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Process optimization and physico-chemical characterization of probiotic yoghurt supplemented with raw and roasted oats' powder

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Abstract
Value addition of yoghurt with functional ingredients like probiotics and oats' (*Avena sativa*) enhances its nutritive and bioactive value. Oats have gained significant importance due to β-glucan content and antioxidant potential whereas probiotic culture like *Bifidobacterium bifidum* BB-12 has shown to be potent for health befitting properties like antibacterial, immunomodulating and anti-cancer. Hence, an attempt was made, where the effect of different levels of starter culture inoculation, raw and roasted oats' powder on yoghurt were studied. Based on sensory evaluation, yoghurt with 2% starter culture, 4% *Bifidobacterium bifidum* BB-12 and 0.5% oats' powder secured the highest scores and was found to be optimum. The optimized probiotic yoghurt incorporated with raw oats' powder had 5.31, 61.95, 6.86, 16.34, 1.49 & 8.05% of moisture, carbohydrates, fat, protein, ash & crude fibre content respectively whereas, the corresponding values were 2.64, 64.01, 6.96, 16.82, 1.50 & 8.07% respectively for roasted oats' powder probiotic yoghurt.

Keywords: *Bifidobacterium bifidum* BB-12, oats, oats powder, probiotic yoghurt, yoghurt culture

Introduction

Today's market demand various nutritionally and therapeutically significant food products. Fermented food products have been part of our diet for ages and are found to be one of the best vehicles to add functional ingredients one such dairy-based fermented product is yoghurt. Probiotic-enriched yoghurt should contain at least 10^{10} cfu/g live microorganisms to provide basic health claims (Chávarri *et al*., 2010; Martirosyan & Singh, 2015; Tufarelli & Laudadio, 2016) [11, 27, 43]. It is observed that 65% of the global market is possessed by the functional food market which is mainly attributed to its bio-functional properties (Burgain *et al*., 2011) [9].

Archaeological evidence shows that process of fermentation is being used in foods for thousands of years. From time to time, fermentation was used in food products to enhance their shelf life and nutritive value. Currently, this technique is commonly practised in products of vegetables, fruits, cereals, meat, milk and fish. Fermented dairy products are an important part of fermented foods and their beneficial effects on health were investigated a hundred years ago. It is reported that consuming fermented dairy products enhances longevity. Also, fermented milk products have tremendous health-promoting properties, such as immunomodulating, antimicrobial, and anti-mutagenic activity for mammalian cell system and mutagens can bind by lactic acid bacteria etc. (Racedo *et al.*, 2009) [34]. Yoghurt can be defined as "A cultured product obtained by using *Streptococcus thermophilus* and *Lactobacillus delbrueckii ssp. bulgaricus*". It is believed to possess special nutritional attributes and its consumption seemed to be associated with the population having greater longevity (Farnworth, 2003) [15].

Yoghurt cultures produce certain metabolites which allow the native milk proteins to be digested and absorbed more rapidly than the native protein. Certain of these metabolites also have a definite antagonistic effect against food-borne pathogens. It is also well supported that lactose-intolerant individuals may be able to consume yoghurt without any adverse health effects. improving the immune function (Hummelen *et al*., 2011) [22], decreasing dental issues (Bafna *et al*., 2018) [6], diarrhoea (Noorbakhsh *et al*., 2019) [31], resistance to antibiotic pathogens (Hill *et al*., 2017) [21], preventing irritable bowel syndrome (IBS) (Noorbakhsh *et al*., 2019) [31], tackling gastrointestinal and respiratory-related infection (Suzuki *et al*., 2017) [40], lowering CVD risks, (Bayat *et al*., 2016) [7], improved glucose metabolism (Mohamadshahi *et al*., 2014). The effectiveness of probiotic bacteria depends on various parameters like strain viability, and dosage level however, every cell and its pieces either live or dead has some beneficial effects (Suharja *et al*., 2014) [39].

