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A study on impact assessment of oat milk on the sensory attributes of iron fortified yoghurt

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Abstract
Yoghurt a fermented milk, is believed to possess special nutritional attributes. Yoghurt is similar to dahi in its physical appearance; it possesses excellent nutritional and therapeutic properties. Oats belongs to the family of *poaceae* and is commonly known as *Avena sativa.* About 6% of oats grains are used for human nutrition. Oat milk used in the preparation of oat milk blended yoghurt. Major constituents are moisture (88.02), protein (1.76), fat (2.00), total solids (11.39), ash (0.86) and crude fibre (0.8). The oat milk exhibited a higher percentage protein and fat optimize the levels of cow milk and oat milk for preparation of cow milk oat milk blended yoghurt were taken at 90:10, 80:20 and 70:30 ratios and subjected for sensory evaluation. It was observed that the ratio of 80:20 of cow milk-oat milk blend was best acceptable based on the sensory evaluation. Sensory evaluation by panel of five judges showed that the maximum sensory scores were given to the cow milk-oat milk blended yoghurt due to the typical flavor of oat.

Keywords: Yoghurt, oat, sensory and optimize

1. Introduction

Fermentation is a method that has been used for thousands of years to provide longer shelf life for perishable foods and to increase the flavor and odor of final food products [1]. Of all, cultured milk products, yoghurts are well known and most popular worldwide [2]. Like milk, yoghurt is a healthy and delicious food due to its high nutritive and therapeutic value [3]. Good quality yoghurt should be smooth, glossy surface, no crakes or holes on the top of yoghurt, no whey syneresis, no off flavor or odor, clean layer on the surface of yoghurt. Yoghurt is generally considered as a safer product and its unique flavor appeals to so many that consideration is being given by nutritionists to incorporate inexpensive source of nutrients to make it an almost complete food [4]. In general, adding one or more essential nutrients to a food and increasing their concentration in that particular food to levels higher than normal is known as fortification and is aimed at preventing and correcting deficiencies in one or more nutrients in the society or specific population groups [5]. Nutrition scientists have mentioned that fortification of food products is one of the best ways to improve the overall nutrient intake. Oats are the seeds of the plant *Avena sativa*, a cereal grain that has been commonly consumed as whole grains and known to provide healthy nutrients to humans. The attenuation of postprandial plasma glucose and insulin levels and the control of cholesterol can be ascribed to the partly soluble and viscous dietary fibers found in oats [6]. Nutritionally oats are an excellent source of soluble fiber in the form of beta-glucans, alpha tocopherols, B vitamins, minerals, proteins, and plant fats. The beneficial nutritional properties of oats have attracted attention from researchers and have resulted in the food industry wishing to use oats as a food ingredient more extensively. Oat milk is free from lactose, provides minerals and phytochemicals which can protect against diseases including cardiac arrest and cancer. Oat milk is second most common vegetable milk in Europe. It is suitable for people suffering from milk protein allergy or lactose intolerance as well as to the people following special diets [7]. Iron deficiency anemia is still a prevalent nutritional problem, which affects 30% of the world's population. One of the cost-effective strategy for controlling iron deficiency anemia is the fortification of foods with fortificants such as ferric sodium EDTA and other ferrous salts. Milk and fermented milks can be potentially useful food vehicles for iron fortification [8]. Therefore, the purpose of this study was to identify blending of oat milk and fortification of iron sources that would cause minimal sensory deterioration in yoghurt.

2. Materials and Methods

2.1 Oat milk preparation

The procedure followed by (Patel and Ghosh, 2015) for preparation of oat milk was adopted with suitable modifications.

2.2 Control Yoghurt

The control yoghurt was prepared by using cow milk as per the procedure outlined by Lee and Lucey (2010)

2.3 Optimization of yoghurt with oat milk

Yoghurt samples were prepared by incorporation of oat milk into the cow milk in the following ratios of 10%, 20% and 30%. The yoghurt was manufactured as described by Lee and Lucey (2010). The resultant yoghurt was subjected for various physico-chemical analysis and served to a panel of judges along with the control to judge the sensory characteristics and overall acceptability. Based on sensory evaluation the best combination was selected and used for further studies.

