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Physicochemical Properties of Functional Yoghurt Prepared With Flaxseed Oil and Guava Pulp

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Abstract

Yoghurt can be enriched with dietary fibre, antioxidant, vitamin C and omega 3 rich oil. In this study functional yoghurt is prepared with flaxseed oil and guava pulp and physico chemical properties were analysed between 0 day and 21 days. Significant decrease in pH and increase in titratable acidity were observed throughout the storage period. There is a mild decrease in the values of fat as well as total solids content noticed from 0 day (23.43±0.05) to 21st day (22.61±0.02 for functional yoghurt. Though the difference was not significant ($P \geq 0.05$) up to 7th day of storage and later on there is a significant ($P \leq 0.05$) difference observed on 14th and 21st day of storage. There was a static decrement in syneresis from control to other three treatments. In regard to total phenolic content, there was a significant ($P \leq 0.05$) difference observed from zero day to 21st day of storage. There was a significant ($P \leq 0.05$) decrease in the DPPH radical scavenging activity from 0 day (4.51±0.14) to 21st day (2.32±0.10) for functional yoghurt. The gradual reduction in the antioxidant property of functional yoghurt during the storage period may be attributed to physicochemical changes occur during storage period which lead to loss of both probiotics and phytochemicals.

Keywords: Flaxseed oil, guava pulp, physicochemical, functional yoghurt

Yoghurt is a functional dairy food which is rich in nutrients and has beneficial effects on human health by supplying prebiotics and probiotics. It helps to strengthen the immune system, improves lactose digestion and gastrointestinal conditions including lactose intolerance, constipation, diarrhoea, colon cancer, inflammatory bowel disease and allergies.

The physiological actions promoted by fibre addition in foods include the maintenance of gastrointestinal health, reduction of intestine transit time, protection against colon cancer, lowering of total and low-density lipoprotein cholesterol in the blood serum, reduction of postprandial blood glucose levels, increase of calcium bioavailability and reinforcement of the immunological system. Fibres also have beneficial effects for human health, with a recommended daily intake of 0.025–0.030 kg/day (Labell, 1990).

Guava is rich in tannins, phenols, triterpenes, flavonoids, essential oils, saponins, carotenoids, lectins, vitamins, fiber and fatty acids. Guava fruit is higher in vitamin C than citrus (80 mg of vitamin C in 100 g of fruit) and contains appreciable amounts of vitamin A as well. Guava fruits are also a good source of pectin - a dietary fiber (Baby Joseph and Mini Priya, 2011).

Dietary recommendations for omega-3 fatty acids (2.2g of ALA/ day and 0.22g/day of EPA and DHA; International Society for the Study of Fatty acids and Lipids, 2004) can be obtained from the diet by the consumption of foods rich in these fatty acids (Gebauer *et al.* 2006). Major sources of ALA include the seeds and oils of flaxseed, soybean and canola, with flaxseed containing 50-60% ALA (Moghadasian, 2008).

With this background this study is aimed to develop functional yoghurt with flaxseed oil (*Linumusitatissimum* L) and guava (*Psidium gujava*) pulp and to analyse the physico chemical properties of the

MATERIALS AND METHODS

Yoghurt samples were tried to prepare with 0% -PY, 1.5%- FY(1), 2% -FY(2) and 2.5%-FY(3) flaxseed oil with 6 percent sugar levels. On the basis of sensory evaluation, 2 % was adjudged as the acceptable level of flaxseed oil in yoghurt and subjected to further studies. Similarly the 2% flaxseed oil yoghurt was incorporated with different level of guava pulp:

1. PY = Plain yoghurt with 6% sugar without adding oil and fruit pulp
2. T1 = 2% Flaxseed Oil and 5% guava pulp with 6% sugar
3. T2 = 2% Flaxseed Oil and 10% guava pulp with 6% sugar
4. T3 = 2% Flaxseed Oil and 15% guava pulp with 6% sugar

Skim milk powder at the rate of 5.760 per cent (w/v), sugar at the rate of 6 per cent (w/v) and flaxseed oil at the rate of 2 percent were added to milk and homogenized at 2500 psi. The contents were mixed well and pasteurized at 85°C for 30 minutes, cooled to 42°C. Guava pulp was added at three different levels viz., 5, 10 and 15 per cent and mixed well and inoculated with 2% of yoghurt cultures containing *Lactobacillus delbrueckii* ssp. *bulgaricus* and *Streptococcus salivarius* ssp. *thermophilus* and incubated at 42°C for 4 to 5 hours and finally stored at 4 to 5°C.