Yoghurt or yoghurt like products has been used as the most popular vehicle for the incorporation of probiotic organisms. Bacteria, especially probiotics, grown during fermentation have positive effects on health such as improvement in the digestive system, lowering effects on cholesterol, improvement in the immune system, beneficial for lactose intolerance, and having anti-mutagenic effects. Probiotics are the live microbial feed supplement, which beneficially affects the host animal by improving the intestinal microbial balance. Probiotic fermented milk is one major segment of fermented milk that has tremendous potential for growth and development (Champagne *et al.*, 2005) [10]. Milk is an excellent medium to carry or generate live and active cultured dairy products. The technology of application of probiotic organisms in fermented dairy products aims to combine the potential health benefits of the bacteria with their ability to grow in milk, resulting in a nutritionally healthy and desirable product for the consumers. The generally used probiotic organisms are Bifidobacterium and Lactobacilli. It has been recommended that foods containing such bacteria should contain at least 10^{10} live organisms per gram or ml of product at the time of consumption in order to provide therapeutic benefits.

Further probiotic products consumed in sufficient quantity provide health beneficial ample properties such as antagonistic effects, immunomodulating, growth of beneficial microflora, anti-microbial, diarrhoea, hypercholesterolemia, anti-obesity, irritable bowel syndrome etc *(*Gibson *et al*., 2017; Hill *et al*., 2014, Kobyliak *et al*., 2016; Lau & Chye, 2018) [18, 20, 24, 25]. Supplementation of bifidobacteria has been shown to influence immune parameters such as stimulation of local IgA production as well as other beneficial effects such as synthesis of folate (Mattila-Sandholm *et al.*, 2002) [29] are well known. *However*, Fuller (1989) [17] reported that probiotics have the following properties and functions: (i) Adherence to host epithelial tissue, (ii) Acid resistance and bile tolerance, (iii) Elimination of pathogens or reduction in pathogenic adherence, (iv) Production of acids, hydrogen peroxide and bacteriocins antagonistic to pathogen growth, (v) Safety, non-pathogenic and non-carcinogenic, and (vi) Improvement of intestinal microflora, (vii) Have generally regarded as safe (GRAS) status, (viii) Normal inhabitants of the intestinal tract of human, (ix) Technically suitable for process application.

Milk and milk products lack some nutrients, value addition is one such key process to fulfilling those requirements by introducing them to milk and milk products. Cereal and cereal products are one of the functional ingredients which exhibit health benefits in fermented milks. Among the cereals, Oats (*Avena sativa*), a cereal grain which is now gaining importance in the human diet because of their health-promoting benefits. Oats belong to the family of ‘Poaceae’. Food application of oats in different forms includes oatmeal, oat flour, oat bran and oat flakes as breakfast cereals and ingredients (Norja and Lehtinen, 2008) [23]. Oats have ample therapeutic properties and are best known for their high protein and fibre content along with cholesterol plummeting abilities. Nutritionally oats are an excellent source of soluble fibre in the form of β-glucans, besides α tocopherols, B vitamins, minerals, proteins, and plant fats. Oat is free from lactose and provides minerals and phytochemicals which can protect against diseases including cardiac arrest and cancer. The beneficial effects are chiefly due to the soluble fibre content of oats (Ahmad *et al.*, 2014; Masood *et al.*, 2008) [2, 28]. Today, oats’ is among the richest and most economical sources of soluble dietary fibre. Moreover, it is permitted by the FDA to claim health benefits for oat supplemented products when 0.75 g of β-glucan is consumed in a serving portion (FDA, 1997) [16].

