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Development and sensory analysis of a buttermilk based fermented drink using barley and fructooligosaccharide as functional ingredients

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Abstract
Background: Functional foods are getting popularity in the world, due to tremendous health benefits conferred by specific components of these foods. During the last few decades the interest and demand for both healthy food and value added beverages has increased and its demand is expected to rise in the future.
Objective: The present study was done to develop a buttermilk based fermented drink using barley and fructooligosaccharide (FOS) as functional ingredients.
Materials and methods: Barley was cooked and fermented with buttermilk, followed by addition of FOS, flavors (rose, khus, chocolate and salt-jeera) and colors. Three successive trials were conducted to screen the panellists using threshold test. Sensory evaluation was done using composite score method, for the four drinks in triplicates. An internal panel of 24 semi trained members evaluated the products for color and appearance, mouthfeel, texture, taste, after taste, and overall acceptability.
Results: A significant difference was observed among drinks with different flavors. Salt-jeera flavor was liked most by all the panel members followed by rose. No after taste or bad mouthfeel was reported in any of the products.
Conclusion: Thus it can be concluded that locally available functional ingredients can be used to develop functional foods in form of foods and beverages. Addition of FOS as a prebiotic can be added to foods without affecting their sensory attributes. Development of such value added products shall also fulfil the increasing demand of health foods by the consumers.

Keywords: Functional food; fermentation; barley; prebiotic; fructooligosaccharide; sensory evaluation

Introduction
Functional foods are defined as foods that, in addition to their basic nutrients, contain biologically active components, in adequate amounts, that can have a positive impact on the health of the consumer (Marchand and Vandenplas, 2000; Tuorila and Cardello, 2002; Prado *et al*, 2008) [20, 33, 29]. Such foods should improve the general and physical conditions of the human organism and/or decrease the risk of occurrence of disease (Siró *et al*, 2008) [31]. These foods generally contain health-promoting components beyond traditional nutrients. One way of creating a functional food is by inclusion of ingredients such as probiotics and prebiotics to levels that enable the consumer to derive optimal health benefits. Prebiotics are non-digestible food ingredients that affect the host by selectively targeting the growth and/or activity of one or a limited number of beneficial bacteria in the colon, and thus have the potential to improve health (Gibson *et al*, 2004; Joanne, 2013) [11, 15]. Fructooligosaccharide a prebiotic, being a carbohydrate and having a sweet taste very similar to that of sucrose, (Yun, 1996) [35] it contributes minimum calories as compared to sucrose. Apart from being classified as a sweetener, it is also classified as a soluble fibre and can be used to increase the fibre without increasing the viscosity of food products (Guggisberg *et al*, 2011) [12] Fructooligosaccharide are also considered as bulking agents and fat substitutes in some foods, they have high solubility and they do not have any after taste or artificial taste (Crittenden *et al*, 1996) [6]. These properties of FOS can play a vital role in developing functional products.
Among cereals, barley is an excellent source of soluble and insoluble dietary fiber and other bioactive constituents, such as vitamin E, B-complex vitamins, enzymes, minerals, and phenolic compounds (Gamlath *et al*, 2008) [10]. It has one of the highest levels (up to 6%) of β-glucan, a water soluble polysaccharide nutritionally classified as soluble dietary fiber

(Izydorczyk and Dexter, 2008) [14]. The effectiveness of barley -glucan in lowering blood cholesterol (Newman *et al*., 1989; Behall *et al*., 2004) [23, 4] and glycemic index (Wood *et al*., 1990; Cavallero *et al*., 2002) [34, 5] has been reported in numerous publications and is widely accepted (Pins and Kaur, 2006) [27]. The Food and Drug Administration (FDA) have allowed whole grain barley and barley-containing products to carry a claim that they reduce the risk of coronary heart disease. Recent findings revealed that cereals also contain phenolic compounds that have antioxidant activity and prevent diseases in humans (Madhujith and Shahidi, 2007) [19]. The risk imposed by the consumption of free radicals and oxidation products towards various forms of cancer and cardiovascular disease could be lowered by the intake of dietary phenolics. The natural antioxidants in cereals may function as reducing agents, free radical scavengers, single oxygen quencher and potential complex of prooxidants (Sharma *et al*., 2012) [25]. Therefore, the consumption of barley should be encouraged as a human food. Thus, the present study was planned to develop a fermented drink using functional ingredients FOS and barley with buttermilk.

Materials and methods

The study was carried out in the Department of Food and Nutrition of The Maharaja Sayajirao University of Baroda, Vadodara.

Procurement of raw materials

Barley was procured from the Rajasthan Agricultural Research Institute, Jobner (Rajasthan), Buttermilk (Goras*)* was purchased on daily basis from Baroda dairy, Vadodara, through a local vender. FOS was procured from Tata Chemicals Pvt. ltd., Mumbai. Colours and flavours (Leeladhar and Co., Mumbai) were purchased from local market of Vadodara.

