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Development of set yoghurt adding three different edible oils

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ABSTRACT

Edible oils constitute valuable natural antioxidants as the bio active compounds and therefore yoghurt can be enriched by fortification with edible oils. Therefore, the aim of this present study was to investigate the nutritional and physical properties and shelf life of yoghurts incorporated with edible oils namely, sunflower oil, and olive oil and sesame oil, at the rate of concentration 1.5% (w/w). Yoghurt samples analyzed for physico-chemical and sensory properties during refrigerated storage at 4^{o}C and sensory characteristics analyzed, at day 1, week 1, week 2, week 3 and week 4 of storage. Ash, dry matter, fat, pH, titratable acidity and mineral contents were significantly difference ($p<0.05$) among the treatments at day one. The results of this study revealed that, the ash (0.85±0.05%) and dry matter (26.28±1.55%) content were significantly ($p<0.05$) higher in yoghurt incorporated with of olive oil. Fat content was significantly ($p<0.05$) higher in yoghurt incorporated with of sesame oil, (8.70±0.17%). pH was significantly higher in yoghurt incorporated with olive oil (4.97±0.02%). Sesame oil added yoghurt showed the highest antioxidant activity (0.311) and least value (0.166) showed in without oil added yoghurt at 593 nm absorbance. Syneresis of yoghurt was significantly ($p<0.05$) higher in yoghurt with olive oil after 1 hour of syneresis. During storage, the ash and dry matter content and fat content was significantly ($p<0.05$) increased. pH was significantly ($p<0.05$) decreased and titratable acidity increased with the storage period. Finally, 1.5% of sunflower oil added yoghurt had the highest mean score of overall quality of all sensory properties among sensory panelists.

Key words: *Edible oils, Physic-chemicals, Yoghurt, Storage, Sensory attributes*

INTRODUCTION

Yoghurt is one of the popular ripened milk product known for its typical flavor, characteristic semi-solid consistency and high nutritive value. Which has great consumer acceptability due to its health benefits. Yoghurt is provided distinctive health benefits such as immune enhancement and prevention of gastrointestinal disorders and also effective in lowering the blood cholesterol level (Weerathilake *et al.,* 2014). Different types of edible oils can be used as supplement for yoghurt, namely, sunflower oil, olive oil, and sesame oil. Edible oil contains a lower saturated fatty acid content and high levels of unsaturated fatty acids, (Farmani *et al.,* 2016; Barrantes *et al.,* 1994).Sunflower, Olive and Sesame oils are well known vegetable cooking oil types. Sunflower oil contained the high amount of monounsaturated (MUFA) and polyunsaturated (PUFA) fatty acids. Mostly, oleic acid and linoleic acid. The oil also contains a considerable amount of vitamin E (O'Brien, 2008). Vitamin E (Tocopherols) is natural antioxidants that inhibit oil oxidation. Tocopherols act as biological kidnappers of free radicals and could prevent diseases, (Brigelius – Flohe *et al*., 2002). Sesame seed oil is well-known as a source of high antioxidant activity (Shyu and Hwang, 2002; Shahid *et al.,* 2006). Many researches has been promoted to evaluate the health promoting effects of sesame oil (Hou *et al.,* 2004). By adding different

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edible oils into yoghurt can adjust the nutritional availability and control the shelf life of the product to full fill the consumer preference and demand. However, it can provide more health benefits which make it effective for reducing atherosclerosis and the risk of cardiovascular disease. That sesame oil can decrease low-density lipoprotein (LDL) levels while maintaining high-density lipoprotein (HDL) levels (Brar and Ahuja, 1980; Simopoulos, 1999; Bopitiya and Madhujith, 2013).

In recent years, there has been increasing interest in the use of natural and healthy food among the consumers to maintain the health benefit of the people. Furthermore, peoples are willing to consume some kinds of edible oils such as sunflower, olive, and sesame oil. Which have been incorporating to improve the nourishment and health benefit to the yoghurt. Therefore, this study was carried out to develop using edible oils such as sunflower, olive, and sesame oil added in yoghurt and to evaluate physico-chemical quality parameters of yoghurt during storage.

