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Influence of Plant Stabilizers on Physico-chemical and Sensory Properties of Yoghurt Made from Cow Milk

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Original Research Article

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Abstract: The study was conducted to investigate Physico-chemical and sensorial properties of different stabilizer added to yoghurt using cow milk. This experiment was designed in Complete Randomized Design. Gelatin, sweet potato starch, cassava starch, citrus fiber and corn starch were used as stabilizers with three replications. Yoghurt was analyzed for chemical, physical and sensory properties. At day one, it was found that quality attributes such as dry matter, ash, fat and titratable acidity did not show significant ($p>0.05$) differences but reducing sugar, total sugar and pH showed significant ($p<0.05$) differences among the types of yoghurt samples. Syneresis was high after half an hour and two hours in corn starch stabilizer treatment. During the storage period Physico-chemical properties showed significant ($p<0.05$) differences between yoghurt samples. At the end of the storage period corn starch stabilizer added yoghurt showed highest value of dry matter content (23.56±0.120%) and ash content (0.80±0.00%) and lowest value of reducing sugar content (2.05±0.04%). Gelatin stabilizer added yoghurt showed lowest value of total sugar content (16.49±0.05%) During the storage period citrus fiber stabilizer added yoghurt showed lowest value of pH (4.17±0.03) than other treatments. The results of the sensory evaluation showed high preference of texture, colour, flavour and overall acceptability for citrus fiber stabilizer added yoghurt.

Keywords: Nutritional properties, organoleptic qualities, stabilizer, yoghurt.

INTRODUCTION

Yoghurt is an acidified coagulated dairy product obtained though lactic fermentation of milk by *Streptococcus thermophilus* and *Lactobacillus delbrueckii spp. bulgaricus*. These organisms are used as yoghurt cultures to produce a characteristic mild clean lactic flavour and typical aroma [1]. Yoghurt is a highly nutritive source of protein and energy from added cane sugar, milk fat, unfermented lactose and vitamins [2]. Consumption of yoghurt has been benefited with tremendous health benefits, as it has been improving the gastrointestinal functions and reducing human diseases [3, 4]. Lactic acid bacteria present in the yoghurt is beneficial on human health including protection against gastrointestinal problem, enhancing the digestion of lactose, decreasing risk of cancer, lowering blood cholesterol and improving immune response [5].

Stabilizers are used to produce a thick and cohesive body, smooth texture and also they are used to prevent the wheying-off [6]. In yoghurt making only stabilizers are added to the milk base. Stabilizer usage is usually attributable to under- stabilization or over-stabilization and improper use of stabilizers. Too fast addition of stabilizer or adding stabilizer at improper temperature may cause lumping of milk product. Adding stabilizer to too hot a mix will cause "case-hardening" or the formation of a thick, leathery pellicle over stabilizer granules, resulting in a grainy texture in the finished product [7, 8]. Gelatin is mostly used stabilizer in yoghurt production process. Gelatin is a natural stabilizer derived from animal collagen [7, 8]. This study investigates some stabilizers of plant origin. These stabilizers include sweet potato, cassava, citrus fiber and corn starch. Therefore, the objectives of this study were to test the plant products used as stabilizers for yoghurt production and to investigate the physico-chemical and sensory properties of yoghurt during storage.

MATERIAL AND METHODS

Raw material

Raw milk was collected from Livestock farm, Eastern University, Sri Lanka throughout the study period.

Commercial starter culture preparation

The freeze-dried commercial starter yoghurt culture (DVS, CHR HANSEN, and Denmark) composed of *Streptococcus thermophilus* (St) and *Lactobacillus delbrueckii subsp. bulgaricus* (Lb) was used. Starter culture was prepared by adding of commercial starter culture at the rate of 0.33 g per one liter of sterilized skim milk (1.5% fat) and stored as 100 ml aliquots in Erlene meyer flsk at frozen temperature (-20^{o}C). The culture used as starter culture for the yoghurt preparation. Each 1 Lit of pasteurized milk was inoculated with 10 mL of commercial starter culture according to the manufacturer's instructions given for yoghurt production.

Stabilizers preparation for yoghurt

Sweet potato and cassava was taken as one kilogram per each. These sweet potato and cassava were washed thoroughly and peeled to remove the rind. They were cut into small pieces. They were kept in the oven at 105^{o}C for 4 to 5 hours. Dried samples were grinded buying grinder. Grinded samples were packed in a polyethylene bag and sealed. They were kept in the refrigerator at 4^{o}C. Corn starch, gelatin and citrus fibre were bought from super market.