Skim milk
↓
Milk preheating (45 ±2 °C)
↓
Addition of cream (2% fat), skim milk powder (5.760 per cent) and Sugar (6%)
↓
Addition of Flaxseed oil (2 per cent)
(Standardized to 4% fat)
↓
Homogenization at 65°C (2500 psi)
↓
Pasteurization (85°C for 30 min)
↓
Cooling (42°C)
↓
Addition of guava pulp (at the rate of 5, 10 and 15%)
↓
Inoculation (2 per cent yoghurt culture)
↓
Incubating at 42°C /4-5 hrs till it reaches the pH 4.5
↓
Stored at 5°C

Fig. 1: Flow diagram of flaxseed oil and guava pulp enriched yoghurt

Analysis of physicochemical properties

The functional yoghurt was subjected to physico-chemical, by using standard procedures during storage period of zero, 7^{th}, 14^{th} and 21^{st} day. pH was estimated by using digital pH meter (Hanna-H-2211). Acidity was estimated as per the procedure described in IS:SP:18 (part XI)-1981. Syneresis (release of whey) of yoghurt was measured by procedure described by (Achanta *et al. 2007*). Fat was estimated as per the procedure described in IS:SP:18 (Part XI) – 1981. Total solids content was determined according to AOAC (1990), 15^{th} edition. The total phenolic content was determined by employing the modified procedure given by Shetty *et al.* (1995). Antioxidant activity determination by 1, 1-Diphenyl-2-Picrylhydrazyl (DPPH) radical scavenging activity (Apostolidis *et al.* 2006)

RESULTS AND DISCUSSION

Table 1 and 2 revealed that the values of pH, titratable acidity, syneresis, fat, total solids, phenolic content, DPPH radical scavenging activity for control and functional yoghurt.

PH

Statistical analysis revealed that addition of guava pulp more than 10 per cent level along with 2 per cent flaxseed oil, significantly ($P<0.05$) reduced the pH value of the functional yoghurt. The reduction in the pH of functional yoghurt may be attributed to the high activity of starter cultures and also the presence of added guava pulp.

This is supported by the findings of Ayar and Gurlin (2014), who opined that addition of fruits affects pH of yoghurt and the average lowest pH value was in blueberry added yoghurt with 4.69, while the highest pH value of 4.91 was found in sesame added yoghurt. Further, it can be opined that, the added flax seed oil had not impacted the pH, which is also supported by Lim *et al.* (2010), who reported that flax seed oil incorporated ice creams stored at different time intervals did not have any change in the pH up on storage.

Titratable acidity

There was a high significant ($P\leq0.05$) difference observed between T3 and other two treatments, which presumably due to continued fermentation by the starter culture especially *Lactobacillus delbreuckiissp bulgaricus*, which usually greatly reduces the pH of functional yoghurt. This increased activity may be attributed to the increased pheneolic content from the added guava pulp in T3 (15 per cent guava pulp), which has the potential to increase the metabolic activity of beneficial microorganisms.

Syneresis (released whey) of flaxseed oil and guava pulp incorporated yoghurt (ml)

There was a static decrement in syneresis from control (PY) to other three treatments which may be attributed to the high pectin content in guava pulp which has gelling property and thus reduced syneresis. Increase in the guava pulp content in yoghurt led to absorption of more water with decrease in syneresis. This in close agreement with the reports of Kumar *et al.* (2015), who reported that the addition of 1% flaxseed flour has reduced the syneresis compared to that in control yoghurt sample and the values further reduced in 2% flour incorporated stirred fruit yoghurt samples. Sarmini *et al.* (2014) also reported that, addition of soy and jack fruit increased the fibre contents in soy jack yoghurt decrease the syneresis.

Fat content

There was a decrease in fat content in all the three treatments of functional yoghurt. But there was no

Table 1: Physico-chemical Properties of Yoghurts Incorporated with 2% Flaxseed oil and Different Concentration of Guava pulp on Zero Day

Parameters	PY	T1	T2	T3
pH	4.50^{a}±0.11	4.41^{a}±0.12	4.39^{a}±0.22	4.10^{b}±0.01
Titratable acidity	0.89^{a}±0.01	0.93^{a}±0.03	0.95^{a}±0.02	1.12^{b}±0.02
Syneresis (ml/100g)	12.14^{d}±0.22	9.35^{c}±0.04	8.45^{b}±0.15	8.01^{a}±0.10
Fat (g/100g)	3.84±0.06	3.80±0.03	3.80±0.04	3.80±0.05
Total solids (g/100g)	23.58±0.12	23.50±0.09	23.43±0.10	23.42±0.12
Phenolic content mgGAE/g	33.00^{a}±0.29	44.10^{b}±0.23	52.29^{c}±0.21	61.78^{d}±0.26
DPPH radical scavenging activity (%)	0.66^{a}±0.06	2.84^{b}±0.15	4.511^{c}±0.14	5.94^{d}±0.12

Different superscripts in a row differ significantly ($P \leq 0.05$).

