

Effect of Supplementation of Oat Flour on Physicochemical and Sensory Properties of Lactose Hydrolyzed *Kulfi*

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Abstract:- In *kulfi* prepared with 70 % lactose hydrolyzed milk added with 7.8 % sugar, oat flour (2, 4 and 6 per cent) was separately incorporated in order to enrich β -glucan to *kulfi*. The effect of this functional ingredient on chemical composition, sensory attributes and physical properties such as melting rate and penetration value were studied separately. As the level of oat flour increased from 0 to 6 % the fat and protein content and specific gravity increased whereas melting rate, penetration value and the sensory evaluation scores decreased significantly. 70 per cent lactose hydrolyzed *kulfi* with 2 per cent oat flour was found better in physico-chemical and sensory attributes.

Keywords:- *Kulfi*, Oat Flour, B-Glucan, Functional and Sensory Properties.

I. INTRODUCTION

Oat (*Avena sativa*) is a cereal grain rich in dietary fiber as β -glucan and protein. Oats are a good source of beta glucan and as such a good source of dietary fiber (Weightman *et al.*, 2004). From *A. sativa* a wide range of chemical constituents like carbohydrates, proteins, avenanthramides, tocopherols, lipids, alkaloids, flavonoids, saponins and sterols have been reported (Singh *et al.*, 2013). Today, interest in oats is increasing and it retains a strong image as a nutritious, health promoting ingredient in food applications due to its high bioactive and functional component contents. Significant positive health effects have been attributed to oat products, including control of cholesterol, modulation of glucose and insulin responses, improved gastrointestinal function and weight management. Probably the most well-recognized health promoting ingredient from oats is a soluble fiber, β -glucans (Duss and Nyberg, 2004).

Beta Glucan is a polymer of D-glucose linked with glycosidic bonds at β (1 \rightarrow 3), β (1 \rightarrow 4), β (1 \rightarrow 6) and is typically found in the endosperm cell wall in oats, barley. Commercially β -glucan is obtained from oats, barley, mushrooms and some microorganisms. Beta glucan constitutes 1 per cent of wheat grains, 3-7 per cent of oats and 5-11 per cent of barley (Skendi *et al.*, 2003). Studies have indicated the hypocholesterolaemic effect of this

compound, leading to 20–30 per cent reduction of LDL-cholesterol, and to an expected overall effect of reduced cardiovascular disease risk (Gallaher, 2000). In 1997, the FDA of US has formally acknowledged as functional the products made of whole-grain oats or oat fiber with a minimum of 0.75 g β -glucan/ serving size (Angelov *et al.*, 2006).

Many studies have shown the use of beta glucan in yogurt and low fat ice creams. Brennan and Tudorica (2008), reported that β -glucan in skim milk yogurt decreased syneresis when compared to yogurt made with full fat milk. The decrease in syneresis was attributed to beta glucan's ability to create a three-dimensional network entrapping water. The low glycemic index of oat products is especially important for diabetics, and the ingestion of β -glucan containing viscous foods is reported to affect the level of fat emulsification in the gastro-intestinal tract and reduces lipase activity. The release of low-molecular fatty acids throughout beta-glucan fermentation within the colon preconditions its potential anti-carcinogenic effect (Gallaher, 2000). In addition, beta-glucan is thought as prebiotic, stimulating the growth of some beneficial residential colon microorganisms such as Bifidobacteria.

The consumer demand in the field of food production has changed considerably in the last decades. Today foods are not only intended to satisfy hunger and to provide necessary nutrients but also to prevent nutrition-related diseases and improve physical and mental well-being of the consumers (Siro *et al.*, 2008). In this regard, functional foods play an outstanding role in value addition. Although the inherent health benefits of milk still remain largely unexploited, milk based products can act as ideal vehicles for fortification and enrichment of these functional ingredients (Sharma, 2006).