Yoghurt production

Skim milk was prepared by using cream separator. Then the milk was pasteurized 65 °C for 30 min, meanwhile different types of stabilizers namely sweet potato starch , cassava starch, citrus fiber and corn starch were separately added in the milk at the rate of 1% w/w and gelatin was use as control. Flavors and coloring were added, mixed well and cooled to 37^{o}C. The pasteurized milk was inoculated with a commercial yoghurt culture (as described in commercial starter preparation). Then mixture of inoculated milk was poured into plastic containers, and incubated at 40 °C for overnight. The yoghurt samples were stored in a refrigerator at about 4-5 °C for analysis at week 1, week 2, week 3 and week 4 of storage.

Analysis the physical and chemical composition of yoghurt

Analysis of chemical composition

Yoghurt samples were analyzed to determine the chemical composition of yoghurt, such as total solid, fat and ash content. The total solid content of yoghurt was determined by oven drying at 105°C to get constant weight as described by AOAC [9]. Ash content was determined by using muffle furnace at 550 °C for 4 hrs. The fat content of yoghurt sample was determined by the Gerber method as described by British Standards Institution [10]. All analyses were carried out in triplicate.

Measurement of pH and titratable acidity

The amount of pH was examined according by Akpakpunam and Safa- Dedeh, [10]. The pH of yogurt was measured using a pH meter (model: Delta320 pH meter). Titratable acidity was analyzed as recommended by AOAC [9]. Total sugar and reducing sugar contents were determined by the Lane–Eynon method based on the reduction of copper [9]. All analyses were carried out in triplicate.

Syneresis

Syneresis of yoghurt was measured using a drainage method [11]. Yoghurt made in 250 mL beakers was cut into 4 parts and these were drained in a funnel equipped with a stainless steel screen (120 meshes). After 0.5 h and 2 h of drainage, the quantity of whey was weighed and syneresis was calculated using following formula. Syneresis percentage = Liquid weight g*100 / Initial weight of yoghurt sample.

Sensory evaluation

All the samples were evaluated for sensory characteristics and overall acceptance by a 10 man panel of judges from food science and technology professionals. A nine-point hedonic scale ranging from 9 (highest score) to 1 (lowest score) was used. Sensory characteristics evaluated include colour, flavour, taste, texture and overall acceptability. Overall acceptance of yoghurt was determined as the average score for sensory characteristics.

Statistical Analysis

Data were collected and tabulated. Multivariate Analysis of Variance (MANOVA) test was used to determine the significance level of the treatments, while the Duncan’s Multiple Range Test (DMRT) was used for mean separation. Descriptive statistics was done on sensory attributes and the means were compared using the Tukey’s test ($p< 0.05$).

RESULTS AND DISCUSSION

Physico-chemical properties of yoghurts made from different types of stabilizers at day one

The Chemical and physical composition of yoghurts made from different types of stabilizers at day one of yoghurt is show in the Table 1. Except reducing sugar, total sugar and pH there were no significance changes ($p>0.05$) in yoghurt made from different types of stabilizers. The changes of total sugar and reducing sugar content of yoghurt mainly depend on types of stabilizers in the yoghurt. This result was agreed with findings of Khalifa [12], who reported starch stabilizers have high reducing sugar content than pectin and other types of stabilizers.

Table-1: Physico-chemical properties of yoghurts made from different types of stabilizers at day one

Attributes	Treatments				
	T1	T2	T3	T4	T5
Dry matter (%)	21.10±0.09^{a}	21.66±0.04^{a}	21.53±0.12^{a}	21.16±0.01^{a}	21.23±0.01^{a}
Ash (%)	0.60±0.40^{a}	0.53± 0.30^{a}	0.46± 0.23^{a}	0.46±0.30^{a}	0.20±0.00^{a}
Fat (%)	0.33±0.10^{a}	0.30±0.00^{a}	0.33±0.20^{a}	0.33±0.10^{a}	0.33±0.08^{a}
Reducing Sugar (%)	2.33±0.02^{d}	2.76±0.07^{b}	2.98±0.05^{c}	2.66±0.04^{bc}	2.60±0.01^{a}
Total sugar (%)	19.74±0.06^{d}	22.53±0.06^{b}	22.23±0.08^{b}	21.29±0.09^{c}	23.60±0.08^{a}
pH	4.04±0.03^{a}	3.97±0.07^{bc}	3.93±0.014^{c}	4.02±0.014^{ab}	4.03±0.03^{a}
Titratable Acidity (%)	0.87±0.11^{a}	0.99±0.18^{a}	1.02±0.13^{a}	0.87±0.11^{a}	0.87±0.25^{a}