Milk and most milk products are devoid of dietary fibre and awareness have been created, in such a way that there is a need to include dietary fibre in one’s diet. The value addition of yoghurt with oats helps in producing such health-promoting products without compromising the taste and texture and quality (AACC, 2001) [1]. β-glucan is a major source of soluble fibre fraction present in oats. Oat β-glucan is a viscous polysaccharide made of monosaccharides D-glucose, which comes from oat kernels. About 20–30 per cent of the total weight of oat kernel. In its unprocessed state, the oat kernel contains approximately 85 per cent insoluble dietary fibre, whereas the hull content is less than 5 per cent. The Food and Drug Administration (FDA) has accepted a health claim stating that a daily intake of 3 g of soluble oat β-glucan can lower the risk of coronary heart disease (Berg *et al.*, 2003, Head *et al.*, 2010) [8, 19]

In addition, dietary fibre promotes beneficial physiological effects such as hypoglycaemic, anti-microbial, anti-oxidant, cholesterol reduction, weight management and many more. Increasing awareness of the therapeutic benefits of dietary fibre among the consumers has led to the production of many readily available commercial dietary fibre products, this has led to the successful development of various dietary fibre fortified dairy products such as cheese, imitation cheese, probiotic ice cream, dairy desserts (Amarnath, 2017; Singh *et al.*, 2012) [3, 38]. Further, oat’s fibre acts as a prebiotic and may enhance its therapeutic value like antioxidant and hypoglycaemic properties (Tapola *et al.*, 2005; Pereira *et al.*, 2013) [42, 32]. The incorporation of probiotic yoghurt with oats’ powder may enhance health benefits. Hence, as dairy industries are evolving with new technologies and products, the product formulated in this study will benefit the dairy industry.

Materials and Methods

All the studies were carried out at the Post Graduate Laboratory of Dairy Chemistry, Dairy Microbiology, and Dairy Technology Department, Dairy Science College, Karnataka Veterinary, Animal and Fisheries Sciences University, Regional Campus, Bengaluru. KMF “Nandini” brand cow milk having 3.5 per cent fat and 8.5 per cent SNF was used for the production of yoghurt. Cleaned and dehulled organic oat groats were procured from Sattvic foods, Goa. Mixed culture of yoghurt containing *Streptococcus thremophilus* and *Lactobacillus delbrueckii* ssp. *bulgaricus* in the ratio 1:1 (YO-MIX) was procured from Danisco company. *Bifdobacterium bifidum* BB-12 single strain culture was procured from Christian Hansen company and the same was used as the probiotic culture for developing the yoghurt. polypropylene (PP) plastic cups with lids were used as the packaging material for the packaging of yoghurt. Roasting of oats powder and process optimization to develop probiotic yoghurt supplemented with oats powder are shown in Fig 1 and 2, respectively.

