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Mango soy fortified set yoghurt: effect of stabilizer addition on physicochemical, sensory and textural properties

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Abstract

The effect of stabilizer addition on physicochemical, sensory, textural properties and starter culture counts of mango soymilk fortified yoghurt (MSFY) were studied. Three stabilizers, namely gelatin, pectin and sodium alginate, were used. The addition rate of stabilizer was 0.2%, 0.4% and 0.6%, w/w. Significant effects of type and addition rate on acidity, moisture content and total solids of MSFY were observed. Syneresis and acetaldehyde content of MSFY was reduced significantly. Lightness (L^*) and yellowness (b^*) of MSFY increased with gelatin and decreased with pectin and sodium alginate. The greenness (a^*) value decreased with increase in addition rate of stabilizers. Gelatin gave better effect on appearance and colour, body and texture, flavour and overall acceptability in comparison with other stabilizers at 0.4% addition rate. Hardness, cohesiveness and adhesiveness of MSFY increased up to 0.4% stabilizer addition, while springiness and gumminess did not follow any trend. There was a significant effect of stabilizer addition on *Streptococcus thermophilus* and *Lactobacillus delbrueckii* subsp. *bulgaricus* counts.

Keywords: Mango; Soymilk; Yoghurt; Stabilizer; Physicochemical; Texture profile

1. Introduction

Yoghurt is regarded as a product of high moisture content and good quality of proteins. The product is accepted by consumers because of its flavour and aroma, mainly acetaldehyde, and texture. Incorporating mango pulp and soymilk can enhance its flavour and nutritional value. The texture of yoghurt is associated with the total solids, composition, presence of stabilizer and fruits (Shaker, Jumah, & Abu Jdayil, 2000). These additions of mango pulp and soymilk to milk influence the physicochemical characteristics, namely sensory and texture profile and reduce syneresis. They may affect the starter culture counts. Several researchers have conducted experiments to investigate how the addition of hydrocolloids influences quality attributes (syneresis, sensory characteristics, firmness and starter counts of yoghurt) (Bals & Kessler, 1999; Chopra & Gandhi, 1990; El Sayed, Abd El Gawad, Murad, & Salah, 2002; Jawalekar, Ingle, Waghmare, & Zanjad, 1993; Keogh & O'Kennedy, 1998; Khalafalla & Roushdy, 1997; Moller, 1995; O'Carroll, 1995; Tayar, Sen, & Gunes, 1995). The textural characteristics of soyogurt samples were improved by the addition of alginate (Yadav, Jha, Garg, & Mital, 1994). The structure of fruit yoghurt can be improved by using stabilizing agents, such as starches, gelatin or pectin (Anon, 1995; Celik & Bakirci, 2003).

The addition of stabilizer improves body and texture, appearance and mouthfeel and retards syneresis (El Sayed et al., 2002; Fiszman & Salvador, 1999; Jawalekar et al., 1993; Khalafalla & Roushdy, 1997; Tayar et al., 1995) of yoghurts. Stabilizers are sometimes referred to as hydrocolloids and have two basic functions in yoghurt: the binding of water and improvements in texture. Preparation of mango soy fortified yoghurt (MSFY) of optimum sensory, textural characteristic and lower syneresis requires proper selection of stabilizers and control of amount added. In the present paper, the

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influence of the type of stabilizer and its addition level on physicochemical, sensory, textural characteristics and starter culture counts are discussed.

2. Materials and methods

2.1. General

Pure freeze dried culture of *Streptococcus thermophilus* NCDC 075 and *Lactobacillus delbrueckii* subsp. *bulgaricus* NCDC 008 were procured from the National Diary Research Institute, Karnal, India. These cultures were maintained in 10% non-fat dried milk (NFDM) and autoclaved at 115 °C for 15 min. Buffalo milk was procured from a local market and its fat content was standardized as needed in the experiment. Soymilk was prepared in the laboratory from whole soybeans (*Glycin max*, Cv. JS-335) using the procedure described by Bourne, Escuela, and Benzon (1976). Canned mango pulp (Tulip brand, Tulip India limited) was purchased from local market. The chemical stabilizers (gelatin, pectin and sodium alginate) were purchased from LOBA Chemicals, Mumbai, India. These were used to prepare experimental samples.