MATERIALS AND METHODS

Starter culture and Edible oils

The freeze dried lactic starter culture (DVS, CHR HANSEN, DENMARK) was used. Cow milk collected at Livestock Farm, Faculty of Agriculture, and Eastern University, Sri Lanka. Extra virgin olive oil and fortune refined sunflower oil and Sesame oil were purchased at supermarket.

Yoghurt preparation

Standardized milk was pasteurized at the temperature 85^{o}C for 30 minutes. At the same time sugar and stabilizer (gelatin) was added to the milk and mixed well and fortified with different edible oils (sunflower oil, olive oil, sesame oil) at a rate of 1.5% at the (w/w) and 1.5% (w/w) of distilled water was added used as a control. Then after milk was allowed to cool at 42^{o}C, then starter culture was added and mixed well. Then mixture of milk was poured into yoghurt cups which were incubated at 42^{o}C for 4 hours (Manjula *et al.*, 2012). A total of 1000 yoghurt samples were prepared and stored in refrigerator at temperature about 7^{o}C for one month. Each sample was randomly taken and analyzed at day 1, week 1, week 2, week 3 and week 4 of storage.

Determination of physico-chemical properties of yoghurt

These yoghurt samples were analyzed in triplicate for dry matter using by oven drying at 105°C to get constant weight according to methods described by AOAC (2002) and percentage of dry matter was calculated. Ash content was determined by using muffle furnace at 550°C for 4 hours (AOAC, 2002). The fat content of yoghurt was determined by the Gerber method (Anon, 1972). The titrable acidity (as % lactic acid) was determined by titration with a 0.1 N NaOH solution using phenolphthalein as an indicator, according the method described by Dave and Shah, (1997). The pH of samples was measured using a pH meter (Hanna Instruments pH Meter) as described by Akpakpunam and Safa- Dedeh, (1995). The pH meter was calibrated in buffer solution 4 and 7 and finally dipped in sample and reading was noticed. Syneresis of yoghurt samples were measured by placed on a filter paper resting on a top of a funnel. After 1 hour and 2 hours of drainage the quantity of whey was measured.

Determination of mineral content

The minerals contents in yoghurt samples were determined by using a flame atomic absorption spectroscopy according

methods described official method 968.08 (AOAC, 2002). Two gram of different types of yoghurt samples were ashes in a muffle furnace at 550 °C for 6 hours. Afterwards, the residues were transferred to the digestion tube and added with 5 ml of 25% HCl. Then after, the digestion tubes were placed into a digestion block and the sample was digested at 125 °C for 30 min. The digests were removed from the digestion block, cooled to room temperature and diluted to a volume of 100 ml with ultrapure water. Afterwards, the digested samples were analyzed directly by flame atomic absorption spectroscopy.

Determination of antioxidant activity

Total antioxidant activity of yoghurt was measured by FRAP method (Benzie and Strain, 1996). The FRAP reagent was prepared by mixing 1ml of (10mmol/l) TPTZ solution in 40mmol/l HCl, 1ml of $FeCl_3$ (20mmol/l) and 10 ml of acetate buffer, (0.3mol/L, pH= 3.6). Twenty milliliter of 0.1g/ml, sample was mixed with 1ml FRAP reagent and the absorbance at 593nm was measured spectrophotometrically after incubating at room temperature for 4 minutes, against the FRAP reagent as the blank.

Sensory analysis

Sensory evaluation was carried out at Laboratory of Animal Science, Eastern University Sri Lanka. Untrained 30 panelists consisting equal number of men and women were used for organoleptic evaluations like texture, flavor, colour, taste and overall acceptability. Nine-point hedonic scale, ranging from (score = 9) to (score = 1) where, 9 indicates extremely like and 1 extremely dislike was used for evaluation (Ihekoronye and Ngoddy, 1985). A questionnaire was used for the sensory assessment. Each panelist was asked to evaluate the samples from different treatment which were arranged to assess the organoleptic qualities.

