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# Physicochemical and sensory evaluation of functional yoghurt enriched with tamarind seed kernel powder

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**Abstract**
The aim of this study was to analyse the physicochemical and sensory parameters of functional yoghurt enriched with purified tamarind seed kernel powder (TSKP) of different levels viz. 0.1, 0.25 and 0.5 per cent. The obtained data were subjected to one way analysis of variance (ANOVA) and Duncan's test. This revealed highly significant difference ($p \leq 0.01$) in pH and titratable acidity. The pH was on a decreasing trend with 3.52 ± 0.02, 3.87 ± 0.01, 3.95 ± 0.03 and 4.02 ± 0.06 and titratable acidity was on increasing trend with 0.77±0.00, 0.75±0.00, 0.74±0.00 and 0.72±0.00 for control and 0.1, 0.25 and 0.5 per cent TSKP incorporated yoghurt respectively. But the other physicochemical parameters like fat, specific gravity and total solids showed no significant changes on sensory analysis. Appearance of the yoghurt incorporated with 0.5% TSKP had a slightly lower score of 7.33±0.33 and there was a significant difference among plain and treatment groups ($p \leq 0.05$). Flavour, body, texture and overall acceptability scores from sensory panel were satisfying. Fortification of yoghurt with TSKP had good consumer acceptability.

**Keywords:** Yoghurt, fortification, tamarind seed kernel powder, analysis

## Introduction
Fortifications of food with functional ingredients are gaining more importance now a day. Fortification is the process of enriching the quality as well as the quantity of nutrients in food. This would effectively prevent the consumers from several lifestyle diseases, nutritional deficiencies and boost up their immunity (Arora *et al.*, 2015) [3]. Among food substances, several dairy products such as yoghurt can act as an excellent vehicle for carrying several important nutrients with their complete nourishing substances.

Yoghurt is a fermented dairy product containing *Streptococcus thermophilus* and *Lactobacillus delbrueckii* spp.*bulgaricus* as starter culture. It is an excellent source of protein, calcium, phosphorous, riboflavin, thiamine, niacin, magnesium and zinc (Hashemi Gahruie *et al*., 2015) [7]. Apart from this, it is an excellent solution to those who are lactose intolerant and can enhance immune modulation linked with a lowered incidence of diseases such as cancer, gastrointestinal disorders and allergic symptoms. This can improve cytokine and antibody production and phagocytic and natural killer cell activities (Isolauri *et al.*, 2002) [9]. With all these, yoghurt lacks in fibre content. Fortification of yoghurt with fibre would make it a complete food. Fibre of various sources added to dairy products would increase the water holding capacity and also increase the yield.

Fibre fortified food reduce lipid retention, improves textural properties and, reduce the caloric content by acting as bulking agent (Larrauri, 1999) [10]. Dietary fibres can be incorporated into food so as to improve textural, gel forming, sensorial characteristics, fat replacer and thickening effects (Abdul Hamid and Siew Luan, 2000; Wang *et al*., 2002) [1, 16]. Fortification with natural products is more functional than use of synthetic nutrients, thus reducing the adverse health effects. Fibres from different sources viz oat, rice, soy and maize (Fernandez and McGregor, 1997) [4], apple, wheat or bamboo fibres (Staffalo *et al*., 2004; Seckin and Baladura, 2012) [14, 13] and date fibre (Hashim *et al*., 2009; Gad *et al*., 2010) [8, 6] have been used for fortification in yoghurt.

The *Tamarindus indica L.*, fruit contains about 55 per cent pulp, 34 per cent seed and 11 per cent shell. The seed is made up of 20 to 30 per cent seed coat or testa and 70 to 80 per cent kernel or endosperm. This tamarind seed is an under-utilized by-product obtained from the tamarind pulp industry. Tamarind seed powder is obtained from the kernel portion. The tamarind seed kernel powder (TSKP) is highly rich in a polysaccharide called xyloglucan, which is water soluble and is composed of glucose, xylose and galactose. The xyloglucan is used as a substitute for food grade starch like polysaccharide due to is high molecular weight.