2.2. MSFY preparation

The blend of 78.15% buffalo milk (2.95% fat; 9% SNF) and 14.74% soymilk (8.2% total solids) were heated to 60 °C; stabilizers were properly mixed and pasteurized at 95 °C for 5 min, cooled to 45 °C and 7.11% mango pulp (18% total solids) was added with high speed stirring. The blends were inoculated with 2% (v/v, *S. thermophilus* and *Lactobacillus delbrueckii* subsp. *bulgaricus* in 1:1 ratio) of 24 h old culture. The blend was incubated at 45 ± 2 °C in a plastic cup (100 ml). Methodology for the preparation of mango soy fortified yoghurt (MSFY) was published elsewhere (Kumar & Mishra, 2002). Blend formulation has been optimized and published (Kumar & Mishra, 2003a). Samples were kept for 24 h at 4 °C before analysis and sensory evaluation. In this study, three stabilizers, namely gelatin, pectin and sodium alginate were used at the rate of 0.2%, 0.4% and 0.6% (w/w). Nine experiments were conducted by the two factor three level factorial design, and were performed in triplicate. MSFY sample without stabilizer was used as control.

2.3. Analysis of physicochemical characteristics

Physicochemical properties of MSFY, and as titratable acidity (IDF, 1991a, 1991b), moisture content and total solids content (IDF, 1991a, 1991b), were determined. For measuring syneresis, 50 ml MSFY, placed in a 150 ml tube, were centrifuged at 100*g* for 10 min. The supernatant was removed and weighed. A low speed was used since high centrifugal force (>500 g) would result in compaction of the gel (Lucey, Munro, & Singh, 1998). Acetaldehyde content of MSFY was measured by the method described by Robinson, Tamime, and Chubb (1977). Colour was measured with a Hunter Lab Colorflex colorimeter and results expressed in accordance with the CIELab system (Hutchings, 1994) with reference to illuminant D65 and a viewing angle of 10° (Calvo, Salvador, & Fiszman, 2001). The measurements were made in triplicate in a 65 mm diameter tray with a sample thickness of 30 mm, using a 13 mm diameter diaphragm.

2.4. Overall acceptability

MSFY samples were prepared in 100 ml cups and stored overnight at 2–5 °C before subjecting them to

