

STUDY ON THE SUITABILITY OF SELECTED PLANT-DERIVED STABILIZERS FOR MANUFACTURING SET YOGHURT

Mazahim.U. L. M¹, David.L. S¹, Lavanya.S¹, Jeganathan.N¹ and Mahusoon.M. M¹

ABSTRACT

An experiment was conducted to find out the suitability of selected plant-derived stabilizers for manufacturing set yoghurt. Three plant-derived stabilizers such as Gum Arabic, Pectin and Agar-Agar were selected after the preliminary study of each stabilizer. Six different concentrations of stabilizers such as 0.025%, 0.05%, 0.075%, 0.1%, 0.125% and 0.15% were used to prepare set yoghurt during the preliminary study and among which three suitable concentrations were selected by means of expert tasting panel for the organoleptic characteristics such as appearance, colour, taste, mouth feel, texture and overall acceptability. These three selected concentrations of each stabilizer were subjected for further sensory evaluation to select the most appropriate concentration for the yoghurt preparation. Among the three different concentrations of each stabilizer, 0.05% of Agar-Agar, 0.1% of Pectin and 0.075% of Gum Arabic were selected as the best concentration for the preparation of set yoghurt.

The selected concentration from each stabilizer was compared with a control treatment prepared using 0.1% Gelatin stabilizer. The results of sensory evaluation were analyzed using Friedman's test in Minitab statistical package. Yoghurt prepared using 0.05% of Agar-Agar was rated as the most suitable stabilizer in relation to all organoleptic characteristics for the preparation of set yoghurt compared to others. The shelf life of set yoghurts were tested by measuring the pH of yoghurts prepared using above selected stabilizers including the control treatment at two days interval, which were stored at $14 \pm 1^\circ\text{C}$. A significant decrease in pH with subsequent increase in acidity was observed during the storage period. The results revealed that the Agar-Agar could be incorporated at a concentration of 0.05% to prepare set yoghurt with a substantial storage life of 16 days at $14 \pm 1^\circ\text{C}$ without deterioration of quality.

Key words: Set yoghurt, Stabilizers, Organoleptic characteristics

INTRODUCTION

Yoghurt is a fermented milk product that contains the characteristic bacterial cultures *Lactobacillus bulgaricus* and *Streptococcus thermophilus*. Originating from central parts of Asia, India and Southern and Central Europe, it is now eaten almost everywhere in the world. Probably no other food product can claim such an illustrious history and popularity, while also being healthy and nutritious, and extremely cheap to buy or easy to make at home. Yoghurt can form an important part of a healthy diet, and there are plenty of yoghurt recipes that may be less suitable for those on a diet. Even better still, there are several health benefits and medical uses for yoghurt. It is nutritionally rich in protein, calcium, riboflavin, vitamin B₆ and vitamin B₁₂. People who are moderately lactose-intolerant can enjoy yoghurt without ill effects, because the lactose in the milk precursor is converted to lactic

acid by the bacterial culture. Yoghurt also has medical uses, in particular for a variety of gastrointestinal conditions and in preventing antibiotic-associated diarrhea. Yoghurt is believed to promote good gum health, possibly because of the probiotic effect of lactic acids present in yoghurt.

Stabilizers and/or emulsifiers are used during the manufacture of some dairy products, but in yoghurt making only stabilizers are added to the milk base. Their application in most countries is governed by legislative regulations. At the international level, the FAO/WHO (1990) have drafted a list of compounds (with permitted concentrations) which can be used in the production of yoghurt and a similar approach has been adopted in the United Kingdom (statutory instruments (SI), 1995). The classification of the food-grade stabilizers has always proved something of a problem and a number of different schemes has been suggested, such as all

¹ Department of Animal Science, Faculty of Agriculture, Eastern University, Sri Lanka. (alshiromi@yahoo.co.uk)

compounds to be referred to as polysaccharide materials, the name to include the botanical origin, the general origin i.e., plant, animal or synthetic and chemical grouping. However the later approach has been modified by Glicksman (1986) and his proposed classifications includes a reference to the processing techniques, for examples: natural gums (those found in nature) modified natural or semi-synthetic gum (chemical modifications of natural synthetic gums or gum-like materials) and synthetic gums (those prepared by chemical synthesis).

The primary aim of adding stabilizers to the milk base is to enhance and maintain the desirable characteristics in yoghurt, for example, body and texture viscosity / consistency, appearance and mouth-feel. Stabilizers are sometimes referred to as hydrocolloids and their mode of actions in the yoghurts includes two basic functions: First, the binding of water and second, promotion of increase in viscosity (Frost *et al.*, 1984; Phillips *et al.*, 1994). Stabilizers used in yogurt are alginates (carageenan), gelatins, gums (locust bean, guar), pectins, and starch.

