriate to ensure good textural quality[12].

Optimization of sodium alginatefor preparation of yoghurt

The mean sensory score of the yoghurt is shown

Table 4. Optimization of sodium alginate for preparation of yoghurt*

Parameter	Sample D	Sample E	Sample F	LSD
Appearance/color	7.1[a](0.99)	7.6[a](0.51)	7.2[a](0.78)	0.786
Flavor	7.4[a](0.51)	6.9[a](1.10)	7[a](1.15)	0.865
Texture/mouthfeel	7.3[a](0.82)	7.1[a](0.87)	7[a](0.81)	0.815
Overall acceptability	7.3[a](0.48)	7.2[a](0.78)	7[a](0.81)	0.707

* Values in the table are the means of triplicates. Figures in the parentheses are the standard deviation. Values on the row bearing similar superscript are not significantly different at 5% level of significance.

There were no significant different in yoghurt samples Sample D, Sample E and Sample F in sensory quality with respect to appearance/color, flavor, texture/mouthfeel and overall acceptability at 5% level of significance. Hence, in terms of economic value, yoghurt sample D having less amount stabilizer (0.2%) was taken for further study.

Optimization of CMC for preparation of yoghurt

The mean sensory score of the yoghurt is shown in Table 5.

Table 5. Optimization of CMC for preparation of yoghurt*

Parameter	Sample G	Sample H	Sample I	LSD
Appearance/ color	8.1[a](0.56)	5.8[b](0.99)	5.7[b](0.82)	0.566
Flavor	7.5[a](0.70)	6.3[b](0.67)	5.2[c](1.03)	0.659
Texture /mouthfeel	7.6[a](0.51)	5.8[b](1.22)	4.9[c](0.99)	0.659
Overall acceptability	7.8[a](0.42)	5.9[b](0.73)	5.2[c](0.78)	0.488

* The values in the table are the means of triplicates. Figures in the parentheses are the standard deviation. Values on row bearing similar superscript are not significantly different at 5% level of significance.

Based on the frequency of occurrence as 'best' in each attribute type and the weightage on eachattribute for describing sensory quality, Sample G appears to be the best formulation.

Comparison of yoghurt prepared from gelatin, sodium alginate and CMC

After optimization 0.2% stabilizer was found to be best than other 0.4% and 0.6%. Thus, yoghurt were prepared by adding gelatin, sodium alginate and CMC each at the rate of 0.2% and one without stabilizer, while other remaining constant. The mean sensory score of the panelist for the yoghurt is shown in Table 6.

Table 6. Comparison of yoghurt prepared from gelatin, sodium alginate and CMC*

Parameter	Yoghurt G	Yoghurt SA	Yoghurt CMC	Yoghurt C	LSD
Appearance/color	7.6[a] (0.84)	6.1[b] (0.87)	6.5[b] (0.97)	7.6[a] (0.69)	0.786
Flavor	7.5[a] (0.7)	6.5[bc] (0.97)	6.4[c] (0.84)	7.2[ab] (0.94)	0.865
Texture/mouthfeel	7.3[a] (1.15)	6.9[b] (0.87)	6[b] (1.15)	7[a] (1.33)	0.815

*The values in the table are the means of triplicates. Figures in the parentheses are the standard deviation. Values on row of table bearing similar superscript are not significantly different at 5% level of significance.

Based on the frequency of occurrence as 'best' in each attribute, Yoghurt G appears to be the best and significantly similar with yoghurt C which may be due to perception of panelists with the yoghurt without stabilizers than yoghurt with stabilizers.

Peanut milk based yoghurt containing gelatin formed a firm gel with no whey at the top and had the highest sensory scores for all the three attributes (Appearance, texture and overall acceptability) as compared to the other stabilizers (HM pectin, PGA, K-carrageenan, xanthan gum and guar gum)[14].

Similarly, addition of gelatin resulted in a significant increase in the intensity of mouthfeel, flavor and creaminess of yoghurt. This might be due to effective immobilization of the aqueous phase by the gelatin in the yogurt network[15].

Chemical composition of yoghurt

Two yoghurt samples were prepared by adding 0.2% gelatin as stabilizer and without stabilizer. After incubation of 4h both samples of yoghurt were stored in refrigeration (4°) and after one day they were subjected for chemical analysis with and the result is shown in table 7.