Development of fermented drink

Barley was weighed (150 gm), washed, soaked in water for 30 minutes and then cooked. Time taken to cook barley was 25 min. The cooked barley was then cooled at room temperature. Buttermilk (600 ml) was then added and blended in an electric mixer for 2 minutes (Panasonic MX AC-220 H Mixer Grinder) to a smooth consistency, without lumps. The mixture was then sieved through 1000 µ sieve and kept for incubation at 35 °C for 8 hours for fermentation.

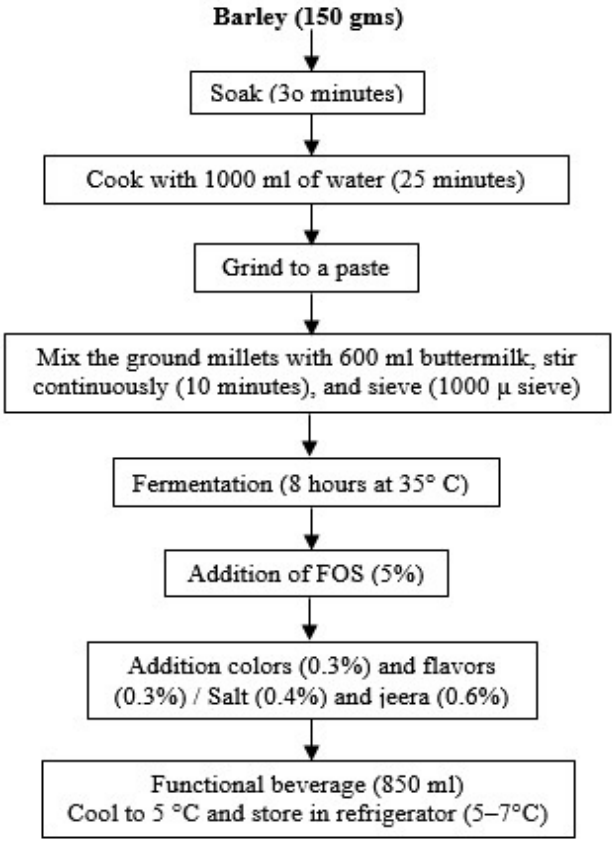

Fig 1: Process flowchart for preparation of functional beverage

Addition of flavours to fermented drink

After fermentation, the drink was divided into four different portions and flavours namely rose, khus, chocolate and salt-jeera were added to each of the portions respectively. Colours (0.3%) and essences (0.3%) were added to develop the sweet flavours and salt - jeera was developed using 0.4% and 0.6% of salt and jeera respectively. The levels of these ingredients were decided on the basis of preliminary trials. FOS (5%) was added to all the flavours of fermented drinks and stirred well. The final product was cooled to 5 °C and stored in refrigerator (5–7 °C).

Sensory evaluation

Three successive trials were conducted for screening the panellist through threshold test (Rangana, 1986) [30]. Sensory evaluation was carried out on the barley fermented drink samples containing different flavours. Twenty four semi trained panellists were selected using the sensitivity threshold test. The panel members were asked to rate the samples for taste, appearance/colour, consistency, and overall acceptability using a composite score analysis in triplicates (Rangana, 1986) [30].

Statistical analysis

Data analysis was conducted using Statistical Package for the Social Sciences (*SPSS – 16 version*). The data was statistically tested using analysis of variance (one-way ANOVA) to determine if statistical difference ($p<0.05$) existed. Triplicate measurements were taken for each analysis. Results from all the tests were expressed as means ± standard deviations (SD).

Results

Acceptability of different flavours of fermented drink

Table 1 indicates that the sensory attributes of the fermented drinks varied significantly with different flavors and colors. Considering the appearance of all the fermented drinks, no significant difference was found between the color and consistency, indicating that all were equally acceptable by the panel. The choice of taste and flavour varied significantly. Maximum acceptability was found for salt-jeera flavoured barley fermented drink, followed by rose. Mouthfeel and after taste of the product were also significantly different. Salt-jeera had the highest score for good mouth feel, followed by chocolate and rose. None of the flavors of drink showed any defects. Overall acceptability showed a significant difference ($p<0.000$) with salt-jeera flavour having the highest acceptability.

Table 1: Organoleptic evaluation of FOS added barley fermented drinks

Flavours		Colour	Consistency	Taste and flavour	Mouthfeel	After taste	Absence of defects	Overall acceptability
Rose	Mean	9.00	8.50	24.32 ^{ab}	7.79 ^{a}	8.06 ^{a}	8.14	16.03 ^{a}
	± SD	± 1.00	± 1.00	± 4.44	± 1.38	± 1.38	± 1.27	± 2.42
Khus	Mean	8.90	8.49	23.75 ^{a}	7.67 ^{a}	8.01 ^{a}	8.19	15.86 ^{a}
	± SD	± 0.99	± 0.97	± 4.49	± 1.44	± 1.21	± 1.27	± 2.30
Chocolate	Mean	8.64	8.62	24.07 ^{a}	7.99 ^{a}	8.12 ^{a}	8.24	16.18 ^{a}
	± SD	± 1.24	± 0.98	± 4.01	± 1.44	± 1.34	± 1.25	± 2.32
Salt- jeera	Mean	8.75	8.83	25.64 ^{b}	8.47 ^{b}	8.60 ^{b}	8.60	17.51 ^{b}
	± SD	± 1.05	± 0.91	± 3.88	± 1.13	± 1.19	± 1.17	± 2.08
F- value		1.57^{NS}	1.96 ^{NS}	2.78*	4.88**	3.17*	2.01 ^{NS}	7.87***
p- value		0.195	0.119	0.041	0.003	0.025	0.110	0.000