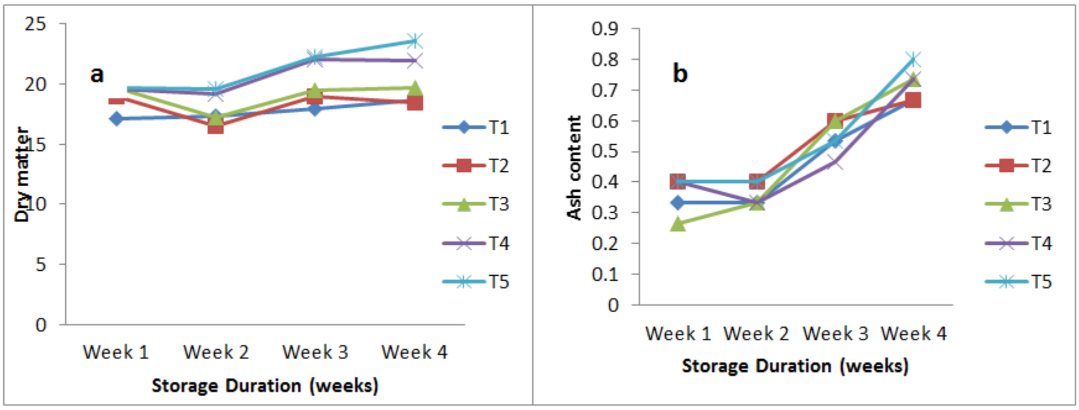
T1-Gelatin stabilizer, T2-Sweet potato starch stabilizer, T3-Cassava starch stabilizer, T4-Citrus fiber stabilizer, T5-Corn starch stabilizer. Values are means ± standard deviations of replicate determination. Mean with the same letters are not significantly different at ($p < 0.05$).

The changes of syneresis of yoghurt varied ($p<0.05$) with different types of stabilizers. After half an hour and two hours syneresis, corn stabilizer added yoghurt showed highest values (26.91±0.02%) and (39.92±0.05%) respectively. Gelatin stabilizer added yoghurt showed lowest value for half an hour (25.20±0.10) and two hours syneresis (35±0.10). The acidity of the yoghurts can be a further contributing factor since higher acidity was known to stimulate syneresis in yoghurt. This result agreed with finding of Khalifa [12]. Stabilizers are mainly affecting the syneresis process [13].

Physico-chemical properties of yoghurts made from different types of stabilizers during storage

Dry matter content, ash and fat contents in yoghurt

The dry matter content of yoghurt varied ($p<0.05$) with different types of stabilizer. Dry matter content in the yoghurt increased with the storage period (Figure 1a).



T1-Gelatin Stabilizer, T2-Sweet potato starch Stabilizer, T3-Cassava starch Stabilizer, T4-Citrus fiber Stabilizer, T5-Corn Stabilizer.

Fig-1: Dry matter (a) and ash (b) content in yoghurt during the storage period

At the end of the storage period corn starch stabilizer added yoghurt showed highest value of dry matter content (23.56±0.12%) and sweet potato starch stabilizer added yoghurt showed lowest value of dry matter content(18.4±0.18%). It may be due to loosing water from the yoghurt sample. This result was agreed with findings of Khalifa, [12]. At the end of the storage period corn starch stabilizer added yoghurt showed highest value of ash content (0.80±0.00%) and Sweet potato starch stabilizer added yoghurt showed lowest value of ash content (0.66±0.28%). Also ash content in the yoghurt increased with the storage period (Figure 1b). It may be due the increase in dry matter content. Fat content was relatively constant during storage, which suggests that types of stabilizer did not affect significantly.