Kulfi, a frozen dessert which is enjoyed by consumers of all ages, is a fair means of offering good nutrition to the consumer. If lactose hydrolyzed milk is used along with addition of oat flour powder, it becomes a functional *kulfi* and can extend therapeutic benefits to consumers. The objective of this study was to optimize the level of supplementation oat flour to *kulfi* prepared from 70 % lactose hydrolyzed milk.

II. MATERIALS AND METHODS

Ingredients Fresh whole milk was procured from Students Experimental Dairy Plant (SEDP) of Dairy Science College, Hebbal, Bengaluru. Fresh cream (40% fat and 6% SNF) which was obtained after separating the fresh whole milk and 'Sagar' brand skim milk powder were used for standardization of milk (fat 5%, SNF 8.5%). Good quality cane sugar was purchased from the local market. Carboxy Methyl Cellulose was used as the stabilizer and emulsifier in this study. Enzyme lactase (β -galactosidase), commercially available as 'LACTOZYM', manufactured by Novo Nordisk A/S, Denmark, 3000 LAU/ml activity, type HP-G was used for hydrolysing lactose. Oat groats were obtained from Satwik foods, Goa. The groats were roasted at 60- 70 °C for 10 to 15 min and powdered to obtain oat flour.

Preparation of lactose hydrolyzed kulfi 4 L of fresh milk was standardised to 5.0 per cent fat and 8.5 per cent SNF. The standardized milk was pasteurized and cooled to 40 °C. 1.5 ml/L of Lactozym was added and incubated at 40 °C for 90 min to obtain 70 % lactose hydrolysis. This milk was further used to prepare lactose hydrolyzed *kulfi* as per the procedure outlined by Salooja and Balachandran (1982).

Preparation of lactose hydrolyzed kulfi supplemented with oat flour To the *kulfi* prepared from the 70 % lactose hydrolyzed milk added with 7.8 % sugar, oat flour was added @ 2, 4 and 6 % on the basis of concentrated milk volume at 65 °C (at the final stage of condensation) and mixed thoroughly. This mix was cooled to 30 °C, filled into moulds and hardened at -18 °C.

Analytical methods Standard of ISI: SP 18 (Part XI) 1981 was adopted for carrying out chemical analysis such as fat, moisture, protein, lactose and ash contents.

Specific gravity of *kulfi* mix was estimated at 30 °C by using a standard specific gravity bottle of 50 ml capacity, taking distilled water as the standard liquid. The melting rate of the *kulfi* was observed by drawing 10g of the sample on to a wire net placed on a funnel over a beaker immediately after removal from the *kulfi* moulds. The time taken by the sample for complete melt down and dripping into the beaker at room temperature was noted. The melting rate was expressed as ml/15 min. Using a cone penetrometer, penetration value was determined as soon as *kulfi* were drawn from the molds after hardening. The distance in millimeter by which the cone travels in 5s of the sample was noted. For each sample reading were recorded at 3 different spots and the mean value was noted.

Sensory evaluation *Kulfi* samples were given to a panel of five judges for sensory evaluation. Each judge was supplied with standard score card of a total of 9 Point Hedonic Scale for colour and appearance, body and texture, flavor and overall acceptability. The scores given by panel of judges were then statistically analyzed. The samples were code numbered to avoid identification and bias.

Statistical analysis The results which are the average of three replications will be statistically analyzed by subjecting to statistical analysis (R Programme, R- Version 3.1.3) using ANOVA technique for one way analysis with independent samples that helps in interpretation (Zar, 2003).

III. RESULTS AND DISCUSSION

Effect of oat flour on chemical composition of lactose hydrolyzed kulfi The effect of supplementation of oat flour on the chemical composition of *kulfi* is presented in Table 1. It is evident that supplementation of oat flour affected moisture, fat and protein contents significantly.

