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Screening of Stabilizers for Peanut Milk Based Set Yoghurt by Assessment of Whey Separation, Gel Firmness and Sensory Quality of the Yoghurt

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Abstract: Seven stabilizers were assessed for their suitability and compatibility to peanut milk based set yoghurt. For the sake of screening, the concentration of the stabilizers added was fixed at 0.2% (w/v). Peanut milk based yoghurt was prepared from a mixture of 60% peanut milk and 40% cow milk. Whey separation, gel firmness and sensory quality of the yoghurt were the quality attributes used for screening the stabilizers. Yoghurt containing κ-carrageenan and gelatin had a firm gel with little or no whey at the top, respectively. Yoghurt containing the other five stabilizers (High methoxy pectin, Propylene glycole alginate, Carboxy methyl cellulose, Xanthan gum and Guar gum) all formed weak gels with little or excessive whey at the top. The yoghurt containing gelatin had higher sensory scores for all the three sensory attributes (Appearance, texture and overall acceptability) as compared to the other stabilizers assessed in this study. Therefore, gelatin was found to be the most appropriate stabilizer compatible to a peanut milk based yoghurt system.

Key words: Peanut milk based yoghurt, set yoghurt, stabilizers, screening, sensory evaluation, whey separation, gel firmness

INTRODUCTION

During yoghurt manufacturing, the thermal processing of milk (80 to 85°C for 30 min or 90 to 95°C for 5 min) denatures whey protein but has little effect on casein micelles (Singh, 1995). The subsequent interaction of whey protein with casein micelles aids in the formation of firm gels with less tendency for syneresis (Aguilera and Stanley, 1999; Tamime and Robinson, 1999). Denaturation of whey proteins promotes interaction through disulfide linkages between β-lactoglobuline (β-Lg) and κ-casein at the micellar surface (Dalgleish, 1990). When the pH drops below the casein isoelectric point (6.7), the β-Lg/κ-casein complex promotes the formation of small-diameter micelle aggregates (Tromp *et al*., 2004) and a gel matrix with increased water-holding capacity (Tamime and Robinson, 1999).

The firmness of yoghurt is affected by homogenization, pH, processing parameters (stirred or set yoghurt) and heat treatment of milk that denatures β-lactoglobulin and that subsequently may bridge adjacent casein micelles (Lucey and Singh, 1997). Yoghurt is usually prepared from homogenized milk to improve stability. This process coats the increased surface of fat globules with casein, enabling the fat globules to participate as a copolymer with casein to strengthen the gel network and reduce syneresis (Keogh and O'Kennedy, 1998). Despite this, thickeners and stabilizers are required during processing to provide an acceptably firm texture and reduce syneresis, particularly in low-fat yoghurt (Staff, 1998).

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Stabilizers are sometimes referred to as hydrocolloids and have two basic functions in yoghurt: the binding of water and improvement in texture. In many dairy products, texture is controlled by adding hydrocolloids that interact with the casein network (Thaiudom and Goff, 2003). For preparation of yoghurt of optimum physical, textural and sensory characteristics, a proper selection of stabilizers and their amounts is required. The optimum concentration of stabilizer to be used in yoghurt is sometimes governed by legislation and/or side effects caused by addition of high amount of stabilizer (Tamime and Robinson, 1999). Food polysaccharides such as carrageenans, pectin, starch, agar, locust bean gum, xanthan gum and guar gum are often added to yoghurt to provide good stability and desirable texture (Sanchez *et al*., 2000).

Several researchers have conducted experiments to investigate how the addition of hydrocolloids influences different yoghurt quality attributes (susceptibility to syneresis, physicochemical, sensory, firmness and texture profile and starter count of yoghurt) (Chopra and Gandhi, 1990; Jawalekar *et al*., 1993; Moller, 1995; Khalafalla and Roushdy, 1997; Keogh and O'Kennedy, 1998; El Sayed *et al*., 2002; Kumar and Mishra, 2004).