2.4 Optimization of cow milk-oat milk blended yoghurt by fortifying with iron salts

Yoghurt samples were prepared by adding oats milk into the milk along with the fortification of iron salts at the levels of 5mg, 10mg, 15mg separately with (ferrous sulphate and ammonium ferric citrate) and the control yoghurt was prepared by using cow milk and oat milk blend. The yoghurt was manufactured as described by Lee and Lucey (2010). The resultant yoghurt was subjected for various physico-chemical analysis and served to a panel of judges along with the control to judge the sensory characteristics and overall acceptability. Based on sensory evaluation the best combination was selected and used for further studies.

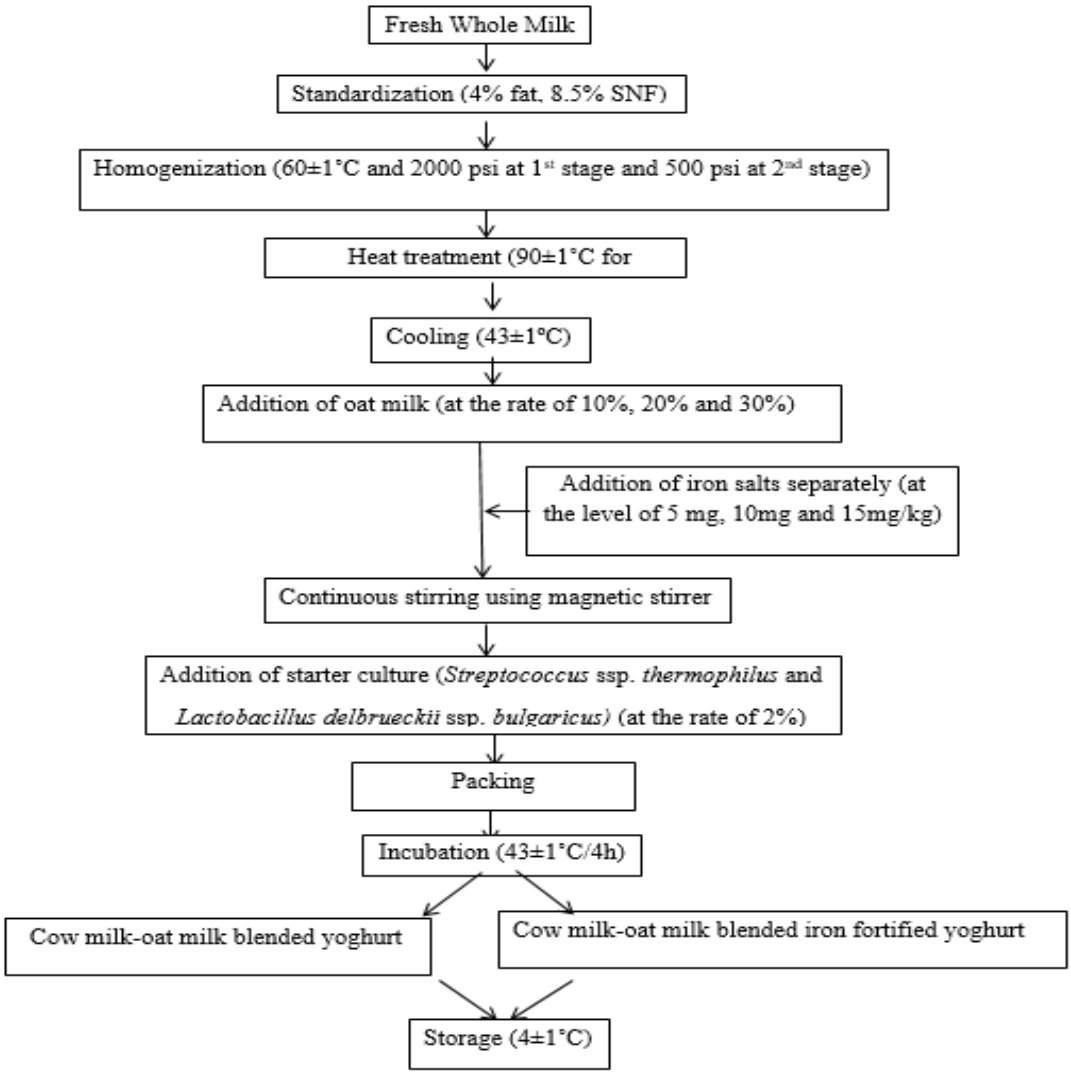

Fig 1: Flow Diagram for preparation of iron fortified cow milk and oat milk blended yoghurt