Commonly the animal-derived stabilizer Gelatine is used in yoghurt preparation in Sri Lanka and therefore a research was carried out to study the significance of using plant-derived stabilizers such as Agar-Agar, Pectin and Gum Arabic for the preparation of set yoghurt.

MATERIALS AND METHODS

Preparation of plain set yoghurt

Fresh cow milk was collected from the livestock farm, Eastern University Sri Lanka. Milk was standardized by adding 3% of skimmed milk powder and 5% of sugar and mixed at 45°C. Milk was pasteurized until it reach 85 – 90°C for 15 minutes in a stainless steel vessel, which was immersed in another stainless steel vessel containing water. The vessels were seated within each other in a way to prevent hot moisture escape during the heating process. The mixture was cooled down to 45°C and the culture was added at a rate of 2% of the volume and stirred well. Each stabilizer was incorporated at different temperatures due to the different chemical nature and solubility of stabilizers. Pectin was mixed with sugar and added to the cold milk prior to heating. Gum Arabic and Agar-Agar were incorporated at 45°C and 90°C respectively to the milk and mixed thoroughly for complete dispersion (Tamime and Robinson, 2001). For the control treatment, 0.1% Gelatin was

incorporated to the milk at 60°C. The mixture was filtrated to remove any inert matter before poured into the plastic cups. Incubation was carried out at 45°C for two and a half hours in an electrically operated yoghurt incubator. Then prepared set yoghurt was stored at $14 \pm 1^\circ\text{C}$ under refrigerated condition.

Preliminary study for the selection of suitable concentration of stabilizers

The stabilizers Pectin, Agar-Agar and Gum Arabic, which were approved by the International Federation for Organic Agricultural Movements (IFOAM), were used to prepare set yoghurt. A preliminary experiment was carried out using six different concentrations such as 0.025%, 0.05%, 0.075%, 0.1%, 0.125% and 0.15% for each stabilizer, which were approved by the FAO (Food and Agriculture Organization)/WHO (World Health Organization). The prepared set yoghurt samples were subjected to sensory test to evaluate organoleptic and physical characteristics. Based on these empirical results concentration series for each stabilizer was narrowed down to three levels and again they were subjected to a sensory test, which consisted of thirty people to evaluate the organoleptic characteristics of the sample. The best concentration from each stabilizer was selected.

Organoleptic evaluation for the selection of suitable stabilizer

The selected concentration from each three stabilizer and the control treatment were subjected to sensory test to select the most suitable stabilizer for the preparation of set yoghurt. Organoleptic evaluation was carried out by testing panel which consisted of thirty experienced panelists during the period of September and October, 2008 at the dairy technology laboratory. The Organoleptic characteristics such as appearance, color, taste, mouth feel, texture and general acceptability were evaluated. The five point hedonic scale was used to evaluate the degree of liking for each quality characteristics. The sample were coded with random numbers and served in random order. The panelists were provided with water to rinse their mouth after each testing.

Evaluation of shelf life

The shelf life was evaluated by measuring the pH of sample at two days interval which was stored at $14 \pm 1^\circ\text{C}$ for a period of 16 days (Man and Jones, 2000). The pH was measured using a digital pH meter.

Statistical Analysis

A non-parametric ranking procedure was used with Friedman's test. The data was analyzed using the MINITAB statistical package.

RESULTS AND DISCUSSION

Results of Preliminary study for the selection of suitable concentration of stabilizers

Agar-Agar

The yoghurt samples added with Agar-Agar stabilizer at the concentrations of 0.025%, 0.05%, and 0.075% were selected as the suitable concentrations by the panel. When the concentration of Agar-Agar increases, the texture of the final product became too firm. Among these selected three concentrations, Agar-Agar stabilizer of 0.05% was selected again as the best concentration for the preparation of set yoghurt. The estimated mean values of yoghurt added with Agar-Agar stabilizer are given in the Table 1.

When interpreting the overall results, it was evident that the panelists have preferred the treatment $T_{A 0.05\%}$ than other treatment such as $T_{A 0.025\%}$ and $T_{A 0.075\%}$. According to Sta (1996), the recommended level of Agar-Agar stabilizer is 0.05-0.6g100g⁻¹.