It was noted that it's possible to produce Peanut Milk Based Yoghurt (PMBY) with acceptable appearance, flavor and texture. However the texture of the peanut milk based yoghurt though acceptable was inferior to that of cow milk yoghurt according to a sixteen member sensory panel (Isanga and Zhang, 2007). It has consistently been reported that the addition of stabilizers improves the appearance, texture and retards syneresis of yoghurt (Jawalekar *et al*., 1993; Tayar *et al*., 1995; Khalafalla and Roushdy, 1997; Fiszman and Salvador, 1999; El Sayed *et al*., 2002).

On the contrary, some stabilizers also do have negative effects on the quality of yoghurt depending upon their interaction with the casein of the milk and under different conditions. The mode of action of the selected stabilizer depends on the type of yoghurt produced but in most applications, the rule of thumb is trial and error (Tamime and Robinson, 1999). Therefore, the objective of this study was to select the most appropriate stabilizer compatible with peanut milk based yoghurt by assessment of whey separation, gel firmness and sensory quality of the yoghurt. For the purpose of screening, the concentration of all stabilizers used was fixed at 0.2% (w/v).

MATERIALS AND METHODS

This study was conducted between June and July 2007 from the Key Laboratory of Food Science and Safety, Southern Yangtze University, Wuxi, People's Republic of China.

Materials

The Spanish red-skinned peanut seeds were purchased from a local supermarket in Wuxi, China. Care was taken to ensure that good quality and mould-free seeds were selected. The whole milk powder was purchased from a dairy factory in Donghuang, Qinghai, China. The culture pack of *Lactobacillus bulgaricus* and *Streptococcus thermophilus* were obtained from the key Laboratory of Food Science and Safety of Southern Yangtze University, Wuxi, China. The stabilizers (Guar gum, Xanthan gum, Carboxy methyl cellulose, Gelatin, High methoxy pectin, Propylene glycole alginate and κ-carrageenan) were purchased from Beijing Fubang Co., Ltd., China.

Milk Preparation

Whole milk powder was reconstituted at 43°C with moderate mixing at 14% w/v total solid concentration and cooled to room temperature then refrigerated at 4-5°C overnight for hydration of the powder before usage.

Peanut milk was prepared by a method reported by Salunkhe and Kadam (1989) with slight modifications. Sorted peanut seeds were roasted at 130°C for 25 min in an oven (Onlin XBO-9278R, Guangdong Xinbao Electrical Appliances Holding Co., Ltd., Foshan, China). The seeds were then de-skinned and weighed before being soaked in 0.5% $NaHCO_3$ for at least 12 h. The de-skinned peanut kernels were then washed with clean water. The kernels were then mixed with water in a ratio of 1:5 [peanuts (g): water (mL)] and transferred to a blender (SS680-A, Shanghai Yuyang Electronics Co.) where they were blended for at least 5 min. The slurry formed was filtered using a double layered cheese cloth to yield peanut milk.

Yoghurt Preparation

To a blend of 60% Peanut Milk (PM) and 40% Reconstituted Whole Milk (RWM) was added 7% (w/v) sucrose as a sweetener and 0.2% (w/v) stabilizer. The toned milk preparations containing different stabilizers were separately homogenized at 25 MPa. The different homogenized milk preparations containing stabilizers were then pasteurized at 85°C for 30 min. The pasteurized milk preparations were cooled to 43°C in a water bath then inoculated with 3% (v/v) starter culture (*Lactobacillus bulgaricus* and *Streptococcus thermophilus*; 1:1) and incubated at 43°C for 4-5 h until a pH of about 4.6 was attained. The yoghurt was then transferred to a refrigerator at ~5°C overnight before being analyzed.

Whey Separation and Gel Firmness of Set Yoghurt

Seven panelists with knowledge of food science and familiar with yoghurt quality were requested to analyze the whey separation and gel firmness of the yoghurt. The results were reported as a consensus of all the seven panelists.

Whey Separation

Whey separation of the yoghurt was assessed by observing if or not there was whey on top of the set yoghurt. To describe the whey separation, statements such as; no whey, little whey or Excessive whey were used.

Gel Firmness

The firmness of the yoghurt gel was assessed by gradually tilting the glass bottles containing the yoghurt samples until the bottles were completely inverted and simultaneously observing to see whether or not the yoghurt pours out on tilting the bottles or falls on completely inverting the bottles. Yoghurt samples which did not fall down even when the bottles were completely inverted were described as being firm gels while those which poured on tilting the bottles or fell down when the bottles were completely inverted were described as weak gels.