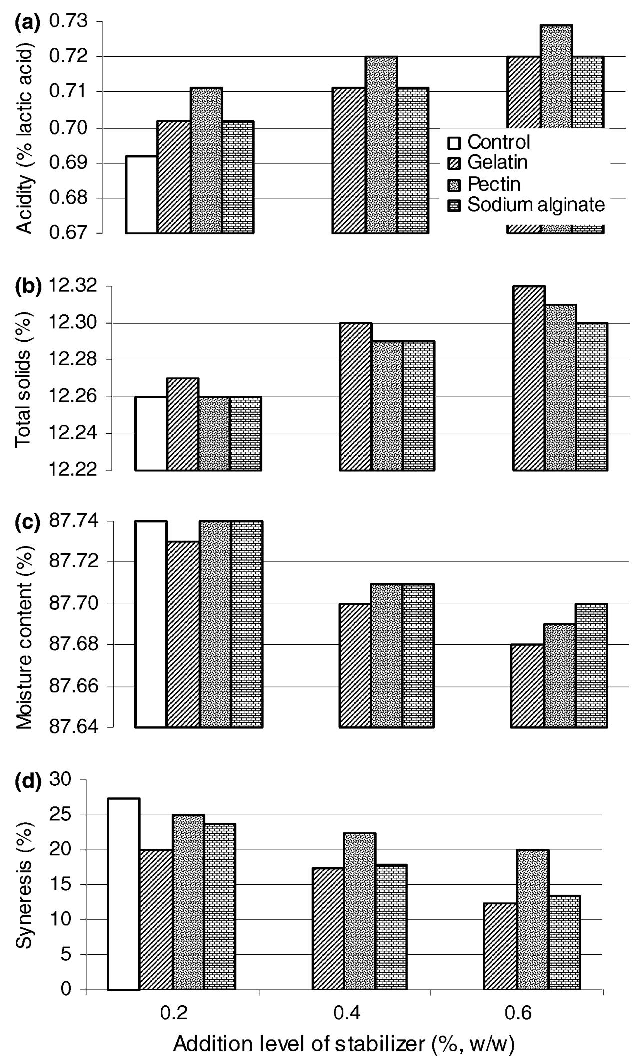

Fig. 1. Effect of the addition of stabilizer on physicochemical properties of MSFY: (a) acidity, % lactic acid; (b) total solids, %; (c) moisture content, %; (d) syneresis, %.

organoleptic evaluation. The samples were served at 10 °C. A panel of 11 judges, from among the faculty and research scholars of the Agricultural and Food Engineering Department, Indian Institute of Technology, Kharagpur, was formed on the basis of their knowledge of the product and their willingness to participate on a regular basis after obtaining agreement among the judges on the characteristics of good quality yoghurt and what they meant by the terminology for sensory evaluation. Appearance and colour, body and texture, flavour and overall acceptability were rated on a 5-point scale (excellent 5, poor 1).

2.5. Texture profile analysis

Textural profile analysis was carried out by the method described by Kumar and Mishra (2003b). TPA tests were carried out using a TA.XT2 Texture Analyzer (Texture Technologies Corp., UK, Model TA.XT2, version 05.16 equipped with 5-kg load cell). Experiments were carried out by compression tests that generated plot of force (grammes) vs. time (s). A 25 mm diameter perplex cylindrical probe was used to measure textural profile of a set yoghurt sample prepared in a 100 ml cup at a temperature of 10 ± 0.5 °C, performing five repetitions. In the first stage, the samples were compressed by 30% of their original depth. The speed of the probe was fixed at 0.5 mm s^{-1} during the pre-test, compression and the relaxation of the samples. The data presented are averages of five replications.

2.6. Enumeration of *S. thermophilus* and *L. delbrueckii* subsp. *bulgaricus*

International Dairy Federation methods (IDF, 1988) were used for enumeration of *S. thermophilus* and *L. bulgaricus*. The *S. thermophilus* agar (M 948) and *L. delbrueckii* subsp. *bulgaricus* agar (M 927), procured from Hi Media Laboratories Limited, Mumbai, were used. The samples were diluted in a mixture of tryptone (0.05%) and peptone (0.05%) in water. The agar plates of *S. thermophilus* were incubated aerobically at 37 °C for 48 h while plates of *L. delbrueckii* subsp. *bulgaricus* were incubated at 37 °C for 72 h under microanaerobic conditions. After incubation, typical colonies of *S. thermophilus* and *L. delbrueckii* subsp. *bulgaricus* were counted. Plates with 30–300 colonies were only used in counting and the counts were averaged for three replicates and expressed in cfu/ml.

The experimental data was analyzed for variance (one way ANOVA) with the help of computer programme Systat 8.0 version.