Pectin

The yoghurt samples added with Pectin stabilizer at the concentrations of 0.125%, 0.075% and 0.1% were selected as the suitable concentrations. The yoghurt samples added with lower concentration of stabilizers were not preferred due to less spoonability and poor texture. The yoghurt sample added with higher concentration of Pectin stabilizer (0.15%) gave sandy mouth feel. Among these selected three concentrations of Pectin stabilizer, 0.1% was selected again as the best concentration for the preparation of set yoghurt. The estimated mean values of yoghurt added with Pectin stabilizer are given in the Table 2.

At 0.1% of Pectin concentration, the surface appearance of yoghurt was uniform and this may have attributed due to the proper stabilizing effect at this concentration. According to Basak and Ramaswamy (1994) the recommended level of pectin stabilizer is 0.02-0.7g100g⁻¹.

GumArabic

The yoghurt samples added with Gum Arabic stabilizer at the concentrations of 0.05%, 0.075% and 0.1% were selected as the suitable concentrations. The yoghurt samples added with higher concentrations of Gum Arabic such as 0.125% and 0.15% gave salty flavor. Among

Table 1: Mean values of Yoghurt added with Agar-Agar Stabilizer

Treatment	Appearance	Colour	Taste	Mouth feel	Texture	Overall Acceptability
$T_{A 0.025\%}$	4.0	3.5	3.0	3.0	3.7	2.8
$T_{A 0.05\%}$	4.0	3.8	4.0	3.0	4.0	3.7
$T_{A 0.075\%}$	4.0	3.2	3.0	3.0	3.8	3.0

T_A = Agar-Agar stabilizer added yogurt samples

Table 2: Mean values of Yoghurt added with Pectin Stabilizer

Treatment	Appearance	Colour	Taste	Mouth feel	Texture	Overall Acceptability
$T_P 0.075\%$	3.0	3.0	4.0	4.0	4.0	4.0
$T_P 0.1\%$	4.0	4.0	5.0	5.0	5.0	5.0
$T_P 0.125\%$	4.0	4.0	4.0	4.0	4.0	4.0

T_P = Pectin stabilizer added yogurt samples

Table 3: Mean values of Yoghurt added with Gum Arabic Stabilizer

Treatment	Appearance	Colour	Taste	Mouth feel	Texture	Overall Acceptability
$T_G 0.05\%$	3.0	3.0	4.0	4.0	4.0	4.0
$T_G 0.075\%$	4.0	4.0	5.0	5.0	5.0	5.0
$T_G 0.1\%$	4.0	4.0	4.0	4.0	4.0	4.0

T_G = Gum Arabic stabilizer added yogurt samples

these selected three concentrations, Gum Arabic stabilizer of 0.075% was selected again as the best concentration for the preparation of set yoghurt. The estimated mean values of yoghurt added with Gum Arabic stabilizer are given in Table 3.

The overall results revealed that the panelists have preferred the 0.075% Gum Arabic stabilizer for the preparation of set yoghurt than others.

Organoleptic evaluation for the selection of suitable stabilizer

The results of sensory analysis revealed that there were significant differences between the treatments for appearance, colour, taste, mouth feel, texture and overall acceptability. The overall results revealed that the most suitable stabilizer for manufacturing of set yoghurt is Agar-Agar at a concentration of 0.05%. The estimated mean values for each treatment obtained were given in the Table 4.

therefore it gave poor spoonability. The Pectin added yoghurt had a sandy nature and at the same time, Gum Arabic generated a salty flavor in the product.

The yoghurt sample added with Agar-Agar stabilizer was observed with uniform surface. At the same time control treatment (T_C), which was added with 0.1% Gelatin also showed the similar characteristics, whereas other two treatments $T_{P\ 0.1\%}$ and $T_{G\ 0.075\%}$ were comparatively poor in surface appearance due to surface moisture. According to Man and Jones (2000) set yoghurt should have a glossy surface appearance without excessive whey and the texture is smooth and almost junket-like, giving a clean cut when spooned. The colour of the treatments $T_{P\ 0.1\%}$ and $T_{G\ 0.075\%}$ were less preferred than treatment $T_{A\ 0.05\%}$ and it may be due to slight color changes brought about by Pectin and Gum Arabic whereas Agar-Agar is colorless compounds. According to Tamime and Robinson (2001), the use of gelatin may give the coagulum a rough texture.