Sensory Quality of Yoghurt

Yoghurt samples were analyzed for appearance/color, texture/mouth feel and overall acceptability after overnight storage at 4-5°C. Ten trained panelists who had knowledge of food science and sensory quality of yoghurt were used to rate the samples on the basis of the nine points hedonic scale (Stone and Sidel, 1993). Eight samples were presented to panelists in three digit random number cups containing approximately 25 mL of sample per cup. Yoghurt samples containing different stabilizers were coded as follows:

101 : Control (No stabilizer)
202 : Gelatin
303 : High Methoxy (HM) pectin
404 : Carboxy Methyl Cellulose (CMC)
505 : Xanthan gum
606 : Propylene Glycole Alginate (PGA)
707 : κ-carrageenan
808 : Guar gum.

The sensory scores included; Like extremely = 9, Like very much = 8, Like moderately = 7, Like slightly = 6, Neither like nor dislike = 5, Dislike slightly = 4, Dislike moderately = 3, Dislike very much = 2, Dislike extremely = 1.

Statistical Analysis

Unless otherwise stated, results were analyzed statistically using a computer program SAS system for windows (SAS, 2002) for analysis of variance (ANOVA) by one way and comparison of means by Duncan's multiple comparison test where $p<0.05$ was considered for significant difference.

RESULTS AND DISCUSSION

Whey Separation and Gel Firmness

From Table 1, firm gels with little or no whey at the top were formed in peanut milk based set yoghurt containing κ-carrageenan and gelatin respectively. This is partly in agreement with other researchers (Guinee *et al.*, 1995; Güven, 1998; Keogh and O'Kennedy, 1998; Fiszman and Salvador, 1999) who also reported that gelatin increased gel firmness and prevented serum separation in yoghurt.

The set yoghurt prepared without any stabilizer (control) also formed a firm gel and had no whey at the top. However yoghurt containing the other five stabilizers (HM pectin, PGA, CMC, xanthan gum and guar gum) all formed weak gels as observed by the panelists. Yoghurt containing HM pectin and PGA formed excessive whey at the top while those with CMC, xanthan gum and guar gum had little whey at the top. Since peanut milk based yoghurt was able to form a firm gel even without addition of any stabilizer, this implies (with the exception of gelatin and κ-carrageenan) that the addition of some stabilizers (HM pectin, CMC, Xanthan gum, PGA and Guar gum) affected its gel firmness negatively. These observations concur with reports that some stabilizer may improve yoghurt quality attributes (Tayar *et al.*, 1995; Khalafalla and Roushdy, 1997; Fiszman and Salvador, 1999; El Sayed *et al.*, 2002) while others may negatively affect the quality attributes (Tamime and Robinson, 1999) depending upon their interaction with the casein of the milk and under different conditions.

Sensory Evaluation

The results of sensory evaluation of PMBY with different stabilizers on the basis of appearance, texture and overall acceptability are summarized in Table 2. The sensory scores for appearance were in the order Gelatin>Control>PGA>Guar gum>Xanthan gum>HM Pectin> κ-carrageenan>CMC. The sensory texture scores were in the order Gelatin>Xanthan gum>PGA>Control>HM Pectin>Guar gum>κ-carrageenan>CMC. The overall acceptability scores were in the order Gelatin>PGA> Control>Guar gum>Xanthan gum>HM Pectin>κ-carrageenan>CMC.