Table 7. Chemical composition of yoghurt*

Parameters	Value*
Acidity	0.83(0.015)
pH	4.1(0.00)
Protein	3.6(0.1)
Fat	4.5(0.1)
Ash	0.76(0.01)
Lactose	3.70(0.1)

*The values in the table are the means of triplicates. Figures in the parentheses are the standard deviation.

The primary aim of adding stabilizers to the milk base is to enhance and maintain the desirable characteristics in yoghurt, without hampering the physical appearance of yoghurt for example, body and texture, viscosity/ consistency, appearance and mouthfeel. Stabilizer has no significant effect on chemical composition except lactose content, pH and acidity[6].

Relation between pH and syneresis of yoghurt sample

Yoghurt samples G and C were prepared to subject for pH and syneresis determination from first to eleventh day with two days interval. Their relation was as shown in fig 1.

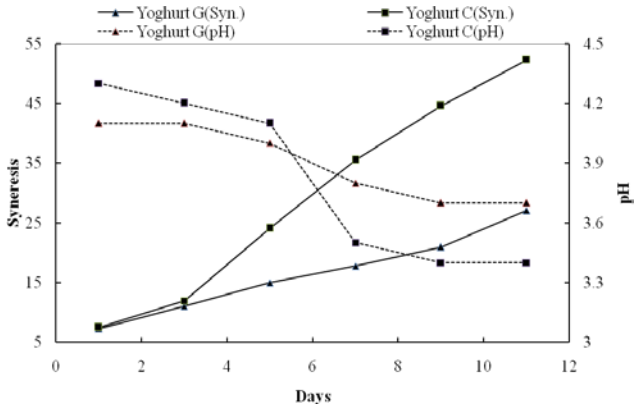

Figure 1. Relationship between the pH and syneresis of yoghurt G and yoghurt C with time

Where Yoghurt G (syn.) was syneresis of yoghurt and yoghurt G (pH) was PH of sample containing gelatin (0.2%) as stabilizer and Yoghurt C (syn.) was syneresis and yoghurt C (pH) was pH sample without stabilizer.

Statistical analysis at 5% level of significance showed that there were significant different in pH and syneresis of yoghurt G and yoghurt C in first, third, fifth, seventh, ninth and eleventh days.

Relation between pH and syneresis showed that pH was decreased while syneresis was increased with storage time which was due to the lactic acid formation with increase in storage time but pH was significantly lower in yoghurt C in each day than yoghurt G while syneresis was significantly higher. Adding stabilizer seems slower the acid development and syneresis of yoghurt.

pH was decreased from 4.14 to 3.62 in case of control and 4.23 to 3.75 in case of gelatin treated yoghurt from first to tenth days. Less decrease in pH was observed in case of sample treated with gelatin than control. Based on observation of this study, decreased pH throughout the storage period might be due to the formation of lactic acid by certain bacteria of yogurt[6]. Chamlagain also reported on higher syneresis on untreated yoghurt samples as compared to treated with stabilizer[6]. For both samples, syneresis increased with increasing storage time but significantly lower in stabilizer treated samples over control ones. Additionally, this study also agreed with the previous findings of Chamlagain[6].

Gelatin increased gel firmness and prevented serum separation in yoghurt and extends the shelf life of yoghurt[13].

Percent syneresis of yoghurt sample containing 9% total solid using non-EPS (exopolysaccharide), capsular EPS and ropy EPS producing starters after two weeks showed that 45, 44, 47% respectively but level of syneresis decreased by approximately 25% when total solid was increased to 14%[10].

Comparison of Sensory evaluation of yoghurt prepared from gelatin and control

The best sample of yoghurt with 0.2% gelatin were subjected for sensory evaluation with two days interval for the determination of shelf life yoghurt G and yoghurt C until products were acceptable sensorically (i.e.upto eleventh day for yoghurt G and seventh day for yoghurt C).

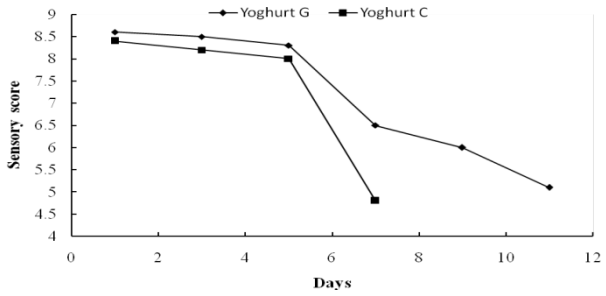

Figure 2. Effect of incubation time in appearance/color of yoghurt G and yoghurt C

Statistical analysis at 5% level of significance showed that there were no significant different in appearance/color between yoghurt G and yoghurt C formulation in first, third and fifth days. In case of yoghurt G there were no significant different between first, third

and fifth days, and between seventh and ninth days. In case of yoghurt C there were no significant different between first, third and fifth while on seventh it was unacceptable.