Table 1
Analysis of variance (ANOVA) for physicochemical, sensory, textural properties and starter counts of MSFY

Responses	Source of variation	
	Sum of square	
	Type	Rate
Physicochemical		
Moisture content	0.0001*	0.003**
Total solids	0.0001*	0.003**
Acidity	0.00001*	0.00003*
Syneresis	53.764*	86.347**
Acetaldehyde	0.02**	0.009**
L^*	185.504**	7.457^{ns}
a^*	0.883**	0.072^{ns}
b^*	99.517**	0.612^{ns}
Sensory characteristics		
Appearance and colour	0.169*	0.040^{ns}
Body and texture	0.081**	0.082**
Flavour	0.176*	0.033^{ns}
Overall acceptability	0.063*	0.050^{ns}
Textural characteristics		
Hardness	531.861**	714.687**
Cohesiveness	0.016*	0.008^{ns}
Adhesiveness	11.783^{ns}	49.558**
Springiness	0.006^{ns}	0.008^{ns}
Gumminess	427.694*	449.653*
Starter counts		
S. thermophilus	0.0001^{ns}	0.0004**
L. delbrueckii subsp. *bulgaricus*	0.00001^{ns}	0.0003*

*$p < 0.05$, **$p < 0.01$, ns not significant

3. Results and discussion

3.1. Physicochemical characteristics

Addition of stabilizer slightly increased the rate of acid development from 0.69% (control) to 0.729% lactic acid (Fig. 1(a)). Addition of stabilizer had significant ($P < 0.05$) effects on TS and moisture content of MSFY (Fig. 1(b) and (c), Table 1). Effect of stabilizers on syneresis is shown in Fig. 1(d). Susceptibility to syneresis was inversely related to amount of stabilizer added. It was found that, in each stabilizer, less syneresis occurred when stabilizers were added at 0.6%. Addition of 0.4% gelatin stabilizer to the milk prior to homogenization reduced whey separation (Abou-Dawood, Abd-Rabo, Ahmed, & Hassan, 1993). Gelatin was compatible with the milk systems over a wide range of concentrations and it prevented syneresis. The susceptibility (of yogurt samples) to syneresis decreased with the addition of xanthan gum or its mixtures (El Sayed et al., 2002). Acetaldehyde content in MSFY samples containing stabilizer (1.88–2.07 mg/100 g) was slightly lower than that in MSFY sample without stabilizer (2.09 mg/100 g). Acetaldehyde content in MSFY samples decreased with all types and rate of stabilizer addition (Fig. 2(a)). Shukla, Jain, and Sandhu (1986) reported that addition of gelatin, pectin and sodium alginate decreased diacetyl and volatile fatty acid (VFA) production in yoghurt. Syneresis and acetaldehyde content of MSFY was significantly ($P < 0.05$) affected by the type and addition level of stabilizers (Table 1). Change in CIELab is shown in Fig. 2. The *L*-value of MSFY containing gelatin increased while pectin and sodium alginate decreased it as rate of addition increased. The *a*-value decreased while *b*-value increased with gelatin but decreased with pectin and sodium alginate at all addition rates. CIELab parameters were significantly ($P < 0.05$) affected by type of stabilizer (Table 1).