Level of oat flour (per cent of <i>kulfi</i> mix)	Chemical constituents (per cent)				
	Moisture	Fat	Protein	Lactose	Ash
0 (control)	61.35 ^a	10.12 ^a	6.67 ^a	4.03	1.27
2	60.60 ^b	10.26 ^b	7.01 ^b	4.03	1.27
4	59.77 ^c	10.39 ^c	7.36 ^c	4.04	1.27
6	58.57 ^c	10.53 ^d	7.68 ^d	4.03	1.27
CD (P=0.05)	0.31	0.006	0.01	0.005	0.004

Table 1:- Effect of supplementation of oat flour on chemical constituents of lactose hydrolyzed *kulfi*

Note:

- Each value is mean of three trials
- Figures in a column with different alphabets differ significantly
- Control- 70 per cent lactose hydrolyzed *kulfi* with 7.8 per cent sugar

It was revealed from the data that as the level of addition of oat flour increased from 0 to 6 per cent, the moisture content decreased from the initial 61.35 to 58.57 per cent, respectively. The addition of oat flour increased the net

weight of *kulfi* which in turn decreased moisture content proportionately. It was observed that as the level of oat flour increased from 0 to 6 per cent the fat and protein content also increased significantly from 10.12 to 10.53 per cent and 6.67

to 7.68 per cent, respectively. According to the composition of oat flour prescribed by USDA (2009) 100 g of oat flour contains 6.9 g fat and 16.9 g protein (Singh *et al.*, 2013). The supplementation of oat flour at 2, 4 and 6 per cent levels contributed towards the increased fat percentages of 10.26, 10.39 and 10.53 compared to that of 10.12 per cent in control. Similarly the protein content also increased from 6.67 in control to 7.01, 7.36 and 7.68 per cent in case of 2, 4 and 6 per cent of oat flour supplementation, respectively.

Effect of oat flour on physical properties of lactose hydrolyzed kulfi The effect of supplementation of oat flour on the specific gravity, melting rate and penetration value of *kulfi* is presented in Table 2. It is apparent from the results that the supplementation of oat flour has significant effect on specific gravity, melting rate and penetration value. As the level of addition of oat flour in *kulfi* is increased from 0 to 6

per cent, the specific gravity also increased from 1.10 to 1.138, respectively. The specific gravity values for 0, 2, 4 and 6 per cent oat flour added *kulfi* was 1.10, 1.113, 1.123 and 1.138, respectively. Addition of oat flour increased the specific gravity due to higher water binding property of oat flour.

The study also revealed that as the level of addition of oat flour increased from 0 to 6 per cent, the melting rate and penetration value decreases significantly from 18.57 to 13.49 ml/15 min and 34.16 to 30.22 mm/5s, respectively, indicating that as the level of fibre increases greater quantities of water being bound by fibre, reducing the portion of free water resulting in significantly lower melting rate and penetration values of *kulfi* samples and as a result harder, compact body of *kulfi*.

Level of oat flour (per cent)	Physical properties		
	Specific gravity	Melting rate (ml/15 min)	Penetration value (mm/5s)
0(control)	1.100 ^a	18.57 ^a	34.16 ^a
2	1.113 ^b	16.36 ^b	32.27 ^b
4	1.123 ^c	15.31 ^c	31.44 ^c
6	1.138 ^d	13.49 ^d	30.22 ^d
CD (P=0.05)	0.001	0.27	0.26

Table 2:- Effect of supplementation of oat flour on physical properties of lactose hydrolyzed *kulfi*

Note:

- Each value is mean of three trials
- Figures in a column with different alphabets differ significantly
- Control- 70 per cent lactose hydrolyzed *kulfi* with 7.8 per cent sugar

These findings are in agreement with that of Giri (2007) in case of *kulfi* with 1 per cent dietary fibre. He reported a significant increase in specific gravity (Control *kulfi* without dietary fibre- 1.095, *kulfi* with 1 per cent dietary fibre- 1.104) and significant reduction in melting rate in ml/15 min (control- 12.58, *kulfi* with 1 per cent dietary fibre- 10.52) and penetration value in mm/5s (control- 30.96, *kulfi* with 1 per cent dietary fibre- 28.40).

