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Physico-chemical and sensory quality of mung bean *(Vigna radiata)* enriched stirred yoghurt

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Abstract

The present study introduces the potential use of mung bean *(Vigna radiata)* as a functional ingredient in yoghurt. Yoghurt was prepared with standardized cow's milk and green gram paste was added to the stirred yogurt at the rates of 5, 10, 15, 20 and 25% (w/w). Sensory evaluation revealed that there was a significant difference among sensory scores of yoghurt enriched with different levels of mung bean paste. The yoghurt enriched with 10% mung bean paste demonstrated the overall high sensory acceptability. Product was further evaluated for microbial and physico-chemical properties during 28 days of storage at 4°C. Titratable acidity and pH of yoghurt demonstrated similar concomitant trends. Yeast, Moulds and Coliform counts were negligible throughout the storage. Total solids, Brix and fat contents of yoghurt enriched with 10% mung bean paste were 25.94%, 21° and 3.5% respectively. Yoghurt made with 10% mung bean paste conformed to the national standards. Therefore, yoghurt enriched with mung bean paste can be considered as a novel dimension to fermented dairy products.

Introduction

There has been an increasing trend in the food market about incorporation of the functional ingredients into fermented milk products. Yoghurt is one such fermented dairy product readily available in the market.

Yoghurt is a product manufactured from milk, with or without the addition of some natural derivative of milk such as skim milk powder, whey concentrates, caseinates or cream, with a gel structure results from the milk protein coagulation due to the action of lactic acid bacteria (Sfakianakis and Tzia, 2014). The popularity of yoghurt is due to its pleasant flavour, creamy consistency and its contribution in promoting good health (Domagla, 2005). Yoghurts are commercially available in various forms and most common types are set yoghurt, strained (stirred) yoghurt, frozen yoghurt and drinking yoghurt (Sfakianakis and Tzia, 2014). The current trends and consumer needs indicate the opportunity for innovations and developments in fermented milk products like yoghurt (Khurana and Kanawja, 2007; Gad *et al.*, 2010). Furthermore fortification or enrichment of yoghurt is a good way to improve nutrient intake in dairy foods (Preedy et al., 2013).

Formulation of yoghurt with added functional ingredients are reported elsewhere in the literature. Studies of Zainoldin and Baba (2009) and Shori and Baba (2011) showed the inclusion of fruits and medicinal herbal extracts into milk during fermentation and its effect on organoleptic properties. In their research Ochanda *et al.* (2015) has reported the possibility of producing probiotic yoghurt fortified with tea containing tea phytochemicals. The replacement of cow's milk with soy milk in the production of yoghurt and other milk products is well documented. The studies of Trindade *et al.* (2001); Denkova and Murgov (2005); Nande *et al.* (2008) and Gosh *et al*. (2011) showed the use of soy milk for the production of yoghurt or yoghurt like product. In addition to soy milk, researchers are exploring the possibilities of adding other grain legumes in yoghurt manufacture. Dobrev *et al.* (2014) examined the use of pea milk supplement with skimmed cow's milk for the production of yoghurt. In his study Bakr (2013) has shown the effect of chick pea water extract in yoghurt made from cow's and camel's milk and showed that it could improve nutritional and biological quality of yoghurt. Studies of Zare *et al*. (2012) showed the possibility of incorporating lentil and chick pea

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flour in to the probiotic fermented milk. However no enough scientific evidence is found on the addition of mung bean *(Vigna radiata)* grains or powder in the production of yoghurt.

Mung bean belongs to pulse group, which includes other grains such as bean, chickpea, pea, lentil etc. Pulses have high protein content (18-32%), balanced nutritional composition including appreciable amounts of dietary fiber (approximately 25%) and low fat content (2-5%) (Potter and Hotchkiss, 1998; Sathe, 2002). It will be advantageous to enrich yogurt with mung bean to enhance the nutritional and dietary quality of the product.

Therefore this study is aimed to investigate the possibility of producing mung bean *(Vigna radiata)* enriched stirred type yoghurt.