Mean values represent the average of 24 determinants in triplicate

a, b, c – The non-identical letters in any 2 rows within the column denote a significant difference at a minimum of 5% level

NS – the difference between the mean values within the columns is not significant.

Level of significance in increasing order – (*$p<0.05$, **$p<0.01$, ***$p<0.001$)

Discussion

Food industry aims at the development of new products towards functional foods and ingredients with regard to the consumer's demands on healthy nutrition. Most of the commercial products containing functional ingredients like probotics and prebiotics available today are dairy-based (Prado *et al*, 2008) [29]. Several food scientists have, however, endeavoured to develop non-dairy, cereal based probiotic and/or synbiotic products (Helland *et al*, 2004; Mcmaster *et al*, 2005; Kedia *et al*, 2007) [13, 21, 16]. The fermented beverage developed in this study had showed good acceptability amongst the panel members, this can be subjected due to lactic acid bacteria and yeasts that are the predominant microorganisms during the cereals fermentation. The activities of lactic acid bacteria produce many antimicrobials and inhibitory substances during fermentation while the yeast contributes to flavour enhancement (Kumari *et al*, 2015) [18]. This fermented drink also contain high content of soluble non-starch polysaccharides β-glucan which has a health promoting role.

A similar study was conducted to develop an oat based drink called as "Oat beverage" using oats as a substrate and was fermented at 37 °C for 6–10 hrs (Angelov *et al*, 2006).

Other types of functional drinks which have been developed are those of cholesterol lowering drinks (with combination of omega-3 and soy), ''eye health'' drinks (with lutein) or ''bone health'' drinks (with calcium and inulin) (Keller, 2006) [17]. In Estonia, fortified juices are produced under the trade name of Largo containing inulin, L-carnitine, vitamins, calcium and magnesium as functional ingredients (Tammsaar, 2007) [32].

Addition of FOS to beverages and regularly consumed products has also been studied. A study conducted on FOS added soup and beverages namely, butter milk, lemon juice, milk and tomato soup at 2.5 per cent, 4 per cent, 5 per cent, 6 per cent, 7.5 per cent has shown positive results on the overall acceptability of the products (Neha and Sheth, 2011). The overall acceptability of the food products developed in this study is good due to the addition of FOS and due to its sweet taste it has not affected the taste, aftertaste and mouthfeel of the product. Similar results have been documented by Parnami *et al*, where cookies and bread were fortified with prebiotic inulin (Parnami and Sheth, 2010) [26]

Barley as a functional ingredient has many health benefits including preventing cardiovascular diseases and cancer, lowers blood pressure, controls cholesterol level and lowers the incidents of heart diseases, reduce the rate of fat absorption, delays gastric emptying and improve gastrointestinal health (Achi *et al*., 2015) [1]. Clinical and epidemiological studies reported that β-glucan from oat and barley based products control cardio vascular disease in human beings (Beck *et al*., 2010) [3].

FOS a prebiotic and a potential functional ingredient has been recognized for its great potential which is becoming apparent as a considerable food element in increasing the bacterial bionomics which might have a concrete role in reducing the burden of CVDs. Many recent researches have documented that consumption of FOS reduces the incidences CVDs by regulating hypertension, improving glycemic, lipemic control and reducing the expression of inflammatory markers (Ooi and Liong, 2010, Dehghan *et al* 2014, Asemi *et al*, 2013) [24, 7, 2].

Conclusion

There is no doubt that functional foods generate one of the most promising and dynamically developing segments of food industry. Cereals have been an essential part of the human diet since the beginning of agriculture and are most economic source of energy. Barley is a commonly consumed cereals in Indian households. Barley is also good for digestive and nervous system as it contains an important amino acid L tryptophan and is helpful for sleeplessness, depression, anxiety and premenstrual syndrome. The formulation of this drink will be beneficial for all the age groups and addition of FOS will

enhance its functional value of the product.

Future recommendations

The probiotic and prebiotic potential of such drinks can be studied so as to identify the classes of bacteria present. Also, such innovations should not be only limited to research papers and thesis, an effort should be made to introduce such functional drinks in the market so that it is easily accessible to the consumers. A joint venture between food industries and researchers can take help make such products available on the shelves of super markets for consumers to choose the healthy beverage options.

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