Reducing sugar and total sugar in yoghurt during storage period

The Reducing sugar and total sugar contents in the yoghurt among the storage period are showed in Table 2. Reducing sugar in yoghurt varied ($p<0.05$) with different types of stabilizer. Reducing sugar in the yoghurt decreased with the storage period. It might be due to the conversion of lactose into lactic acid with time of storage by lactic acid bacteria. During the storage period corn starch stabilizer added yoghurt showed the lowest value of reducing sugar content (2.05±0.04%) than other types of stabilize added yoghurt. This result was agreed with findings of Khalifa [12]. A starch stabilizer has high reducing sugar content than pectin and other types of stabilizers. This result agreed with finding of Tammie and Robinson [14].

Table-2: Changes of reducing sugar and total sugar in yoghurt during storage

Treatments	Attributes	Week 1	Week 2	Week 3	Week 4
T1	Reducing sugar	2.98±0.05^{abc}	2.75±0.07^{c}	2.91±0.17^{abc}	2.77±0.06^{bc}
	Total sugar	19.43±0.40^{de}	18.66±0.07^{defg}	17.17±0.08^{hi}	16.49±0.05^{i}
T2	Reducing sugar	2.83±0.12^{bc}	3.14±0.08^{a}	3.01±0.07^{ab}	2.98±0.05^{abc}
	Total sugar	21.28±0.12^{ab}	19.31±0.03^{def}	18.28±0.15^{fg}	17.69±0.04^{gh}
T3	Reducing sugar	3.12±0.06^{a}	2.47±0.13^{d}	2.90±0.07^{abc}	2.89±0.04^{abc}
	Total sugar	21.81±0.12^{a}	17.90±0.21^{gh}	19.22±0.11^{def}	18.53±0.12^{efg}
T4	Reducing sugar	3.01±0.04^{ab}	2.30±0.06^{e}	2.11±0.04^{e}	2.18±0.11^{e}
	Total sugar	21.29±0.09^{ab}	20.52±0.05^{bc}	19.51±0.09^{cde}	19.59±0.07^{cde}
T5	Reducing sugar	2.85±0.03^{bc}	2.47±0.05^{d}	2.10±0.07^{e}	2.05±0.04^{e}
	Total sugar	21.46±0.06^{ab}	19.69±0.09^{cd}	17.77±0.02^{gh}	17.68±0.10^{gh}

T1-Gelatin Stabilizer, T2-Sweet potato starch Stabilizer, T3-Cassava starch Stabilizer, T4-Citrus fiber Stabilizer, T5-Corn starch Stabilizer. Values are means ± standard deviations of replicate determination. Mean with the same letters are not significantly different at ($p < 0.05$).

Total sugar in all types of yogurt was ($P<0.05$) decreased with storage period. During the storage period Gelatin stabilizer added yoghurt showed lowest value of total sugar content (16.49±0.05%) than other types of yogurt. The total sugar content of yoghurt mainly depends on types of stabilizers and concentration of the stabilizers. This result was agreed with findings of Khalifa [12].

pH and titratable acidity in yoghurt during storage

Table 3 shows the pH values of the different types of stabilizer added yoghurts decreased ($P<0.05$) with storage period. During the storage period citrus fiber stabilizer added yoghurt showed lowest value of pH (4.17±0.03) than other types of stabilizer added yogurt. The changes in pH due to fermentation process by microorganism. The reduction in pH can be due to the breakdown of lactose into lactic acid. Also pH values of different types of stabilizers added yoghurts were different and it might be due to different types of stabilizers using in yogurt.

Table-3: Changes of pH and titratable acidity in yoghurt during storage

Treatments	Attributes	Week 1	Week 2	Week 3	Week 4
T1	pH	4.37±0.006^{a}	4.33±0.010^{b}	4.23±0.013^{efg}	4.21±0.003^{fghi}
	Titratable acidity (%)	0.33±0.09^{efg}	0.36±0.00^{efg}	0.39±0.08^{ef}	0.66±0.06^{b}
T2	pH	4.33±0.006^{b}	4.27±0.003^{c}	4.23±0.006^{efg}	4.22±0.00^{fgh}
	Titratable acidity (%)	0.36±0.00^{efg}	0.63±0.11^{b}	0.57±0.07^{bc}	0.63±0.1^{1b}
T3	pH	4.26±0.010^{cd}	4.24±0.00^{def}	4.19±0.003^{hij}	4.18±0.003^{ij}
	Titratable acidity (%)	0.27±0.17^{fg}	0.51±0.07^{cd}	0.36±0.00^{efg}	0.75±0.06^{a}
T4	pH	4.26±0.006^{cde}	4.22±0.00^{fgh}	4.19±0.00^{hij}	4.17±0.003^{j}
	Titratable acidity (%)	0.39±0.08^{ef}	0.42±0.08^{de}	0.42±0.08^{de}	0.78±0.05^{cd}
T5	pH	4.32±0.017^{b}	4.24±0.006^{def}	4.20±0.003^{ghij}	4.18±0.00^{j}
	Titratable acidity (%)	0.24±0.01^{g}	0.39±0.08^{ef}	0.39±0.08^{ef}	0.51±0.07^{a}