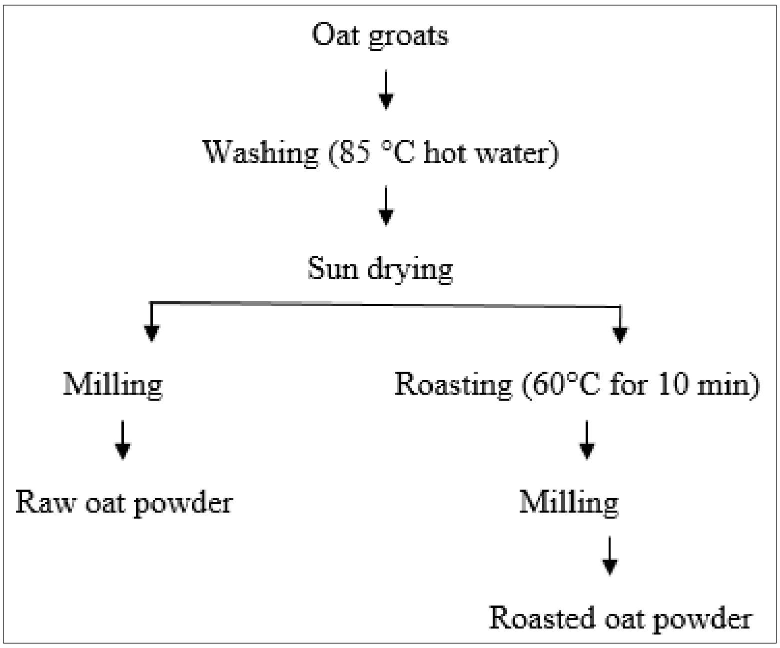

Fig 1: Flow chart for the preparation of raw and roasted oats' powder

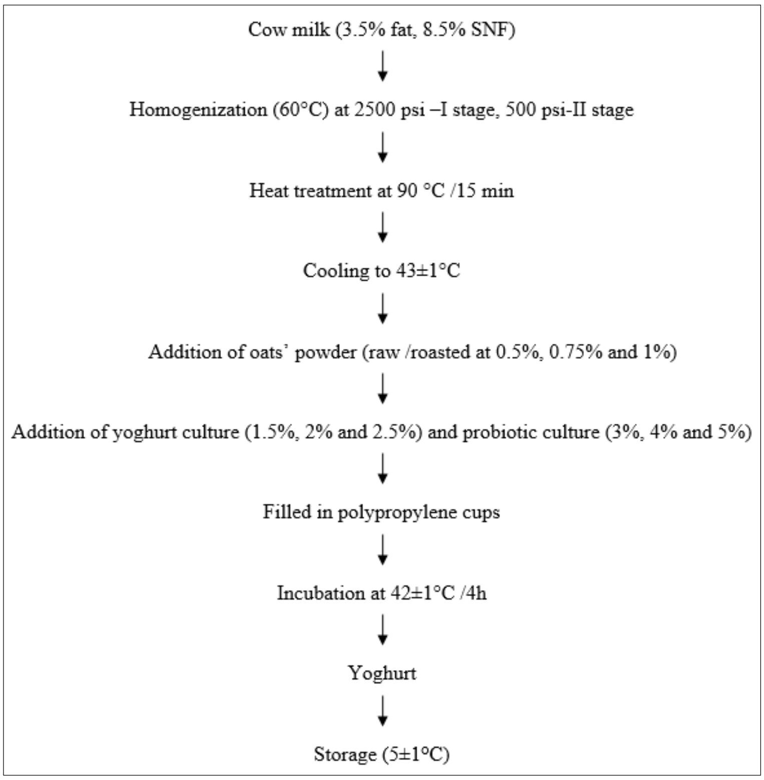

Fig 2: Flow Diagram for preparation of modified probiotic yoghurt

Compositional analysis of raw and roasted oat powders supplemented probiotic yoghurt

Physicochemical analysis: Fat, Protein, Total ash, Moisture, Total solids, Carbohydrates, pH and Titratable acidity of raw and roasted oat powders and respective probiotic yoghurt were determined as per ISI: SP 18 (Part XI) 1981. The total fibre content of raw and roasted oats' powders and their respective probiotic yoghurt was determined by the AOAC method (1980). Syneresis of optimized probiotic yoghurt sample was determined by centrifuging 35g sample at 1100 rpm for 10 min at 5°C. The clear supernatant was poured off, weighed and recorded as syneresis (%) as per the procedure described by Ares *et al.* (2007) [5]. The chemicals and reagents used were of analytical reagent grade.

Sensory Evaluation: Samples were given to a panel of five judges. Each judge was provided with a standard scorecard of a total of 9 Point Hedonic Scale for colour and appearance, body and texture, flavor and overall acceptability. The scores given by the panel of judges were then statistically analysed. The samples were code numbered to avoid identification and bias (Pimentel *et al.*, 2016) [33].

Statistical analysis: The results (average of 3 trials) were analysed statistically for the test of significance by using ANOVA as per R-software (R i386 3.4.3 Revised)

Results and Discussion

Optimization of probiotic yoghurt: Raw and roasted oats' powder was incorporated at 0.5, 0.75 and 1 per cent; different levels of yoghurt cultures and probiotic culture were added @ 1.5, 2 and 2.5 per cent and 3, 4 and 5 per cent, respectively. After culture inoculation, the samples were incubated at 42±1°C for 4 h and later subjected to sensory evaluation.