Tamarind seed polysaccharide differs from fruit pectins in a way that, it can form gel over a wide range of pH including neutral and basic conditions (Thombare *et al*., 2014) [15]. The tamarind seed polysaccharide is given the name "jellose" because it has both jelly forming properties and carbohydrate character. TSKP also acts as a soluble fibre, thus can be incorporated as a source of prebiotic, further increasing the beneficial effects on health.

Considering the above benefits as well as the ample availability of the by-product tamarind seeds, the study was undertaken to fortify the nutrient rich yoghurt with fibre content using the under-utilized by-product, tamarind seed kernel powder.

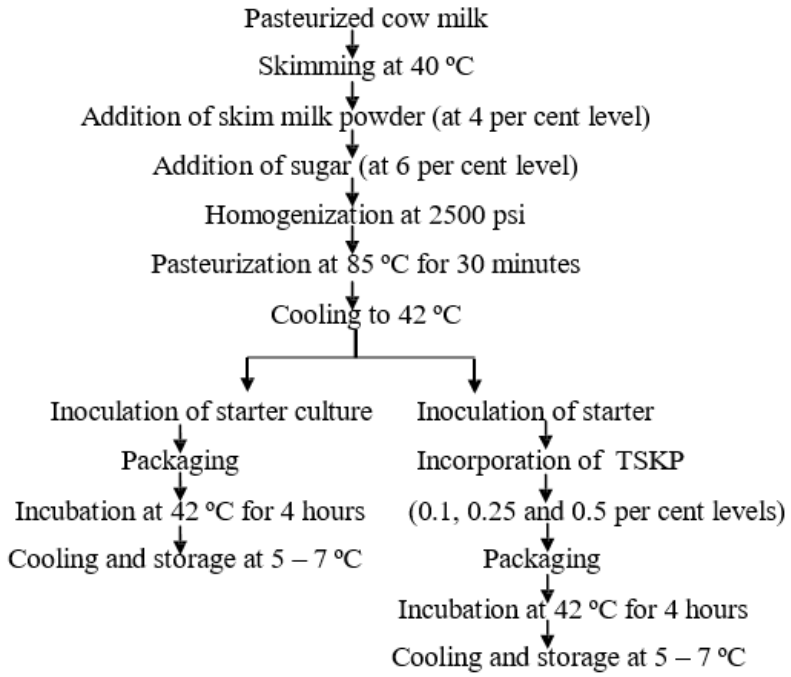
## Materials and methods

The experimental design consisted of plain yoghurt (control) and fibre fortified yoghurt with lyophilized tamarind seed kernel powder (TSKP) incorporated at 0.1, 0.25 and 0.5 per cent levels. Milk for preparation of yoghurt was procured from Model Dairy Plant, Department of Livestock Products Technology (Dairy Science), Madras Veterinary College, Chennai. Other raw materials were procured from local super market. Finely ground TSKP was prepared by subjecting the raw tamarind seeds to washing, drying in hot air oven at 60 ºC for 6 hours, roasting at 150 ºC for 10 minutes, mechanical crushing, grinding and sieving. Further, the fine powder was defatted by ether extraction and was dissolved in distilled water at 10 per cent level with continuous stirring for two hours. The contents were then heated at 80 ºC for 30 minutes, cooled and centrifuged. The supernatant was dialysed with 12,000 – 14, 000 Daltons dialysis membrane for two days at room temperature and then was freeze dried to get purified TSKP. Incorporation of purified TSKP was done along with the starter culture inoculation step of yoghurt making. The process of plain as well as purified TSKP incorporated yoghurt was represented as flowchart.

Physicochemical parameters viz fat, total solids and acidity were analysed as per IS: IP:18 (Part XI) - 1981. The specific gravity was estimated by gravimetric method using specific gravity bottle. The pH values were determined with the using pH meter (Systronics, micro pH system 361). Sensory analysis was carried out using 9 point hedonic scale for appearance, flavour, body and texture through a sensory panel consisting of 6 members (Adhikari *et al.*, 2003).

The obtained data for the physicochemical and sensory parameters were subjected to one way analysis of variance (ANOVA) for statistical analysis. The test of significance was determined with Duncan's test at $p \leq 0.05$ probability using the SPSS statistics® 20 software (Snedecor and Cochran, 1994).