Table 2: Changes in Physicochemical Properties of Plain Yoghurt and Functional Yoghurt During 21 Days of Refrigerated Storage at 5°C (Mean±SE)

Parameters	Particulars	0 day	7th day	14th day	21st day
pH	Plain yoghurt	4.50±0.11^{Aa}	4.33±0.13^{Ba}	3.88±0.03^{Ca}	3.70±0.03^{Da}
	T2	4.35±0.02^{Ab}	4.10±0.03^{Bb}	3.73±0.03^{Cb}	3.46±0.03^{Db}
Titrable acidity	Plain yoghurt	0.89±0.01^{Aa}	0.96±0.01^{Ba}	1.07±0.01^{Ca}	1.16±0.01^{Da}
	T2	0.95±0.02^{Ab}	1.09±0.01^{Bb}	1.17±0.01^{Cb}	1.28±0.0 2^{Db}
Syneresis value	Plain yoghurt	12.14^{Ab}±0.22	13.20^{Bb}±0.21	14.07^{Cb}±0.11	15.35^{Db}±0.18
	T2	8.45^{Aa}±0.15	8.57^{Aa}±0.24	8.62^{Aa}±0.25	10.05^{Ba}±0.09
Fat	Plain yoghurt	3.84^{Ca}±0.06	3.78^{Ca}±0.04	3.56^{Ba}±0.03	3.42^{Aa}±0.02
	T2	3.80^{Ca}±0.04	3.77^{Ca}±0.04	3.58^{Ba}±0.02	3.39^{Aa}±0.01
Total solids	Plain yoghurt	23.58^{C}±0.12	23.38^{C}±0.05	22.08^{Ba}±0.08	20.89^{Aa}±0.20
	T2	23.43^{C}±0.05	23.23^{C}±0.11	22.71^{Bb}±0.12	22.61^{Ab}±0.02
Phenolic content	Plain yoghurt	33.00^{Da}±0.09	32.44^{Ca}±0.05	29.57^{Ba}±0.17	18.63^{Aa}±0.25
(mgGAE/g)	T2	52.29^{Db}±0.12	51.16^{Cb}±0.14	41.89^{Bb}±0.44	30.70^{Ab}±0.12
DPPH radical scavenging activity(%)	Plain yoghurt	0.66^{Da}±0.06	0.31^{Ca}±0.03	0.27^{Ba}±0.02	0.11^{Aa} ±0.03
	T2	4.51^{Db}±0.14	4.10^{Cb}±0.23	3.56^{Bb}±0.23	2.32^{Ab}±0.10

T2: 2% flaxseed oil with 10% guava pulp yoghurt; Different uppercase superscripts in row differ significantly ($p \leq 0.05$); Different lowercase superscripts in column differ significantly ($p \leq 0.05$).

significant (P≥0.05) difference observed between control (PY) and three treatments of functional yoghurt viz. T1, T2 & T3. Generally fruit contains low level of fat. Hence, addition of fruit pulp replacing the fat would have decreased the fat per cent of guava yoghurt.

Sengupta *et al.* (2014) also reported that, watermelon juice yoghurt was significantly low (p≤0.05) in fat content (3.40 ± 0.02 per cent) as compared with fresh cow milk plain Yoghurt (3.67 ± 0.02 per cent) and opined that addition of fruit juice decreased the fat per cent of fruit. Sawant *et al.* (2015) found that addition of pineapple pulp resulted in no significant difference in regard to fat per cent between the control and treatment samples.

Total solids

There was a decrease in total solids content in all the three treatments of functional yoghurt and no significant (P≥0.05) difference was observed between control (PY) and treatments. As the fat content of fruit is generally low, addition of fruit pulp might have decreased the fat per cent of guava yoghurt and consequently decrease the total solids. Zhang *et al.* (2006) reported that fat, protein and dry matter contents in cheese were not affected by dietary oilseed supplementation.

Total phenolic content

Recent studies have shown that phenolic phyto-chemicals have high antioxidant activity and certain therapeutic properties including anti-diabetic and anti-hypertension activities. In the present study, an increasing trend observed in phenolic content in all the three treatments of functional yoghurt than in plain yoghurt. This might be due to the addition of guava pulp which contains high phenolic compounds such as phenolic acids and polyphenols which are commonly known to be found in plants.

Zainoldin and Baba (2009) reported that fruit enriched yoghurt showed an increase in total phenolic content compared to plain yoghurt. The addition of dragon fruit increased (P<0.05) the total phenolics content in yoghurts compared to plain yoghurt with white dragon fruit yoghurt showing higher total phenolic content ($P<0.005$) than that of red dragon fruit yoghurt.

DPPH radical scavenging activity (per cent)

Statistical analysis revealed that, there was an increase in DPPH radical scavenging activity in all the three treatments of functional yoghurt than in plain yoghurt. The antioxidant activity of plain yoghurt may be attributed to the presence and activity of probiotics in yoghurts. Li-chen Wu (2006) opined that, higher antioxidant activity of both white and red dragon fruit yoghurt is a desirable characteristic that may enhance the therapeutic values of yoghurt. The findings of the present study concurred with Sengul (2014), who reported that the total antioxidant activity increased with the incremental strawberry concentration. By increasing the strawberry concentration from 8 to 16 per cent, the total antioxidant activity increased from 78.42 to 82.42 per cent.

CONCLUSION

It is to be noted that, inclusion of dietary fibre, antioxidant and vitamin c rich fruits and omega 3 rich oil is expected to enhance the nutritional and therapeutic values of yoghurt and as such encourage consumption of yoghurt**.** Based on the physicochemical and functional attributes, it is concluded that functional yoghurt developed had a keeping quality of 14 days, while the control had a shelf life of only 7 days.

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