Effect of oat flour on sensory attributes of lactose hydrolyzed kulfi The effect of supplementation of oat flour on the sensory attributes of *kulfi* is presented in Table 3. It is evident from the results that the control samples were rated higher for their sensory attributes in comparison to other experimental *kulfi* samples added with oat flour at different levels. It was revealed from the data that as the level of addition of oat flour increases the scores of all the sensory attributes were shown decreasing trend. As the level of oat flour in *kulfi* increased from 0 to 6 per cent, the scores for colour and appearance decreased significantly from initial 8.0

to 7.36, respectively. This may be due to the presence of oat flour particles, which were visible on the product body since oat flour is not soluble. Similar result was observed by Giri (2007) in *kulfi* supplemented with dietary fibre. He reported that control *kulfi* without dietary fibre scored 7.5 while the *kulfi* with 1 per cent dietary fibre scored 6 for colour and appearance on nine point hedonic scale. The body and texture scores also shown decreasing trend as the level of oat flour increased in *kulfi*. However there was no significant difference between the scores of control and *kulfi* added with 2 per cent oat flour. But 4 per cent and 6 per cent oat flour added *kulfi* shown significant decrease in the scores. Above 2 per cent level of addition the oat flour added *kulfi* possessed a heavy and chewy body due to greater water binding property of oat flour. This observation is in agreement with that of Giri (2007) in *kulfi* supplemented with dietary fibre. He reported that as the level of dietary fiber in *kulfi* increased from 0 to 1 per cent the body and texture score decreased from 8 to 6 on nine point hedonic scale.

Addition of oat flour (per cent of <i>kulfi</i> mix)	Colour & appearance	Body & texture	Flavour	Overall acceptability
	Scores on nine point hedonic scale			
0 (control)	8.00 ^a	7.90 ^a	8.50 ^a	8.08 ^a
2	7.84 ^b	8.04 ^a	7.67 ^b	7.85 ^b
4	7.49 ^c	7.85 ^b	7.31 ^c	7.63 ^c
6	7.36 ^d	7.73 ^c	7.27 ^c	7.40 ^d
CD (P=0.05)	0.05	0.10	0.08	0.08

Table 3:- Effect of supplementation of oat flour on sensory properties of lactose hydrolyzed *kulfi***Note:**

- Each value is mean of three trials
- Figures in a column with different alphabets differ significantly
- Control- 70 per cent lactose hydrolyzed *kulfi* with 7.8 per cent sugar

It can be also observed from the table that flavour scores also shown decreasing trend as addition of oat flour increased. There was significant difference in the flavour scores between the control and the other oat flour added *kulfi* samples. This may be due to the detectable powdery flavour contributed by the oat flour. Judges also noticed raw oat flavour in 4 and 6 per cent levels of oat flour addition. Chatterjee and Patel (2016) reported similar trend in 3 per cent oat fibre added chocolate flavoured milk. They observed that fibre addition decreased overall flavour quality (control- 7.45, sample- 7.23). Giri (2007) also observed a reduction in flavor score in *kulfi* from 8 to 5.9 when the *kulfi* is supplemented with 1 per cent dietary fibre. The judges rated control *kulfi* as more acceptable than oat flour added *kulfi* samples. As the level of oat flour increased from 0 to 6 per cent, the overall acceptability scores decreased from 8.21 to 7.40, respectively. This may be due to the powdery flavour and chewy body contributed by the oat flour. Giri (2007) also reported that fibre addition decreased the overall acceptability of the *kulfi* samples due to the chalky flavour and chewy body from 7.5 in control to 6.5 in case of *kulfi* with 1 per cent dietary fibre.

IV. CONCLUSION

The present investigation was carried out to develop lactose hydrolyzed *kulfi* supplemented with oat flour. The effect of supplementation of oat flour on chemical composition, physical properties and sensory attributes shows that, as the level of oat flour increased from 0 to 6 % the fat and protein content and specific gravity increased whereas melting rate, penetration value and the sensory evaluation scores decreased significantly. 70 per cent lactose hydrolyzed *kulfi* with 2 per cent oat flour was found better in physico-chemical and sensory attributes than 4 % and 6 % oat flour added 70 % lactose hydrolyzed *kulfi*.

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