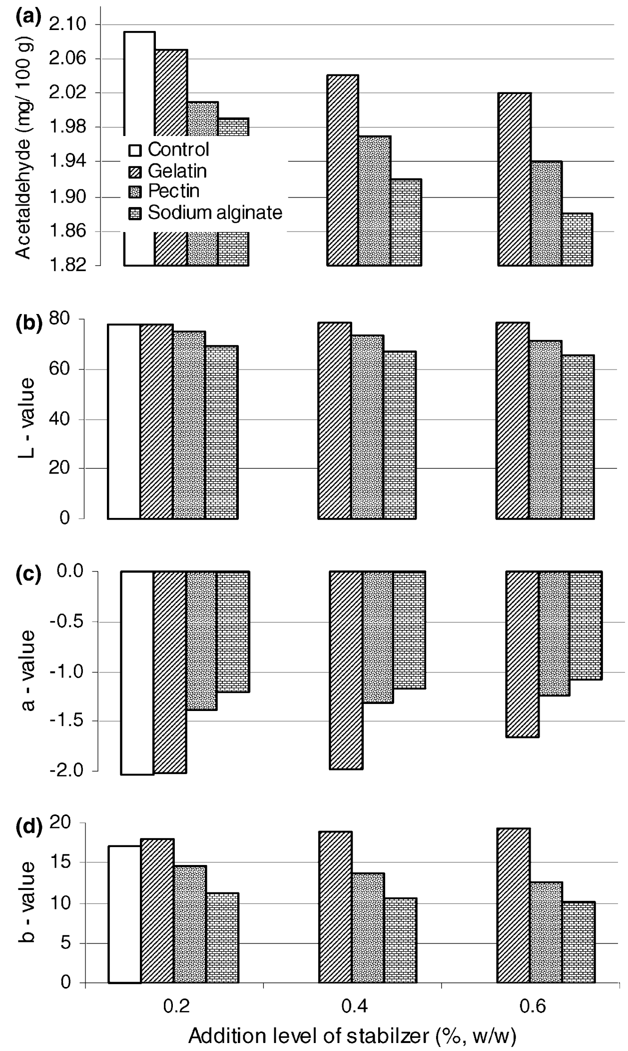

Fig. 2. Effect of the addition of stabilizer on physicochemical properties of MSFY: (a) acetaldehyde content, mg/100 g; (b) *L*-value; (c) *a*-value; (d) *b*-value.

3.2. Sensory quality

The scores in MSFY were in the order: gelatin > control > pectin > alginate for appearance and colour, gelatin > pectin > alginate > control for body/texture and gelatin > control > alginate > pectin for flavour. Almost the same trend were noted when stabilizers were added in cow and buffalo milk for production of yoghurt (Jawalekar et al., 1993). Effect of stabilizers on sensory score is shown in Fig. 3. Sensory scores increased with level of stabilizer up to 0.4%, but addition of 0.6% resulted in lowered score in all cases. Gelatin gave higher sensory score for colour and appearance, body and texture and for flavour when added at the rate of 0.4%. Shukla and Jain (1991) described that increasing addition of stabilizer beyond 0.3% adversely affected the sensory properties yoghurt samples. Sensory scores increased with level of stabilizer up to 0.35%, but addition of 0.5% resulted in an undesirable flavour, especially in stored yoghurt (Mehanna & Mehanna, 1989). Addition of 0.4% gelatin improved body/texture and appearance of the yoghurt (Abou-Dawood et al., 1993). Appearance and colour, flavour and overall acceptability of MSFY were significantly ($P < 0.05$) affected by stabilizer addition rate while body and texture were significantly ($P < 0.05$) affected by both the type of stabilizer and their addition level (Table 1).

3.3. Textural characteristics

Both proteins and polysaccharides contribute to the structural and textural properties of yoghurt. The effect of stabilizer addition on textural profile characteristics is