Materials and Methods

Preparation of mung bean paste for incorporation into yoghurt

Mung bean free from pest attack was purchased from the local food market at Colombo, Sri Lanka. Thoroughly washed grams were mechanically dried and ground in to fine powder using a kitchen grinder. Mung bean powder and mono and diglyceride of fatty acid was weighed according to the industry standard (ratio not shown) and mixed together. The mixture was then cooked at 105°C for 5 mins in an autoclave (Biobase, Jinan, China). Sugar solution (30°Brix) was prepared dissolving white cane sugar in drinking water. Cooked mung bean was mixed with sugar solution to make a fine paste. The paste was prepared, by adding sugar solution (amount not specified), into the consistency which was not paste on the palm.

Preparation of mung bean incorporated stirred yoghurt

Fresh cow's milk standardized to 3.5% fat and 23.5% total solids was obtained from the processing plant of Newdale Dairies (Pvt) Ltd. Biyagama, Sri Lanka. Plain yoghurt was prepared according to the industry standard. In brief milk was pasteurized at 85-90°C for 30 minutes, cooled to 42°C and 2% of yoghurt starter culture (*Streptococcus thermophilus* and *Lactobacillus bulgaricus*) maintained at the laboratory was added. Yoghurt mixture was then incubated at 42°C for 7.5 hours until the pH reached to 4.4 ±0.05. Yoghurt was stabilized at 4°C for overnight and coagulum was broken by stirring. Yoghurt mix was replaced with mung bean paste in the ratios of 5, 10, 15, 20 and 25% (w/w) and filled into 80 ml cups and stored at 4 ± 1°C until further analysis.

Assessment of sensory quality of mung bean enriched yoghurt

Mung bean enriched yoghurts were evaluated for its sensory appeal with 25 experienced panel members to decide the optimum proportion of mung bean paste to be incorporated to yoghurt. Sensory evaluation was carried out in the standard sensory laboratory with three taste panels. Three taste panels using the same panelists were used to evaluate the sensory properties of three replicates of five levels of treatments. A seven point hedonic scale was used to evaluate the appearance, flavour, spoon ability, mouth feel and overall acceptability of the product. A seven point hedonic scale including 1= 'dislike extremely', 2='dislike very much', 3='dislike slightly', 4= 'neither like nor dislike', 5='like slightly', 6='like very much', 7='like extremely' was completed by each participant for any sample labeled with random numbers.

The best ratio of the mung bean paste was identified based on the results of sensory evaluation. This product was further investigated for its physicochemical properties and microbiological quality over the period of 28 days, with four days interval, stored at 4 ±1°C temperature.

Determination of pH and titratable acidity

pH and change in acidity of the product stored at 4 ±1°C was evaluated over the period of 28 days with four days interval. pH was measured with the calibrated pH meter (Mettler Toledo MP 220, Schwezenbach, Switzerland) and titratable acidity was determined by titrating 9 ml of diluted sample with 0.1 N NaOH in the presence of 1 ml of 1% phenolphthalein indicator. Readings were obtained for duplicated samples.

Determination of total solids and Brix value

The total solid content was obtained by the weight of residue obtained from moisture content analysis using Sartorius MA-30-000X3 (Goettingen, Germany) moisture analyzer. The total soluble solids or Brix value was measured using ATIGO refractometer -Type NAR-1T (Japan).

Determination of fat content

The fat content was determined according to the Mojonnier ether extraction method as published by AOAC (1995). The fat was extracted to ether and then dried to a constant weight. The fat content was expressed as percent fat per weight.

Microbiological quality evaluation

The yoghurt with optimum sensory appeal was tested for the growth of Coliform, yeast and mold for 28 days of storage at 4±1°C. Growth of Coilform bacteria was detected using the selective growth media, Violet Red Bile Agar (HIMEDIA, India). One gram of yoghurt was placed on the sterilized petri dishes and about 12ml of growth medium previously sterilized at 121°C for 15 mins was poured into the petri dishes under the aseptic condition. Inoculated media was incubated at 35°C for 24 hours and growth of Coliforms was identified by the pinkish red colonies on the medium if available.