**Flow chart for the preparation of plain yoghurt**




## Results and Discussion

### Physicochemical parameters of functional yoghurt enriched with tamarind seed kernel powder

The analyzed values of physicochemical parameters of functional yoghurt enriched with purified TSKP enriched in comparison with plain yoghurt (control) were displayed in Table 1. The pH values of plain and 0.1, 0.25 and 0.5 per cent TSKP incorporated yoghurts were 3.52±0.02, 3.87±0.01, 3.95±0.03 and 4.02±0.06 respectively. There was a highly significant ($p \leq 0.01$) difference in the pH values between the control and treatment. There was an increasing trend of pH values with increase in level of incorporation of TSKP. Hence, the mild increase of pH value at each level of incorporation might be due to the influence of pH value of TSKP which is around 5.2 ± 0.01 as reported by Oluseyi and Temitayo (2015) [12].

The titratable acidity of control and treatments (0.1, 0.25 and 0.5 per cent purified TSKP incorporated yoghurts) were 0.77±0.00, 0.75±0.00, 0.74±0.00 and 0.72±0.00 per cent Lactic acid respectively. There was a highly significant ($p \leq 0.01$) difference among the different groups. There was a decrease in titratable acidity. This might have taken place due to the increase in pH with increasing concentration of the added purified TSKP. Similar trend was observed by Natukunda, *et al*., (2015) in mango juice enriched with tamarind kernel powder.

The estimated fat percentage of plain and treatments (0.1, 0.25 and 0.5 per cent purified TSKP incorporated yoghurts)

were 4.05±0.08, 4.15±0.06, 4.00±0.10 and 4.13±0.11 respectively. No significant difference of fat percentage was observed between the plain and purified TSKP incorporated yoghurts. Since the TSKP was defatted and purified, there was no much influence on the fat levels of the final products.

Total solids contents of plain and 0.1, 0.25 and 0.5 per cent purified TSKP incorporated yoghurts were 14.76±0.08, 14.85±0.04, 14.85±0.04 and 14.85±0.04 per cent respectively, while the specific gravity of plain and 0.1, 0.25 and 0.5 per cent purified TSKP incorporated yoghurts were 1.04±0.00, 1.03±0.00, 1.03±0.00 and 1.04±0.00 respectively. Both total solids as well as specific gravity showed no significant differences among the control and treatments. There was no much influence on total solids content and specific gravity of the purified TSKP incorporated yoghurts which might be due to the minimal level of incorporation.

**Table 1:** Physico-chemical properties of functional yoghurt fortified with 0.1, 0.25 and 0.5 per cent purified TSKP

| Attributes | Control | YT1 | YT2 | YT3 | F value |
|---|---|---|---|---|---|
| pH | 3.52±0.02a | 3.87±0.01b | 3.95±0.03bc | 4.02±0.06c | 41.08** |
| Acidity (%LA) | 0.77±0.00d | 0.75±0.00c | 0.74±0.00b | 0.72±0.00a | 48.11** |
| Fat (%) | 4.05±0.08 | 4.15±0.06 | 4.00±0.10 | 4.13±0.11 | 0.93NS |
| Total solids (%) | 14.76±0.08 | 14.85±0.04 | 14.85±0.04 | 14.85±0.04 | 0.75NS |
| Specific gravity | 1.04±0.00 | 1.03± 0.00 | 1.03±0.00 | 1.03±0.00 | 1.40NS |

Control – Plain yoghurt
YT1 – Yoghurt with 0.1% tamarind seed kernel powder YT2 – Yoghurt with 0.25% tamarind seed kernel powder YT3 – Yoghurt with 0.5% tamarind seed kernel powder
Mean bearing different superscripts within columns differ significantly.
NS – Non significant (P > 0.05); ** – Highly significant (P ≤ 0.01)

**Sensory parameters of functional yoghurt enriched with purified tamarind seed kernel powder**

Sensory scores obtained through the 9 point hedonic scale were mentioned in Table 2 and Fig.1. Appearance scores of plain and 0.1, 0.25 and 0.5 per cent purified TSKP incorporated yoghurts were 8.67±0.21, 8.17±0.17, 8.00±0.26 and 7.33±0.33 respectively. The scores for appearance showed a significant (p≤0.05) difference. The acceptability with appearance decreased with increasing proportion of the purified TSKP. The appearance score was highest for the control (plain yoghurt) and was lowest for yoghurt with 0.5 per cent purified TSKP which might be due to the consumer preference of the natural yoghurt. The purified TSKP fibre fortified yoghurts were darker and showed a brownish tinge compared to plain yoghurt.