Statistical analysis

Samples were randomly collected and parametric data were analyzed by using Multivariate Analysis of Variance (MANOVA) by using Statistical Analysis System (SAS 9.1 Version, North Carolina, USA) software statistical package and used to determine the significance level of the treatments, while the Duncan's Multiple Range Test (DMRT) was used for mean separation. The sensory analysis was carried out using Friedman's test for non-parametric data analysis.

RESULTS AND DISCUSSION

Nutritional and physical attributes of yoghurts by adding of edible oil at day 1

The Table 1 show that the higher amount of dry matter content (26.28±1.55%), and ash content (0.85±0.05%) were ($p<0.05$) observed in olive oil added yoghurt, this indicates that, olive oil added yoghurt is the better source of minerals among the other types of yoghurt. While the higher fat content ($p<0.05$) observed in sesame oil added yoghurt. Furthermore, higher titratable acidity content (0.41±0.04%) observed in sesame oil added yoghurt at day 1 and lowest acidity value (0.24±0.40%) shown in without oil added yoghurt, also higher pH content (4.97±0.02%) showed in olive oil added yoghurt, lower pH content (4.80±0.02%) was shown in without oil added yoghurt.

Table1: Nutritional and physical attributes of yoghurts by adding of edible oil at day 1

Attributes	Treatments			
	T_1	T_2	T_3	T_4
Dry Matter%	23.47 ± 1.53^{ab}	26.28 ± 1.55^{a}	24.97 ± 0.40^{ab}	21.9 ± 2.71^{b}
Ash%	0.62 ± 0.07^{c}	0.85 ± 0.05^{a}	0.82 ± 0.08^{ab}	0.70 ± 0.05^{bc}
Fat%	8.20 ± 0.36^{b}	8.56 ± 0.20^{ab}	8.70 ± 0.17^{a}	6.83 ± 0.15^{c}
Titratable acidity%	0.30 ± 0.05^{b}	0.29 ± 0.00^{b}	0.41 ± 0.04^{a}	0.24 ± 0.40^{b}
pH	4.93 ± 0.03^{a}	4.97 ± 0.02^{a}	4.87 ± 0.02^{b}	4.80 ± 0.02^{c}

T_1= sunflower oil added, T_2= olive oil added, T_3= sesame oil added, T_4= without oil added. The Values are means of triplicates ± standard deviation. Mean with the same letters are not significantly different at ($p< 0.05$).

In this study, significant difference ($p<0.05$) found in syneresis among yoghurts made by adding different edible oils. According to the results, higher syneresis (26.23±0.13%) showed in olive oil added yoghurt and lower syneresis value (21.97±0.08%) showed by sesame oil added yoghurt at one hour syneresis. The syneresis value is varied of different types of edible oil added yoghurt, and also with the time the value was increased. These study findings in line with the results revealed by Salvador and Fiszman (2004) and Singh *et al.* (2011) who were reported that incorporation of oil into yoghurt, which is increasing the syneresis.

Nutritional and physical attributes of yoghurts by adding edible oilduring storage period

(a) Dry matter, Ash and Fat contents in yoghurt

As shown in Table 2, the dry matter content of the yoghurt ranged from 22.06% to 39.80%. The highest mean value of dry matter content, at first week (27.70±0.80%) observed in olive oil added yoghurt and lowest mean value (22.06± 2.84%) showed in without oil added yoghurt. At four week, highest mean value (39.80±0.10%) showed in olive oil added yoghurt and lowest value (37.17±0.29%) showed in without oil added yoghurt. So, adding of different types of edible oils to the yoghurts were significantly ($p<0.05$) differed from without oil added yoghurt, because edible oil increased the total solid content in yoghurt. Furthermore, dry matter content increased during four weeks of storage. This increment of dry matter content along the storage period may be due to water evaporation along the refrigerated storage period (Ei-Nagar and Shenana, 1998).