Yeast and mould were tested according to the AOAC (2000). In brief samples were serially diluted in sterile saline (0.85% NaCl). 1ml of the sample was placed on sterile petri dishes and added with sterile culture media. The culture media used was Potato Dextrose Agar (HIMEDIA, India). Plates were incubated at 37 ±1°C for 3 days.

Statistical analysis

Statistical analysis was done with the help of computer aided software MINITAB version 14. A non parametric ranking procedure was used with Kruskall Wallis test for the evaluation of sensory attributes. The significance was tested at the level of 0.05.

Results and Discussion

Sensory evaluation

The effect of the panel on the evaluation of quality parameters is not significant indicating that there is no bias effect on the decision made by the sensory panel. Panelist to panelist variation is not observed (data not shown). There are significant differences among the yoghurt samples with respect to sensory attributes as shown in the Table 1. Results reveal that sensory attributes are significantly affected by the level of added mung bean paste. As shown in the results there are statistically significant differences in appearance, flavour, mouth feel and overall acceptability of yoghurt with the level of added mung bean paste (P<0.05).

The mouth-feel of yoghurt is related to texture (viscosity) and consistency which are affected by the enrichment (Staffolo *et al.,* 2004). Results show that consistency of the yogurt is greatly affected by the enrichment. Significantly difference acceptability for mouth feel is shown among different mung bean paste levels. As results show addition of more mung bean paste leads to poor consistency (flowing nature of yoghurt). In the present study, the overall sensory evaluation reveals that the yogurt containing 10% mung bean paste is the best. Similar to the present study Munasinghe *et al.* (2013) reported that yoghurt based weaning food prepared with grain mixture containing 11% mung bean scored higher on average than samples with 17% and 22% mung bean in terms of appearance, aroma, mouth feel and colour.

Table 1. Scores for sensory attributes of yoghurt enriched with mung bean pastes at different ratios

Level of mung bean paste (%)	Sum of rank				
	appearance	Flavour	Spoon ability	Mouth feel	Overall acceptability
5	79.5	78.1	76.0	80.4	76.5
10	81.1	79.5	70.2	80.8	78.6
15	63.2	61.5	60.0	66.6	66.8
20	52.1	52.7	54.1	46.5	52.5
25	39.1	43.2	54.7	40.7	40.6
P value	0.000	0.001	0.126	0.000	0.000

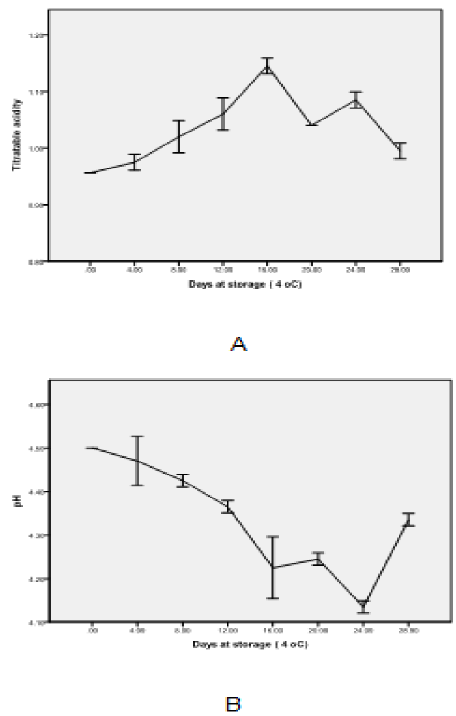

Figure 1. Variation of acidity and pH of yoghurt enriched with 10% mung bean paste during storage at 4 °C
A = titratable acidity, B=pH
Values are the Mean ± SD of duplicate determinations

Change in pH and titratable acidity

The variation in pH and titratable acidity of yoghurt enriched with 10% mung bean paste is illustrated in the Figure 1. The change in pH and titratable acidity is due to the acid production by yoghurt culture. Previous studies show that pulse ingredients: pea protein, chickpea flour, lentil flour, pea fiber, soy protein concentrate and soy flour has

Table 2. Total counts of Yeast, Moulds and Coliform in mung bean enriched yoghurt throughout the storage