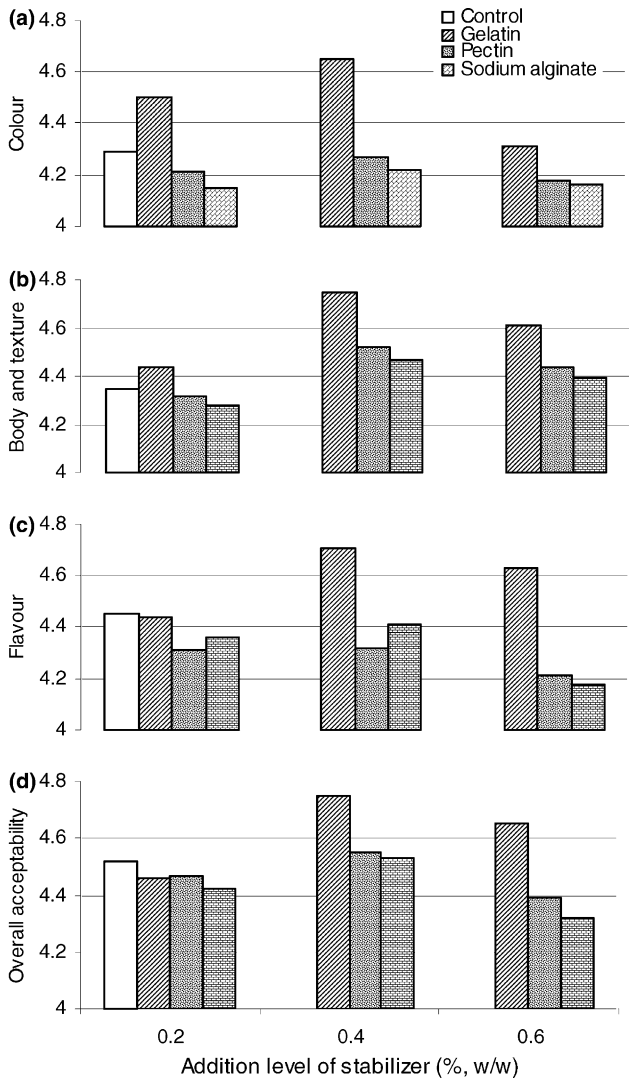

Fig. 3. Effect of the addition of stabilizer on sensory characteristics of MSFY: (a) colour; (b) body and texture; (c) flavour; (d) overall acceptability.

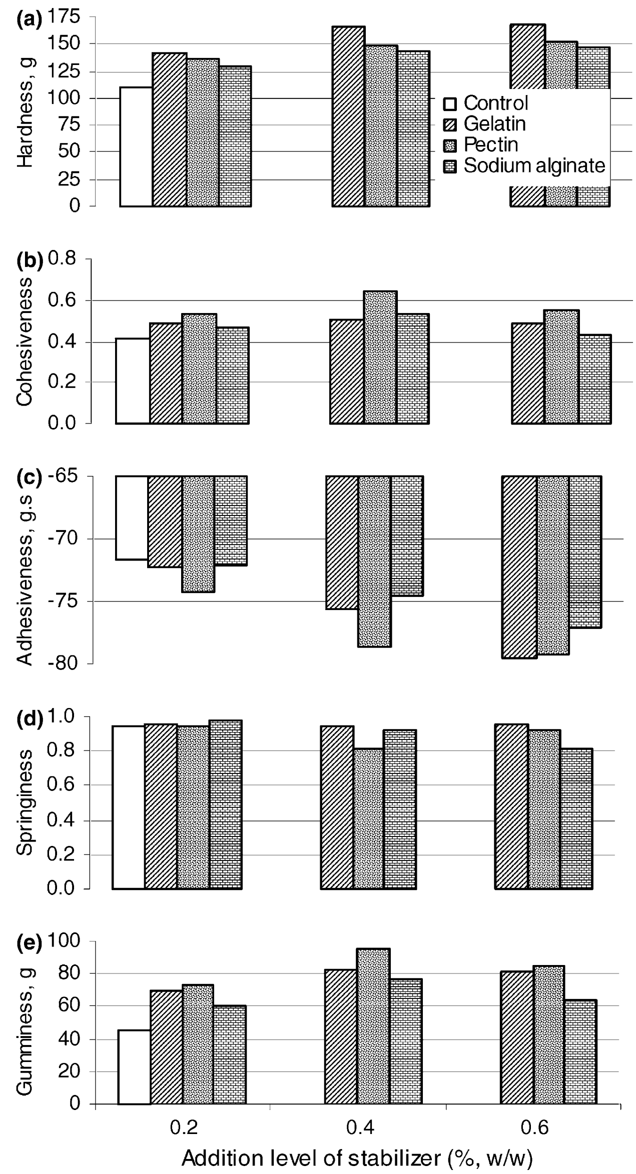

Fig. 4. Effect of the addition of stabilizer on textural profile of MSFY: (a) hardness, g; (b) cohesiveness; (c) adhesiveness, g.s; (d) springiness; (e) gumminess, g.