Ash content of edible oil added yoghurt it noticed that, the ash content were significant ($p<0.05$) differences among the all types of yoghurt. As indicated in Table 2. At first week, the higher mean value of ash content (0.87±0.08%) presented in olive and lowest mean value of ash content (0.65±0.05%) observed in sunflower oil added yoghurt. So adding of edible oil in to the yoghurt increased the ash content stated by Munzur *et al.*, (2004). According to results proved by this, there is a significant effect of different edible types on ash content of yoghurt sample and all treatments showed slightly increased ash content along the storage period. These differences may be due to the changes in dry matter along the refrigerated storage period (Yangilar and Yildiz, 2018).

The significant different of fat ($p<0.05$) were detected among different types of edible oil added yoghurt showed in Table 2. At first week of storage, the highest mean value of fat content (8.67±0.21%) showed by sesame oil added yoghurt and lowest value (6.93±0.16%) in without oil added yoghurt, respectively. This result is in accordance with the findings of Ammar *et al.* (2014). Who reported that, the fat content of edible oil added yoghurt, slightly increased during storage period.

Table 2: Dry matter, Ash and Fat contents in yoghurt during storage period

Treatments	Parameter	Week 1	Week 2	Week 3	Week 4
T_1	Dry mater %	23.78 ± 1.22^{ef}	25.23 ± 0.83^{de}	39.10 ± 1.21^{a}	39.53 ± 0.55^{a}
	Ash %	0.65 ± 0.05^{g}	0.66 ± 0.04^{g}	0.81 ± 0.02^{de}	0.83 ± 0.03^{cde}
	Fat%	8.20 ± 0.10^{b}	8.3 ± 0.36^{b}	8.47 ± 0.32^{ab}	8.50 ± 0.10^{ab}
T_2	Dry mater %	27.70 ± 0.80^{c}	28.33 ± 0.21^{c}	39.63 ± 0.12^{a}	39.80 ± 0.10^{a}
	Ash %	0.87 ± 0.08^{abcd}	0.89 ± 0.08^{abc}	0.93 ± 0.03^{a}	0.92 ± 0.01^{ab}
	Fat%	8.60 ± 0.20^{ab}	$8.73`\pm0.15^{ab}$	8.87 ± 0.21^{ab}	8.90 ± 0.20^{ab}
T_3	Dry mater %	25.60 ± 0.10^{d}	28.53 ± 0.06^{c}	29.40 ± 0.10^{a}	39.37 ± 0.06^{a}
	Ash %	0.84 ± 0.04^{cde}	0.86 ± 0.02^{cde}	0.91 ± 0.01^{ab}	0.92 ± 0.03^{ab}
	Fat%	8.67 ± 0.21^{ab}	8.73 ± 0.20^{ab}	8.60 ± 0.21^{ab}	9.00 ± 0.10^{a}
T_4	Dry mater %	22.06 ± 2.84^{g}	23.23 ± 0.06^{gf}	37.10 ± 0.01^{b}	37.17 ± 0.29^{b}
	Ash %	0.82 ± 0.06^{de}	0.74 ± 0.02^{f}	0.74 ± 0.03^{f}	0.80 ± 0.01^{e}
	Fat%	6.93 ± 0.16^{c}	7.03 ± 0.25^{c}	7.10 ± 0.59^{c}	7.37 ± 0.44^{c}

T_1= sunflower oil added, T_2= olive oil added, T_3= sesame oil added, T_4 = without oil added.The Values are means of triplicates ± standard deviation. Mean with the same letters are not significantly different at ($p< 0.05$)

(b) pH and titratable acidity in yoghurt during storage period

In this study, pH content ranged from 4.94 to 4.61. At first week, the highest mean value (4.94±0.01) and lowest value (4.74±0.04) of pH was showed in olive oil added yoghurt and without oil added yoghurt, respectively. Moreover, at fourth week, the highest mean value (4.74±0.02) recorded by sesame oil added yoghurt and these results proved (4.91±0.11) by Ahmet and Gürlin. (2014) and lowest value (4.61±0.02) in without oil added yoghurt. During the storage period, the pH value decreased in the different types of yoghurt due to post acidification, these results were in line with the findings of Sabbah *et al.* (2012) and Ozcan and Kurtuldu (2014). On the other hand, at first week, the higher mean value (0.42±0.02%) of titratable acidity and lower value (0.28±0.03%) recorded without oil added yoghurt (Table 3). These results were in agreement with the observation made by Abbas and Osman (1998), who reported that the titratable acidity was increased gradually during storage in all types' yoghurt. This variation may be due to fermentation of lactose, which produces lactic acid and acetic acid during fermentation during period of storage. The post acidification of yoghurt during storage by converting