3. Results and Discussion

3.1 Sensory attributes of cow milk-oat milk blended dahi

It is observed from the sensory attributes (Table 1) that, the maximum score was secured by 20% oat milk blended yoghurt compared to 10% and 30% oat milk blended samples. The colour and appearance was not affected significantly by increasing the levels of oat milk. At 30% level of oat milk incorporation the score decreased due to the weaker body probably due to the lower total solids compared to 20 percent and 10 percent oat milk incorporation. Similar findings were observed by Singh *et al.*, (2012) in the yoghurt prepared using different levels of purified oat β - glucan. As regards body and texture attribute, maximum score was awarded to the yoghurt sample with 20 percent oat milk. This may be due to the decreased sourness and decreased syneresis, the score for body and texture also showed a decreasing trend on increasing the level of incorporation of oat milk. Similar findings were reported by Singh *et al.*, (2012), the increased concentration of oat β – glucan decreased softness and resiliency of the yoghurt gel and reduced water in gel caused

increased syneresis. However, there was no significant difference observed between the levels of cow milk-oat milk blends with respect to body and texture attribute. It is clear from the results that, there was an increase in scores for flavour attribute for cow milk-oat milk blended yoghurt with increase in the levels of oat milk. However, the scores were lower compared to control. The improved flavour score may be due to oat milk contributing a complex collection of volatile flavor components (Kale *et al.*, 2011) and the bland taste. The scores for sourness decreased with the increase in oat milk level. The reason may be attributed to the increased level of oat milk which reduces the lactose content in blends there by caused lesser amount of lactic acid decreased sourness. The overall acceptability score was maximum for control, followed by yoghurt with 20 percent oat milk. The sample with 20 percent oat milk showed optimum scores with respect to other sensory attributes like colour and appearance, flavor and body and texture. Hence, the panel of judges evaluated yoghurt with 20 percent oat milk with maximum overall acceptability scores. Similar findings with respect to increase in the sensory scores for 2 percent oat powder incorporation in yoghurt was reported by Ramanathan and Sivakumar (2013). Hence, the level of oat milk at 20 percent was selected as the optimum level for yoghurt preparation and this level was used in the further studies.

3.2 Sensory attributes of cow milk-oat milk blended yoghurt by fortifying with iron salts

- **Effect of different levels of Ferrous sulphate on sensory attributes of yoghurt**

As could be seen from the results of Table 2 for colour and appearance the highest score was observed for cow milk-oat milk blended yoghurt fortified with 10 mg ferrous sulphate / kg of yoghurt when compared with yoghurt fortified with 5 and 15mg ferrous sulphate /kg of yoghurt. Colour and appearance of yoghurt fortified with ferrous sulphate were not significantly affected by the different levels of ferrous sulphate which appeared natural yoghurt colour i.e., control samples up to level of 10mg ferrous sulphate /kg of yoghurt. These are in agreement with those reported by El-kholy (2011) and El-Din *et al*., (2012). Hekmat and McMahon (1997), who also reported that the consumer panels did not observe significant difference in the appearance of fermented product i.e., yoghurt fortified with iron. Yoghurt should possess a firm, custard- like body with a smooth homogeneous texture. The highest score was awarded for body and texture was observed yoghurt fortified with iron at 5 mg/kg level of ferrous sulphate. The yoghurt fortified with of 10 and 15 mg ferrous sulphate /kg of yoghurt showed slightly higher syneresis and weak body. The reason for higher syneresis and weak body might due to the fortification of salt at higher concentration. It is also clear from the Table 2 that, the optimum sensory score for flavour was obtained for ferrous sulphate at 5 and 10 mg ferrous sulphate /kg of yoghurt. The reason may be attributed due to higher level of fortification with ferrous sulphate at 15mg /kg of yoghurt imparted metallic flavour in the yoghurt. Hence, for the experimental studies an optimum level of 10 mg ferrous sulphate /kg of yoghurt was employed. The sensory score for sourness was higher for 10 mg ferrous sulphate /kg of yoghurt fortification in cow milk-oat milk blended yoghurt when compared to control, 5 and 15 levels of fortification. The decreased acidity was observed in yoghurt with 10mg ferrous sulphate /kg of yoghurt fortification when compared to all other yoghurt samples. The maximum scores for overall acceptability attribute was awarded to the product with 10mg ferrous sulphate /kg of yoghurt which have scores on par with the control, which had better scores for colour and appearance, flavor and body and texture. Hence the yoghurt fortified with 10mg ferrous sulphate /kg of yoghurt was selected.