shown in Fig. 4. Addition of stabilizer up to a level of 0.4% increased the hardness but at addition rate of 0.6%, the increase was less (Fig. 4(a)) and the same trend was followed for cohesiveness. The pectin molecules adsorb onto the casein micelles at low concentrations of pectin, and bridging flocculation is observed. On increasing the pectin concentration further, the casein micelles become fully coated and attraction between the particles is lowered (Maroziene & Kruif, 2000). Adhesiveness increased from −71.64 g.s. (control) to −79.47 g.s. Springiness ranged from 0.812 to 0.957. Gumminess increased due to stabilizer addition but there was no particular trend. Addition of stabilizers increased the curd tension of buffalo milk yoghurt, gelatin having the greatest and starches the least effect (Jawalekar et al., 1993). A penetrometry study was carried out into the effect of the addition of gelatin on the texture characteristics of yoghurts (Fiszman & Salvador, 1999). Hardness and gumminess of MSFY were significantly ($P < 0.05$) affected by type and addition rate of stabilizers while cohesiveness was affected by stabilizer type only and adhesiveness was significantly ($P < 0.05$) affected only by addition rate. There was no significant ($P < 0.05$) effect of stabilizers on springiness (Table 1).

3.4. Starter culture counts

There were marked changes in starter counts when stabilizer was added to MSFY (Fig. 5). The *S. thermophilus* and *L. delbrueckii* subsp. *bulgaricus* counts varied from 2.22×10^8 to 2.24×10^8 cfu/ml and 1.57 to

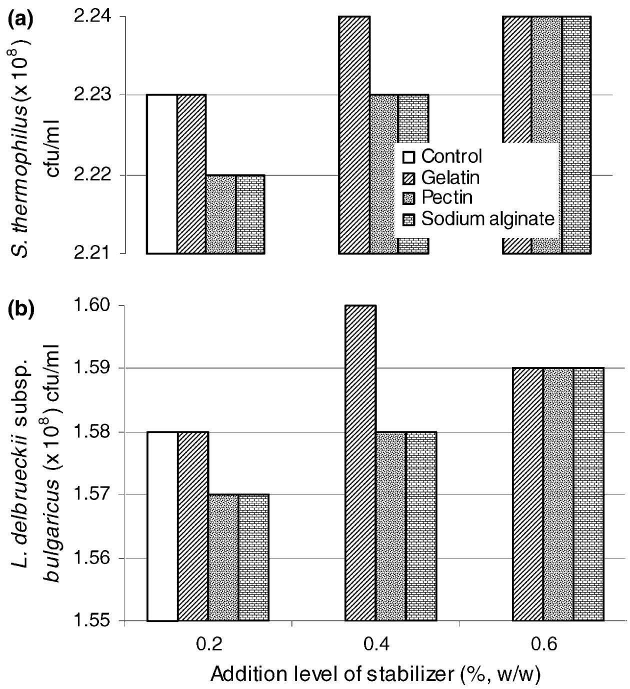

Fig. 5. Effect of the addition of stabilizer on starter culture counts of MSFY: (a) *S. thermophilus* counts, cfu/ml; (b) *L. delbrueckii* subsp. *bulgaricus* counts, cfu/ml.

1.60×10^8 cfu/ml. Type of stabilizer had no significant effect on starter counts but addition rate significantly ($P < 0.05$) affects the *S. thermophilus* and *L. delbrueckii* subsp. *bulgaricus* counts (Table 1).

4. Conclusion

Nine different runs, according to the experimental design, were used to study the quality parameters of MSFY at different type and rate of stabilizers addition. Physicochemical properties of MSFY, such as acidity, moisture content, total solids, syneresis and acetaldehyde content, were affected by stabilizer addition. Yoghurt stabilized with gelatin was the most acceptable on sensory evaluation, followed by that made with pectin and sodium alginate. Textural characteristics of MSFY were improved by stabilizer addition. Starter counts of MSFY were also affected by addition rate of stabilizers.

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