lactose into lactic acid (Sabbah *et al.*, 2012). This result is in agreement with Kosikowski and Mistry (1977) and Akın and Konar. (1999) who reported that slight increase in titratable acidity during four week of storage.

Table 3: pH and titratable acidity in yoghurt during storage period

Treatments		Week 1	Week 2	Week 3	Week 4
T_1	pH	4.93 ± 0.02^{a}	4.64 ± 0.47^{bc}	4.72 ± 0.02^{abc}	4.66 ± 0.02^{bc}
	Titratable acidity%	0.31 ± 0.02^{de}	0.33 ± 0.01^{d}	0.44 ± 0.00^{c}	0.61 ± 0.02^{a}
T_2	pH	4.94 ± 0.01^{a}	4.85 ± 0.04^{abc}	4.67 ± 0.02^{bc}	4.65 ± 0.04^{bc}
	Titratable acidity%	0.29 ± 0.01^{de}	0.32 ± 0.01^{de}	0.46 ± 0.03^{bc}	0.64 ± 0.01^{a}
T_3	pH	4.87 ± 0.02^{ab}	4.76 ± 0.01^{abc}	4.75 ± 0.02^{abc}	4.74 ± 0.02^{abc}
	Titratable acidity%	0.42 ± 0.02^{c}	0.33 ± 0.01^{d}	0.46 ± 0.01^{bc}	0.62 ± 0.03^{a}
T_4	pH	4.74 ± 0.04^{abc}	4.75 ± 0.02^{abc}	4.71 ± 0.01^{abc}	4.61 ± 0.02^{c}
	Titratable acidity%	0.28 ± 0.03^{e}	0.44 ± 0.07^{bc}	0.49 ± 0.02^{b}	0.60 ± 0.01^{a}

T_1= sunflower oil added, T_2= olive oil added, T_3= sesame oil added, T_4 = without oil added yoghurt. The Values are means of triplicates ± standard deviation. Mean with the same letters are not significantly different at ($p< 0.05$).

(c) Mineral content of yoghurt

As mentioned in Table 4 mineral content of yoghurt with different edible oils were analyzed. The higher value of Calcium, Phosphorus, Magnesium, Copper and Manganese were constituted in olive oil added yoghurt, and the higher value of Zinc constitute in without oil added yoghurt. It might be due to the different composition of mineral present in the edible oils.

Table 4: Mineral content of yoghurt

Parameter	T1	T2	T3	T4
Calcium (mg/g)	1398.7	1661.5	1642.7	1197.8
Phosphorus (mg/g)	618.9	756.7	670.6	719.7
Magnesium (mg/g)	28.7	41.4	23.1	41.0
Copper (mg/g)	3	2.8	1.9	1.8
Zinc (mg/g)	1.9	1.8	1.9	2.7
Manganese (mg/g)	1	1.9	1.9	1.8

T_1= sunflower oil added, T_2= olive oil added, T_3= sesame oil added, T_4 = without oil added yoghurt

(d) Antioxidant activity of yoghurt

As mentioned in Table 5 sesame oil added yoghurt showed the highest antioxidant activity (0.311) at day one and least value (0.166) showed in without oil added yoghurt. According to results at week one, the higher value (0.389) showed in sesame oil added yoghurt compared to other treatments and least value showed in without oil added yoghurt. So adding of edible oil in to the yoghurt increased the antioxidant activity stated by Azizkhani and Parsaeimehr (2018) and antioxidant activity was high in week one than day one