Table 4: The estimated mean values of yoghurt prepared using three different stabilizers

Treatment	Appearance	Colour	Taste	Mouth feel	Texture	Overall Acceptability
$T_{P\ 0.1\%}$	2.7	3.3	2.5	2.4	2.1	1.9
$T_{A\ 0.05\%}$	4.2	3.8	4.0	3.8	4.3	4.2
$T_{G\ 0.075\%}$	2.6	3.0	3.1	3.2	3.3	2.9
T_C (Control)	3.8	4.0	3.9	3.3	3.4	3.7

$T_{P\ 0.1\%}$ = 0.1 % Pectin, $T_{A\ 0.05\%}$ = 0.05% Agar-Agar, $T_{G\ 0.075\%}$ = 0.075% Gum Arabic and T_C = 0.1% Gelatin

Table 5: Changes in the pH of yoghurt during storage at $14 \pm 1^\circ\text{C}$

Treatment	Days after storage at $14 \pm 1^\circ\text{C}$							
	2	4	6	8	10	12	14	16
T_P	4.37	4.32	4.28	4.26	4.24	4.22	4.21	4.20
T_A	4.39	4.33	4.29	4.27	4.26	4.24	4.23	4.21
T_G	4.38	4.33	4.28	4.27	4.25	4.23	4.21	4.20
T_C	4.39	4.34	4.29	4.26	4.24	4.22	4.22	4.21

The treatment $T_{A\ 0.05\%}$ has gained the highest estimated mean value for appearance, taste, mouth feel, texture and overall acceptability compared to other treatments. There were no significant difference between the control treatment (T_C) and Agar-Agar treatment ($T_{A\ 0.05\%}$) for appearance, colour, taste and overall acceptability of yoghurt.

Pectin (0.1%) added yoghurt sample gave sandy mouth feel while the Agar-Agar (0.05%) added yoghurt sample gave a soft and smooth mouth feel compared to other treatments. The yoghurt with 0.1% Pectin showed immediate syneresis after breaking with a spoon and

Shelf life evaluation

The changes of pH in all treatments during storage at $14 \pm 1^\circ\text{C}$ are given in the Table 5. A decrease trend in pH was observed in all treatments throughout the storage period. Fermentation to the desired pH the yoghurt is cool to below 20°C and often stored for a short period prior to filling (Man and Jones, 2000).

According to Table 5, the pH of yoghurt during storage at $14 \pm 1^\circ\text{C}$ had a maximum value of 4.39 and a minimum value of 4.20 and the value coincided with the standards specified for the set yoghurt. In all treatments, the pH was decreased and it could be attributed to the action

of microbial enzymes towards the production of lactic acid. Individual variation in pH among four treatments could be due to facts like difference in initial microbial population in starter culture, the water binding ability of the stabilizer and storage temperature.

CONCLUSION

The results of preliminary study for the selection of suitable concentration of stabilizer revealed that 0.05% of Agar-Agar, 0.1% of Pectin and 0.075% of Gum Arabic are the best concentrations for the preparation of set yoghurt. Sensory evaluation for the selection of suitable stabilizer indicated that 0.05% of Agar-Agar is the most suitable stabilizer for the preparation of set yoghurt, than other stabilizers. There were no significant difference between the control treatment (T_c) and Agar-Agar treatment ($T_{A.0.05\%}$) for appearance, colour, taste and overall acceptability of yoghurt. A decreasing trend in pH with subsequent increase in acidity was observed throughout the storage period of yoghurt at $14 \pm 1^\circ\text{C}$ for sixteen days period. The results revealed that the Agar-Agar could be incorporated at a concentration of 0.05% to prepare set yoghurt with a substantial storage life of 16 days at $14 \pm 1^\circ\text{C}$ without any drastic change in pH.

REFERENCES

- Basak, S. and Ramaswamy, H. S. (1994). *Journal of Food Engineering*, 21, pp.385.
- FAO/WHO (1990). *In Codex Alimentarius – Abridged Version*, Joint FAO/WHO Food Standards Programme-Cordex Alimentarius Commission, Ed. By Smith, B.L., Food and Agricultural Organization of the United Nations, Rome.
- Frost, J., Hegedus, E. F and Glicksman, M. (1984) *Food Technology*, 38(1), pp.118.
- Glicksman, M. (1986). *In Food Hydrocolloids*, Vol. III, Boca Raton: CRC Press.
- Man, D. and Jones, A. (2000). Shelf-life Evaluation of Foods, pp 89-105, USA: Aspen Publishers, Inc.
- Phillips, G. O., Williams, P. A. and Wedlock, D. J. (1994). *In Gums and Stabilizers for the Food Industry VII*, Oxford: Oxford University Press.
- SI (1995). *In Food – The Miscellaneous Food Additives Regulation*, Statutory Instruments No.3187, HMSO, Edinburgh.
- Sta, J. (1996). *Dairy Industries International*, 61(11), pp.23.
- Tamime, A. Y. and Robinson, R. K. (2001). *Yoghurt Science and Technology*, pp 35-41, Cambridge, England: Woodhead Publishing Limited.