Days at storage	Yeast and Mould	Coliform
4	ND	ND
8	ND	ND
12	1/g	ND
16	1/g	ND
20	1/g	ND
24	1/g	ND
28	1/g	ND

ND: not detected
Values are the mean of duplicate determinations

no negative effect on the acidification trends of the fermented milk by yoghurt starters (Zare *et al*., 2012). The pH of the yoghurt enriched with 10% mung bean paste shows decrease trend up to 16 days of storage at 4±1°C and variable up and down afterwards. The pH of the yoghurt at the 28 days of storage is 4.34 with no unpleasant odour. Titratable acidity of yoghurt supplemented with 10% mung bean paste shows increasing trend up to 16 days and variation is observed beyond that period concomitant to change in pH values. Similar observation is reported by Kumari *et al.* (2015) who reported that pH of rice incorporated yoghurt decreased up to 16 days during storage and increased at the latter part of storage at 4±1°C. The change in pH due to changes in acid content of food is lower, when the buffering capacity of the media is high (Kailasapathy, 2008). In the present study it seems that addition of mung bean paste increases the acidifying ability of starter culture during storage. Although, the increased acidification is observed during 28 days of storage values conform to the Sri Lankan Standards (Table 3).

Physico-chemical properties

Total solids, brix and fat contents of yoghurt enriched with 10% mung bean paste are 25.94%, 21° and 3.5% respectively. Higher acidity levels can stimulate the whey separation in yoghurt (Tamine and Robinson, 1999). However, less whey separation is observed in yoghurt enriched with mung bean paste (data not shown) in the present study. This could be attributed with high total solids content (Remeuf *et al.*, 2003) of yoghurt made with mung bean paste. In addition, the stabilizer (gelatin) added during the manufacture can effectively immobilize the aqueous phase of yoghurt. According to Lal *et al.* (2006); Supavititpatana *et al.* (2008) and Kumari *et al.* (2015), gelatin induces the formation of gel network with sodium caseinate and reduces the whey separation in yoghurt. Further, if the total solids content of yoghurt is increased it could results higher consistency and viscosity values (Tamine and Robinson, 1999), which can affect sensory appeal of the yoghurt. In the present study 10% mung bean paste added yoghurt with 25.94% total solids gives the best sensory appeal in terms of mouth feel.

Table 3. Sri Lankan standards for yoghurt

Character	Specification
Fat % (w/w)	3 minimum
Milk Solids Non Fat % (w/w)	8 minimum
Titratable acidity	0.8-1.25
Escherichia coli	Not more than 1 per gram
Yeast	Not more than 1000 per gram
Moulds	Not more than 1 per gram

Source: SLSI, 1989.

Microbial content

The microbial content of the yoghurt enriched with 10% mung bean paste is shown in Table 2. Yeast and moulds can spoil yoghurt during storage as they can strive in acidic environment and tolerate low temperature (Beitane and Klava, 2013). The results reveal that there is no particular pattern of yeast and mould growth in yoghurt over 28 days of storage at 4±1°C. The yeast and mould counts are within acceptable standards of the country (Table 3). No Coliform bacteria were detected throughout 28 days of storage. The absence of Coliform indicates that yoghurt with 10% mung bean paste is free from any faecal contamination. This is due to the hygienic practices employed during manufacturing stages.

Conclusion

Enrichment of yoghurt with mung bean *(Vigna radiata)* can improve the nutritional quality of the product. Among different levels of mung bean pastes, yoghurt enriched with 10% mung bean demonstrated higher scores in organoleptic qualities namely appearance, flavour, spoon ability, mouth feel and overall acceptability. Yoghurt enriched with 10% mung bean paste showed overall good storage ability during 28 days of storage at 4°C. Yoghurt was within the acceptable pH and acidity range with no evidence of microbial growth in terms of yeast, moulds and Coliform bacteria. Mung bean enriched yoghurt showed higher total solids (25.94%), brix (21°) and 3.5% fat conforming to the yoghurt standards. However, further investigation on consumer acceptability and stability of yoghurt during extended (over 28 days) storage is required.

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