3.3 Effect of different levels of ammonium ferric citrate on sensory attributes of yoghurt

The score for colour and appearance (Table 3) decreased with the increase in the fortification level of iron. However, there was no statistical difference that there is no effect of iron salt on the colour and appearance at all level. The reason may be attributed to decrease score because tinge brownish colour was observed at higher levels at 15mg ammonium ferric citrate /kg of yoghurt. Body and texture scored highest for 5 and 10 mg ammonium ferric citrate /kg of yoghurt but lesser than the control. The higher level of fortification at 15mg ammonium ferric citrate /kg of yoghurt was observed higher syneresis and weak body when compared at 5 and 15 mg iron/kg of yoghurt. However, there was no significant difference observed at different levels of iron fortification for body and texture attribute. It is clear from the results that, there was an increase in scores for flavour attribute with increase in fortification level. The yoghurt fortified with 15mg ammonium ferric citrate /kg of yoghurt secured highest score. The reason may be attributed due to decreased acidity. However there was no significant difference was observed at different levels with respect to flavour attribute. The sensory score for sourness increased with increase in fortification level. The increased scores may be due to the decreased developed acidity due to the fortification of iron salt. Higher level of fortification masked the developed acidity in the yoghurt. The maximum scores overall acceptability score was given to the product with 15mg/kg ammonium ferric citrate fortified yoghurt which have scores on par with the control, which had better scores for colour and appearance, flavor and body and texture. Hence, the yoghurt fortified with 15mg ammonium ferric citrate /kg of yoghurt was selected.

Table 1: Effect of different levels of oats milk on the sensory attributes of yoghurt

Level of oats milk (%)	Sensory attributes				
	Colour and appearance	Body and Texture	Flavour	Sourness	Overall Acceptability
Control	8.33^{a}	8.60^{a}	8.50^{a}	8.43^{a}	8.65^{a}
10	8.28^{a}	7.91^{b}	7.41^{b}	8.20^{b}	7.79^{b}
20	8.40^{a}	8.45^{b}	8.30^{c}	8.38^{b}	8.40^{c}
30	8.08^{a}	7.40^{c}	7.87^{b}	7.30^{c}	7.91^{c}
CD ($P \leq 0.05$)	NS	0.57	0.60	0.22	0.60

Control: cow milk yoghurt

Similar superscripts indicate non-significant at the corresponding critical difference

Table 2: Effect of different levels of ferrous sulphate on the sensory attributes of cow milk-oat milk blended yoghurt

Levels of ferrous sulphate (mg/kg yoghurt)	Sensory attributes				
	Colour and appearance	Body and Texture	Flavour	Sourness	Overall Acceptability
Control	8.40[a]	8.45[a]	8.30[a]	8.38[a]	8.40[a]
5	8.08[a]	8.12[a]	7.70[a]	8.10[b]	8.12[a]
10	8.45[a]	8.04[a]	7.58[a]	8.35[c]	8.29[a]
15	6.83[b]	6.91[b]	6.00[b]	7.21[d]	6.50[b]
CD ($P \leq 0.05$)	0.70	0.52	0.75	0.20	0.60

Control: cow milk yoghurt
Similar superscripts indicate non-significant at the corresponding critical difference

Table 3: Effect of different levels of ammonium ferric citrate on the sensory attributes of cow milk-oat milk blended yoghurt

Levels of Ammonium Ferric Citrate (mg/kg yoghurt)	Sensory attributes				
	Colour and appearance	Body and Texture	Flavour	Sourness	Overall Acceptability
Control	8.40[a]	8.45[a]	8.30[a]	8.38[a]	8.40[a]
5	8.05[a]	7.83[a]	7.25[b]	8.20[b]	7.90[a]
10	8.08[a]	7.83[a]	7.91[a]	8.45[a]	8.00[a]
15	7.95[a]	7.82[a]	8.33[a]	8.60[c]	8.16[a]
CD ($P \leq 0.05$)	NS	NS	0.79	0.13	NS

Control: cow milk-oat milk blended yoghurt at (80:20)
Similar superscripts indicate non-significant at the corresponding critical difference
NS: Non significant

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