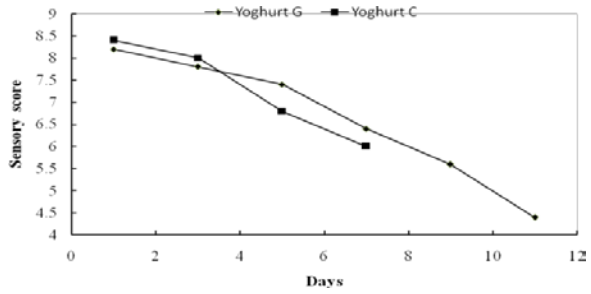

Figure 3. Effect of incubation time in Flavor of yoghurt G and yoghurt C

Statistical analysis at 5% level of significance showed that there were no significant different in flavor between yoghurt G and yoghurt C formulation in first and third days. In case yoghurt G, there were no significant different upto fifth days. In case of yoghurt C there were no significant different between first and third while in other days there were significant different. Among sensory attributes, flavor is considered to be the most important factor for determining consumer's response.

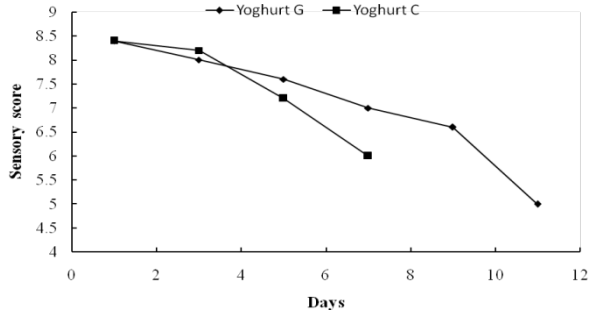

Figure 4. Effect of incubation time in texture/mouthfeel of yoghurt G and yoghurt C

Statistical analysis at 5% level of significance showed that there were no significant different in texture/mouthfeel between yoghurt G and yoghurt C formulation in first and third days. In yoghurt G there were no significant upto 9th days. In case of yoghurt C there were no significant different between first and third days while in other days it was deteriorated. It is concluded that using stabilizer increase the sensory parameters for longer days. Yoghurt G was preferred equally by sensory panelist after 3 days but acceptable sensory properties were really changed after 7 days storage, Sensory evaluation of peanut based milk yoghurt with different stabilizers showed that sensory score for texture were in the order gelatin > xanthangum > propylene glycol alginate > control > high methoxy pectin > guar gum> k-carrageenan > carboxymethyl cellulose at 5% level of significance[14].

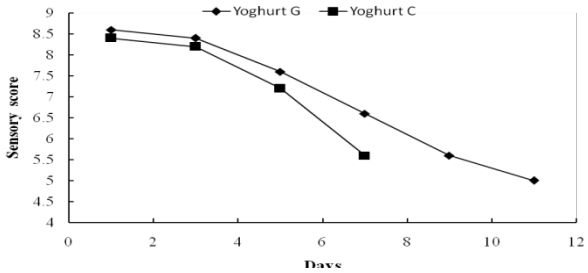

Figure 5. Effect of incubation time in overall acceptability of yoghurt G and yoghurt C

Statistical analysis at 5% level of significance showed that there were no significant different in overall acceptability between yoghurt G and yoghurt C in first and third day. In yoghurt G the product was superior for longer storage periods than yoghurt C which is sample without stabilizer.

CONCLUSION

Yoghurt samples treated each with 0.2% stabilizer, gelatin, sodium alginate and carboxymethyl cellulose, were found to better over samples with 0.4% and 0.6%.Gelatin were preferred as best among subjected: gelatin, stabilizer sodium alginate, carboxymethyl cellulose, by panelist. Acidity and syneresis were significantly lower in yoghurt treated with 0.2% gelatin than without stabilizer but pH was significantly higher. Adding stabilizer seems slower the acid development and syneresis of yoghurt. Quality parameter, acidity, syneresis, pH and sensory properties, were significantly affected by added gelatin. Addition of gelatin as stabilizer showed remarkable improvement in terms sensorial body and texture. Yoghurt treated with 0.2% gelatin was accepted up to eleventh days whereas yoghurt without stabilizer was accepted upto seventh days.

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