T1-Gelatin Stabilizer, T2-Sweet potato starch Stabilizer, T3-Cassava starch Stabilizer, T4-Citrus fiber Stabilizer, T5-Corn starch Stabilizer. Values are means ± standard deviations of replicate determination. Mean with the same letters are not significantly different at ($p < 0.05$).

This result was also agreed with findings of Jimoh *et al*. [15]. Titratable acidity of the treatments increased ($P<0.05$) with storage period (Table 3). During the storage period Citrus fiber stabilizer added yoghurt showed highest value of titratable acidity (0.78±0.05%) than yogurt added with gelatin, sweet potato, cassava and corn. The rise of acidity of yoghurt may be due to metabolism of lactose by lactic acid bacteria and different types of stabilizers. Jimoh *et al*. [15] reported similar finding in soy-yoghurts.

Effect of storage on sensorial attributes of different treated yoghurt samples

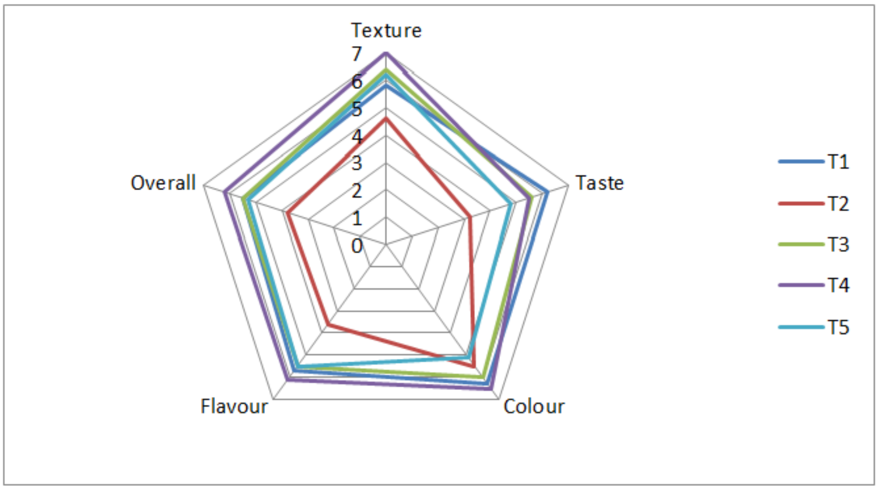


Fig-2: Variation in sensory attributes at day one

T1-Gelatin Stabilizer, T2-Sweet potato Stabilizer, T3-Cassava Stabilizer, T4-Citrus fiber Stabilizer, T5-Corn Stabilizer

The results of sensory evaluation of yoghurt on the basis of texture, taste, colour, flavor and overall acceptability are summarized in Figure 2. Highest value was observed for texture, color, flavor and overall acceptability in citrus fiber stabilizer added yoghurt than to other treatments. Highest value for taste was observed for gelatin stabilizer added yoghurt. Lowest value was observed of taste, texture, flavor and overall acceptability were observed sweet potato stabilizer added yoghurt. Loss of taste may be due to development of acidity and proteolysis of proteins.

CONCLUSION

At day of preparation quality attributes such as dry matter, ash, and treatable acidity did not ($p< 0.05$) show significance changes but the The total sugar, reducing sugar, fat content and pH showed significant diference ($p<0.05$) among the treatments. During the storage period dry matter, ash content, total sugar, reducing sugar, pH, and titratable acidity showed significance differences. Fat content did not show significant difference ($p<0.05$) among treatments. At the end of the storage period corn starch Stabilizer added yoghurt showed highest value of dry matter and ash content. Sweet potato starch added yoghurt showed highest value for reducing sugar and citrus fiber added yoghurt showed highest value for total sugar. The results of this study showed that addition of plant stabilizers improves the composition and sensory properties of yoghurt.

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