Effect of addition of different levels of starter culture on the sensory attributes of yoghurt

To optimize yoghurt with a starter culture (*Streptococcus thermophilus* and *Lactobacillus delbrueckii* ssp. *bulgaricus*) the levels used were 1.5, 2 and 2.5 per cent. The results pertaining to the effect of different levels of starter culture in yoghurt on sensory attributes are delineated in Table (1). Based on sensory scores, no significant difference was observed in colour and appearance of the yoghurt samples. A significant difference was observed with body and texture which could be attributed to the higher level of acid production by increased level of yoghurt culture leading to the formation of firm curd. The highest score was awarded to the 2 per cent culture sample may be due to the superior body and texture of yoghurt ascribed to the development of higher acid production and this may be the reason for the firm body and texture. This is in accordance with the findings of Chidanand (2003) [12] who developed by using a 2% level of inoculum in egg white-based yoghurt. The mean sensory scores for flavour and sourness of the yoghurt prepared by using 2 per cent inoculum were awarded higher than the sensory scores. The acetaldehyde is the main reason for the flavour of the yoghurt besides the acidity. The formation of the acetaldehyde component is governed by many factors. This is in conformity with the reports of Tamime and Robinson (2007) [41] and also with the findings of Ekinci and Gurel (2008) [14] in the preparation of yoghurt using propionic bacteria as an adjunct culture. The lower and higher sensory scores for 1.5 and 2.5 per cent inoculated yoghurt culture levels may be attributed to lower and higher acetaldehyde and acid production content in the yoghurt, respectively. Overall, the yoghurt prepared by inoculating 2 per cent yoghurt culture was awarded maximum scores for overall acceptability attributes of 1.5 and 2.5 per cent. Hence, yoghurt with a 2 per cent yoghurt culture was adjudged as the optimum level of starter culture for yoghurt preparation compared to control. This level was optimized and used in further studies.

Table 1: Effect of addition of different levels of starter culture on the sensory attributes of yoghurt

Level of starter culture (%)	Sensory attributes				
	Colour and appearance	Body and texture	Flavour	Sourness	Overall acceptability
1.5	8.29^{a}	7.93^{a}	7.91^{a}	7.98^{a}	7.70^{b}
2.0	8.45^{a}	8.22^{a}	8.20^{a}	8.27^{a}	8.46^{a}
2.5	8.25^{a}	7.50^{b}	8.00^{a}	7.76^{b}	7.58^{b}
CD ($P \leq 0.05$)	0.24	0.33	0.37	0.45	0.53

Note: All the values are averages of three replicates; On a 9-point hedonic scale; CD: Critical difference; Similar superscripts indicate non-significant at the corresponding critical difference

Effect of addition of different levels of probiotic culture on the sensory attributes of yoghurt

The probiotic culture was added at three different levels i.e., 3, 4 and 5 per cent and then subjected to sensory evaluation. The effect of different levels of probiotic cultures and sensory scores of overall sensory attributes is depicted in Table 2. Yoghurt with a 4 per cent probiotic culture had overall higher sensory scores. This level of inoculation had ideal colour and appearance, firmer body and texture, optimum flavour, sourness and/or acidity with practically free of wheying-off whereas 3 and 5 per cent probiotic inoculation resulted in a lack of uniform colour and appearance, thin and loose body and texture, and with an increase in level, the intensity of sourness and the acidic flavour was increasing with whey separation. In addition, 3 per cent level scored lesser due to lower-level production of acidity due to slow acid production and dominancy by yoghurt culture that might have led to slow growth of the probiotic culture. Bifidobacteria produce both lactic acid and acetic acid but higher amounts of acetic acid are produced (Rasic, 1983). However, from the results obtained, it can be observed that with 5 per cent Bifidobacterium inoculation, sensory scores were lower which may be due to developed acidity and subsequent drop in pH which are in accordance with Dave and Shah (1998) [13], who reported that drop in pH was observed in yoghurt with a higher level of probiotic culture. Also, these findings are in agreement with the findings of Lokesha (2006) [26] and Santhosh (2017) [37] in the production of improved consistency of enriched probiotic yoghurt drink and stirred yoghurt enriched with mango, pineapple juice and finger millet respectively. Hence, the level of 4 per cent probiotic culture was selected as an optimum level for the preparation of probiotic yoghurt and this level was used in further studies.