The commercially acceptable range for scores of any yoghurt sensory attribute as recommended by the Karl Ruther nine points scheme is 4-9 scores (Tamime and Robinson, 1999). However from Table 2, the sensory scores of yoghurt containing CMC and κ-carrageenan for all the three sensory attributes assessed fell below the acceptable range of 4-9 as per the 9-point hedonic scale. Therefore

Table 1: Whey separation and gel firmness of peanut milk based set yoghurt with different stabilizers

Analytical method	Sample codes							
	101	202	303	404	505	606	707	808
Whey at the top	No	No	Excessive	Little	Little	Excessive	Little	Little
Gel firmness	Firm	Firm	Weak	Weak	Weak	Weak	Firm	Weak

Table 2: Sensory evaluation of peanut milk based yoghurt with different stabilizers

	Scores for different sensory attributes		
Samples	Appearance/color	Texture/mouth feel	Overall acceptability
101	8.28 ± 0.12^{b}	7.30 ± 0.14^{c}	7.60 ± 0.15^{b}
202	8.56 ± 0.09^{a}	8.61 ± 0.06^{a}	8.43 ± 0.04^{a}
303	5.83 ± 0.09^{e}	6.83 ± 0.11^{d}	5.24 ± 0.13^{d}
404	2.28 ± 0.17^{g}	2.03 ± 0.02^{g}	2.29 ± 0.01^{f}
505	6.11 ± 0.13^{d}	7.53 ± 0.09^{b}	6.11 ± 0.18^{c}
606	7.62 ± 0.10^{c}	7.40 ± 0.14^{bc}	7.80 ± 0.13^{b}
707	2.83 ± 0.11^{f}	2.84 ± 0.07^{f}	2.66 ± 0.05^{e}
808	6.32 ± 0.11^{d}	6.50 ± 0.10^{e}	6.19 ± 0.17^{c}

Results are reported as means±SD for ten replicates of each sensory attribute. Means bearing different letter(s) in a column are significant at level of $p<0.05$

CMC and κ-carrageenan were unsuitable for use as stabilizers in peanut milk based yoghurt. κ-carrageenan formed a firm gel with little whey at the top (Table 1) but it was very unacceptable when subjected to sensory evaluation for all the attributes assessed i.e. appearance, texture and overall acceptability. This implies that the formation of a firm gel alone is not enough to categorize set yoghurt as being good. On the other hand, although PGA and Xanthan gum reduced the gel firmness of PMBY (Table 1), they significantly ($p<0.05$) improved its sensory texture and overall acceptability (Table 2).

Guar gum and HM pectin reduced gel firmness, increased whey separation (Table 1) and significantly ($p<0.05$) reduced the sensory texture, appearance and overall acceptability of PMBY (Table 2). However the sensory scores remained within the acceptable range (4-9) as per the 9-point hedonic scale. The reduction of yoghurt gel firmness by guar gum can be attributed to the fact that guar gum is hydrolyzed to its monosaccharides at high temperatures and under acidic conditions (Tuinier *et al.*, 2000; Wang *et al.*, 2000). This is further supported by reports that the viscosity of guar gum solutions is reduced upon hydrolysis (Tuinier *et al.*, 2000). It was recommended that guar gum should only be used in cultured products where heat is not applied in their production (Wang *et al.*, 2000). Therefore guar gum reduced the quality attributes of PMBY (Table 1) probably due to the heat treatment during pasteurization of the toned milk at 85°C for 30 min.

Gelatin maintained the gel firmness of PMBY (Table 1) and significantly improved the appearance, texture and overall acceptability of the yoghurt (Table 2). This implies that the main effect of gelatin on the PMBY was the improvement of sensory quality and not gel firmness. These results are supported by previous reports that gelatin is compatible to milk systems over a wide range of concentrations and that it improves body/texture and appearance of yoghurt (Abou-Dawood *et al.*, 1993). It was also later reported that gelatin gave higher sensory scores than pectin and alginate for color and appearance, body and texture and for flavor when added to mango soy fortified set yoghurt (Kumar and Mishra, 2004).

CONCLUSIONS

Though peanut milk based yoghurt formed a firm gel with no whey at the top even when no stabilizer was added to it, its sensory attributes improved on addition of stabilizers like PGA, Xanthan gum and gelatin. This implies that stabilizers in peanut milk based yoghurt are mainly needed for improvement of sensory quality but not for gel firmness or reduction of whey separation. PMBY 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 acceptability) as compared to the other stabilizers (HM pectin, PGA, CMC, κ-carrageenan, xanthan gum and guar gum) assessed in this study. Therefore gelatin was found to be the most appropriate stabilizer compatible to a peanut milk based yoghurt system.

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