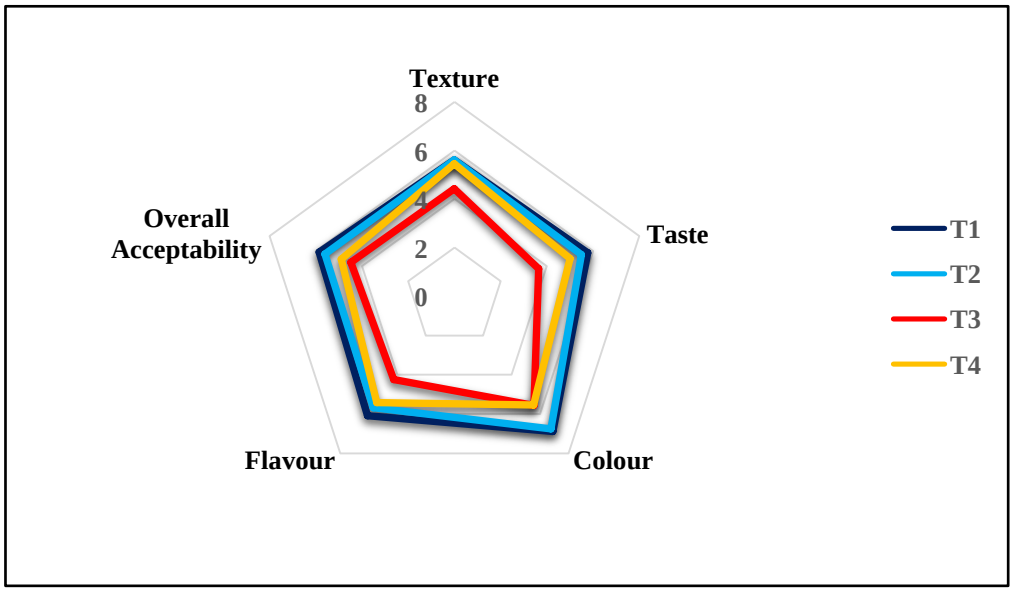
reading, it may be due to the gradual release of edible oils antioxidant components (Azizkhani and Parsaeimehr, 2018).

Table 5 : Antioxidant activity of yoghurt at 593 nm absorbance

Treatments	Day 1	Week 1
T_1	0.172	0.19
T_2	0.178	0.198
T_3	0.311	0.389
T_4	0.166	0.175

Evaluation of sensory qualities of yoghurt made by adding different edible oils

The overall quality is indicated below in Figure 1. Organoleptic point of view, the overall quality of the products determined by considering organoleptic characteristics namely, colour, taste, texture, flavor and overall acceptability. Overall quality evaluation revealed that, 1.5% of sunflower oil added yoghurt had the highest value of all sensorial properties namely, colour, taste, texture, flavor, and overall acceptability. Out of nine (9) point hedonic scale, mean score of 6.9 for colour, 5.8 for taste, 5.6 for texture, 6.1 for flavor and 5.9 for overall acceptability were observed. As a results revealed that overall quality of products 1.5% of sunflower oil added yoghurt organoleptically acceptable. It might due to pleasant flavor of the sunflower oil.



T1= sunflower oil added, T2= olive oil added, T3= sesame oil added, T4 = without oil added yoghurt

Figure 1: Overall quality of the product

CONCLUSION

In this study, quality parameters such as dry matter, ash and fat contents of edible oil added yoghurt were significantly changed among the different yoghurt. Dry matter, ash and fat contents were also increasing with storage period. On the other hand, pH, and titratable acidity were also significantly changed among the different types of yoghurt and pH was decreasing while titratable acidity was increasing during the storage period. The mineral contents such as calcium, phosphorus, magnesium, copper and manganese were higher in olive oil added yoghurt than other type of yoghurt. Finally, the results of the sensory evaluation show that organoleptic parameters have influence on overall acceptability of yoghurt product. According to the panelist preference of texture colour flavour and overall acceptability were preferred yoghurt made from 1.5% of sunflower oil incorporated yoghurt other types of yoghurt.

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