Table 2: Effect of addition of different levels of probiotic culture on the sensory attributes of modified yoghurt

Level of probiotic culture (%)	Sensory attributes				
	Colour & appearance	Body and texture	Flavour	Sourness	Overall acceptability
Control	8.45^{a}	8.22^{a}	8.20^{a}	8.27^{a}	8.46^{a}
3	7.97^{a}	7.72^{b}	7.77^{a}	7.72^{a}	7.71^{ab}
4	8.10^{a}	8.05^{a}	8.00^{a}	8.25^{a}	8.02^{ab}
5	7.90^{b}	7.80^{a}	7.70^{b}	7.70^{b}	7.82^{b}
CD ($P \leq 0.05$)	0.53	0.49	0.46	0.56	0.52

Note: All the values are average of three replicates, On a 9-point hedonic scale, Control: Cow milk yoghurt, CD: Critical difference; Similar superscripts indicate non-significant at the corresponding critical difference

Effect of addition of different levels of raw oats' powder on the sensory qualities of probiotic yoghurt: The optimization of probiotic yoghurt with raw oats' powder was carried out using raw oat powder at the levels of 0.5, 0.75 and 1 per cent. The sensory score revealed that probiotic yoghurt with 0.5 per cent raw oats' powder has been awarded the highest score in all sensory attributes with superior characteristics. The addition of raw oats' powder above 0.5 per cent significantly affected the overall acceptability of the product (Table 3). According to sensory evaluation, above 0.75 per cent incorporation, overall sensory attributes score was declining which is mainly attributed to undesirable whitish brown colour, masking off natural flavour, colour and appearance. In the case of body and texture, with the surge in level of raw oats' powder above 0.5 per cent, scores were reduced which is mainly due to visible oat powders spec, settling of raw oats' powder, lack of firmness, intense raw oats flavour, increased acidity and wheying off. This is in accordance with reports of Singh *et al*., (2012) [38] that as the oats level increases, the oat fibre decreases the softness and resiliency of the yoghurt gel and reduces water in the gel causing syneresis. However, the typical flavour of probiotic yoghurt is mainly attributed to its acetaldehyde content in it. This undesirable flavour and higher acidity in ROP probiotic yoghurt were similar to findings with respect to an increase in flavour for 2 per cent oats' powder incorporation in probiotic Dahi as reported by Ramanathan and Sivakumar (2013) [35]. Overall, scores for sourness were decreasing which may be contributed mainly by probiotic organisms by utilizing oat powder and the formation of lactic acid and acetic acid leading to higher sourness in the product. This is in accordance with the findings of Rasic (1983) that, Bifidobacteria produce both lactic acid and acetic acid by utilizing the probiotic components. Hence, a 0.5 per cent level was optimized to develop raw oats' powder supplemented probiotic and was found significantly different compared to control and other yoghurt samples.