The flavour, body and texture scores of plain, 0.1, 0.25 and 0.5 per cent purified TSKP incorporated yoghurts were 8.5±0.22, 8.17±0.17, 8.17±0.17 and 8.00±0.26 and 8.5±0.22, 8.33±0.21, 8.17±0.17 and 8.17±0.17 respectively. Overall acceptability of plain, 1.10.25 and 0.5 per cent purified TSKP incorporated yoghurts were 8.56±0.21, 8.22±0.16, 8.11±0.19 and 7.84±0.17 respectively. Flavour, body, texture and overall acceptability showed no significant difference among control and treatments. It was evident that except for appearance, other sensory parameters were almost similar to that of plain yoghurt and would gain a good response from the consumers.

**Table 2:** Sensory scores of functional yoghurt fortified with 0.1, 0.25 and 0.5 per cent purified tamarind seed kernel powder

| Sensory parameters | Control | YT1 | YT2 | YT3 | F value |
|---|---|---|---|---|---|
| Appearance | 8.67±0.21b | 8.17±0.17b | 8.00±0.26 ab | 7.33±0.33a | 4.85* |
| Flavour | 8.5±0.22 | 8.17±0.17 | 8.17±0.17 | 8.00±0.26 | 1.02NS |
| Body and texture | 8.5±0.22 | 8.33±0.21 | 8.17±0.17 | 8.17±0.17 | 0.68NS |
| Overall acceptability | 8.56±0.21 | 8.22±0.17 | 8.11±0.19 | 7.84±0.17 | 2.68NS |

Control – Plain yoghurt,
YT1 – Yoghurt with 0.1% tamarind seed kernel powder YT2 – Yoghurt with 0.25% tamarind seed kernel powder YT3 – Yoghurt with 0.5% tamarind seed kernel powder
Mean bearing different superscripts within columns differ significantly.
NS – Non significant (P > 0.05); * – Significant (P ≤ 0.05).

**Conclusion**

Incorporation of purified TSKP yoghurt had resulted in a product with good consumer acceptability which was evident with the sensory scores obtained. The pH values showed increasing trend with mean values of 3.52±0.02, 3.87±0.00, 3.95±0.03 and 4.02±0.06 for control and 0.1, 0.25, 0.5 per cent TSKP incorporated yoghurts respectively. This increase in pH was due to the influence of pH value of TSK powder. In correlation with increase in pH, there was a steady decrease in the titratable acidity. Yoghurt consumption has increased among all age groups, due to its surplus health benefits. The lack of dietary fibre in the yoghurt could be bridged with the incorporation of TSKP. Thus along with its beneficial microbial population, inclusion of purified TSKP with prebiotic potential would produce a positive symbiosis maintaining the gut health. Thus the TSKP along with the yoghurt could provide several health benefits as well as protect people from many of the diseases.

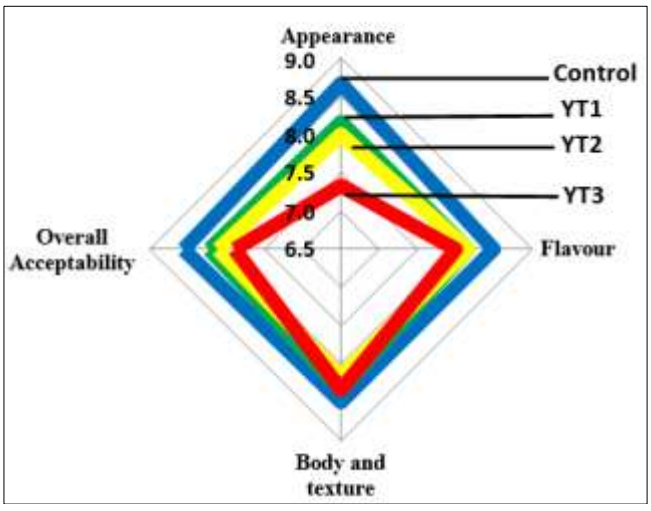



**Fig 1:** Sensory scores of functional yoghurt

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