Table 3: Effect of addition of different levels of raw oats' powder on the sensory attributes of probiotic yoghurt

Level of raw oats' powder (%)	Sensory attributes				
	Color and appearance	Body & texture	Flavour	Sourness	Overall acceptability
Control	8.10^a	8.05^a	8.00^a	8.25^a	8.02^a
0.50	8.05^a	7.91^a	7.97^a	7.89^a	7.81^a
0.75	7.75^a	7.47^a	7.61^a	7.56^a	7.28^b
1.00	7.50^a	7.24^b	7.40^b	7.36^b	7.02^b
CD ($P \leq 0.05$)	0.67	0.66	0.57	0.62	0.67

Note: All the values are averages of three replicates; on a 9-point hedonic scale; Control: Probiotic yoghurt with 2 per cent yoghurt culture, 4 per cent probiotic culture and without raw oats' powder; Similar superscripts indicate non-significant at the corresponding critical difference

Effect of addition of different levels of roasted oats' powder on the sensory qualities of probiotic yoghurt

The results and scores pertaining to the selection of different levels (0.5, 0.75 and 1 per cent) of roasted oats' powder for the preparation of roasted oats' powder supplemented with probiotic yoghurt are shown in Table 4. The results observed were in a similar trend as that of raw oats powder supplemented probiotic yoghurt were above 0.5 per cent inoculation, and the sensory scores were significantly declining. It was observed that a higher level of addition i.e. 0.75 and 1 per cent, affected colour and appearance which masked the natural yoghurt's characteristics. However, the maximum body and texture score was awarded to the probiotic yoghurt sample incorporated with 0.5 per cent level of roasted oats' powder and the minimum score to the sample incorporated with 0.75 and 1 per cent roasted oats' powder due to the formation of whey-pockets and lack of textural characteristics as Bifidobacterium utilizes components present in roasted oats powder. Overall, 0.5 per cent supplemented probiotic yoghurt had optimum colour and appearance, firmness, free from wheying-pockets and particulate settling, and uniform texture. Similar findings were reported by Singh *et al.*, (2012) [38] where a higher level of oats affected the softness, syneresis and resilience of yoghurt gel. So, with an increase in levels of roasted oats powder, sensory and quality characteristics were diminishing. Further, statistical analysis revealed that the different levels of addition of roasted oats' powder were non-significant with the control at 0.5 and 0.75 per cent level of incorporation but at 1 per cent level of incorporation showed significant difference with control in accordance with sensory characteristics. Hence, 0.5 per cent of roasted oats powder was optimized for preparation of probiotic yoghurt supplemented with roasted oats' powder.

Table 4: Effect of addition of different levels of roasted oats' powder on the sensory attributes of modified probiotic yoghurt

Level of roasted oat powder (%)	Sensory attributes				
	Color and appearance	Body & texture	Flavour	Sourness	Overall acceptability
Control	8.10^a	8.05^a	8.00^a	8.25^a	8.02^a
0.50	7.64^a	7.60^a	7.78^a	7.89^a	7.51^a
0.75	7.50^a	7.50^a	7.40^b	7.64^a	7.39^b
1.00	7.41^b	7.39^b	7.34^b	7.57^b	7.28^b
CD ($P \leq 0.05$)	0.66	0.59	0.58	0.63	0.62

Note: All the values are average of three replicates; On a 9-point hedonic scale; Control: Probiotic yoghurt with 2 per cent yoghurt culture, 4 per cent probiotic culture and without roasted oats' powder; Similar superscripts indicate non-significant at the corresponding critical difference

Physico-chemical characteristics of the optimized probiotic yoghurt supplemented with oats' powder: The optimized yoghurt with 2 per cent yoghurt culture, 4 per cent probiotic culture, 0.5 per cent raw oats' powder and 0.5 per cent roasted oats' powder were subjected to physical and chemical characteristics analysis, compared with the control (probiotic yoghurt). The results obtained are presented in Fig. 3, Table (5) and Table (6). Overall, a significant difference was observed in the developed sample compared to control in terms of pH, acidity, syneresis, moisture, fat, ash, fibre content and non-significant difference in protein and fat content.

Table 5: Physico-chemical characteristics of optimized probiotic yoghurt supplemented with oats' powder

Samples	Parameters		
	pH	Acidity	Syneresis (%)
Control	4.81^{a}	0.81^{a}	19.60^{a}
R1	4.87^{b}	0.78^{b}	19.64^{b}
R2	4.88^{b}	0.79^{b}	19.68^{b}
CD ($P \leq 0.05$)	0.03	0.01	0.02

Note: All the values are average of three replicates; Control: Probiotic yoghurt; CD: Critical difference; R1: Probiotic yoghurt with 0.5% raw oats' powder, R2: Probiotic yoghurt with 0.5% roasted oats' powder; similar superscripts indicate non-significant at the corresponding critical difference

Table 6: Gross composition of optimized probiotic yoghurt supplemented with oats' powder

Yoghurt	Constituents (%)						
	Moisture	Protein	Fat	Lactose	Total solids	Ash	Fibre
Control	88.44^{a}	3.43^{a}	3.55^{a}	3.96^{a}	12.06^{a}	0.72^{a}	--
R1	87.87^{b}	3.57^{a}	3.66^{a}	3.98^{a}	12.13^{b}	0.92^{b}	0.01
R2	87.71^{b}	3.58^{a}	3.79^{b}	3.98^{a}	12.29^{b}	0.94^{b}	0.01
CD ($P \leq 0.05$)	0.13	0.17	0.17	0.09	0.08	0.04	--

Note: All the values are average of three replicates, Control: Probiotic yoghurt; CD: Critical difference, R1: Probiotic yoghurt with 0.5% raw oats' powder, R2: Probiotic yoghurt with 0.5% roasted oats' powder, similar superscripts indicate non-significant at the corresponding critical difference

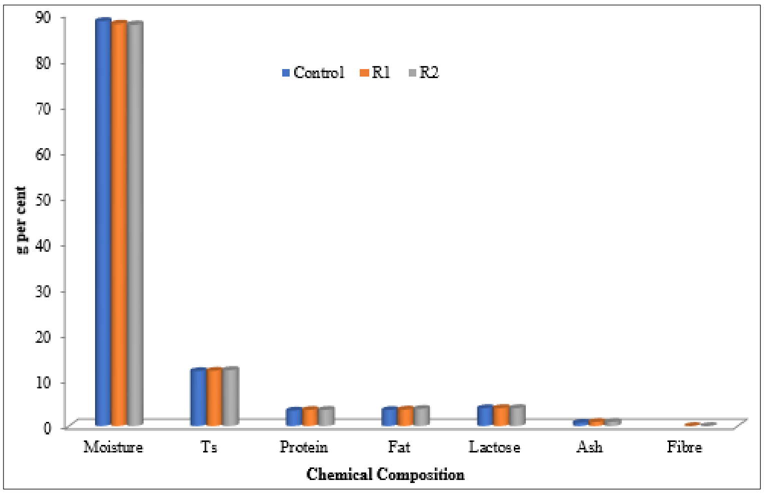

Fig 3: Gross composition of optimized probiotic yoghurt supplemented with oats' powder

Conclusion

This investigation was mainly focused on exploring the inconclusion of probiotic culture (*Bifidobacterium bifidum* BB-12) and supplementing it with raw and roasted oats' powders to enhance its nutritive and bio-functional value. Efforts were made to investigate the effect of different levels of yoghurt cultures, probiotic cultures, raw oat powder, roasted oat powder and the sensory, and physicochemical characteristics of developed probiotic yoghurt. Based on sensory judgements pertained, yoghurt incorporated with 2 per cent yoghurt culture, 4 per cent probiotic culture, and 0.5 per cent of raw and roasted oats powder, respectively, was found to be superior compared to control probiotic yoghurt. Supplementing the functional ingredient i.e. oats powder has slightly affected the overall compositional characteristics of the probiotic yoghurt giving the additional benefit of fibre content which the yoghurt lack. Further investigation is required to prove the effectiveness of this inclusion for their bio-functional and health beneficiary effects.

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