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Research Article

EXTRACTION AND STANDARDIZATION OF INDIGENOUS OAT MILK

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A B S T R A C T

Background: The development and consumption of functional foods, beyond providing basic nutrition are on the rise and probiotic products are considered vital amongst them. Fermented dairy foods are conventionally associated with probiotics whereas, cereal-based probiotic products are not being very widespread. Interest in oats as a food ingredient has increased in recent years due to its high functional properties.
Objectives: The study was carried out to identify the desirable form of oats and extraction technique suitable to formulate oats milk extract feasible to serve as vehicle for probiotic delivery and subject the product to physicochemical, organoleptic, nutrient and microbial analysis.
Methodology: Extraction technique using various forms of oats including whole grain, spilt grain and oat meal was carried out. Prior to milk extraction procedure trials with variations on the quantity of oats to be used, soaking method and duration were performed and a suitable method was identified depending on the consistency, yield and was subjected to the quality analysis
Results: The yield of milk ranged from 55 to 70 per cent. Dietary fiber and β-glucan content ranged from 18.36 – 18.70 g and 2.28 - 3.44 g per cent respectively. The product had 4.38 pH, titrable acidity 0.34 per cent, total solids of 32.04 per cent and viscosity ranged from 3 – 3.5 cPS.
Conclusion: Split oats grain extract both with and without roasting was found to have maximum yield, high functional component β-glucan and desirable consistency suitable for further fermentation process and to serve as a vehicle for delivering probiotic organisms.

INTRODUCTION

Many food and drinks were associated with cereals throughout the history, and they serve as a major source of energy for millions of people worldwide and also considered to be beneficial to human health (Nirupama Gangopadhyay, *et al.*, 2015). Whole grain oats are also good potential sources of fiber, vitamins, minerals and bioactive compounds such as phenolics, carotenoids, vitamin E, phytic acid, β-glucan and sterols. Wholesome oat based food products such as breads, biscuits, cookies, probiotic drinks, breakfast cereals, flakes and infant food are gaining increasing consideration due to their high nutritional value (Prasad Rasane, 2015).

Many epidemiological studies stated the benefit associated with the consumption of whole grain cereals with decreased risk of chronic diseases such as cardiovascular disease , cancer, diabetes and obesity , these benefits are mostly attributed to the content of dietary fiber, essential fatty acids, vitamins and antioxidant phytochemicals including several phenolic compounds in these cereals (Venn, Mann, 2004 and Slavin, 2005). There is wide range of phenolic components present in oats including ester linked glycerol conjugates, ester linked alkyl conjugates, ether and ester linked glycerides, anthranilic acids and avenanthramides (AVAs) and these compounds possess high level of antioxidant activity (Prasad Rasane, 2015). Oat also contains micronutrients such as vitamin E, folates, zinc, iron, selenium, copper, manganese, carotenoids, betaine, choline, sulphur containing amino acids, phytic acid, lignins, lignane and alkyl resorcinols (Flander *et al.*, 2007). Slow rate starch digestibility is important for human health to maintain blood glucose levels. Slowly digestible starch (SDS) is one of the most important fractions as it moderates the glycemic response and improves nutritional quality of the food). Resistant starch has been recognized as functional fibre, it escapes digestion and provides fermentable carbohydrates for colonic bacteria, similar to oligosaccharides such as fructo-oligosaccharides and aids in the production of desirable metabolites including short chain fatty acids. Oats contain approximately 7 % rapidly digestible starch (RDS), 22 % slowly digestible starch (SDS) and 25 % resistant starch (RS) of its total starch. Regular

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consumption of oat can be used to supplement these starches in diet (Ovando-Martinez *et al.,* 2013).

Plant-based or non-dairy milk alternative is the fast growing segment in newer food product development category of functional and specialty beverage across the globe. Nowadays, cow milk allergy, lactose intolerance, calorie concern, prevalence of hypercholesterolemia and more preference to vegan diets have influenced consumers towards choosing cow milk alternatives. Plant-based milk alternatives are a rising trend, which can serve as an inexpensive alternate to poor economic group of developing countries and in places, where cow's milk supply is insufficient (Sethi *et al.,* 2016)

The study aims at identifying the desirable form of oats and extraction technique suitable to formulate oats milk extract feasible to serve as vehicle for probiotic delivery. The specific objectives of the study was to identify the desirable form of oats and extraction technique suitable to formulate oats milk extract and to subject the product to yield, physicochemical, nutrient, microbial and organoleptic analysis.

MATERIALS AND METHODS

Preparation of oats milk

The processing of cereal milk was based on preliminary experiments. The variations adopted were types and quantity of oats, roasting and duration of soaking prior to grinding. Three different forms of oats namely Whole Grain (WG), Split Grain (SG) and Oat Meal (OM) were procured. The quantities of the oats used were 15, 20 and 25g, the variation carried out prior to soaking was done with and without roasting. Prior to soaking the oat grain was tempered in water boiled at 80° C for 3 mins and the water was drained out. The tempered oats was then soaked in 150 ml of sterilized hot water and the duration adopted for soaking was 4hrs, 8hrs and 12 hrs at room temperature. The soaked oats were ground using a mixer grinder and the slurry was filtered using a nut milk bag till the oats milk is completely extracted.

Analysis performed

The extracted milk was subjected to various analysis such as yield analysis (to find out maximum extracted quantity of oat milk), physico chemical analysis (pH, Titrable acidity, Total solids, Viscosity and Moisture content), and nutrient analysis (Energy, protein, carbohydrate, fat, Dietary fiber and β Glucan) microbial load testing and organoleptic evaluation.

Physicochemical Analysis

The pH of the extracted oats milk samples were measured using pH-meter (IS 2860 – 1964). Viscosity was measured using a viscometer adopting ASTM D445 method. Titrable acidity was determined as acid present by titrating with 0.1 NaOH, using phenolphthalein indicator (IS 1155 – 1968). Total solids present in the sample was determined by IS 12711:1989 (Reaffirmed in.1994) procedure. Moisture content of the extracted milk was estimated using techniques adopted from AOAC (17th Edn.2006, 934.01).

Nutrient Analysis

`AOAC protocol was used to determine the proximate principles such as protein (N x 6.25) (17Th Edn.2006, 990.03), fat (17th Edn. 2006, 954.02) and carbohydrate by difference (17th Edn. 2006) from the extracted milk samples. Total energy content was estimated by calculation using FAO method. Total dietary fiber and β-glucan content was estimated using AOAC (17th Edn, 2006, 995.16).

Microbial Analysis

Ten milliliter of *the oats milk extract* samples was thoroughly mixed in 90 mL sterile distilled water to obtain 10^{-1} dilution, from which further dilutions were made. Viable counts (Total plate count, yeast and mold count) present in the extracted oats milk sample were determined with the procedure as given by IS 5402:2002 and IS 5403:1999 (Reaffirmed in.2009). Determinations were carried out in triplicates and counts were expressed in logarithmic of colony-forming unit per mL / g of sample (log CFU/mL/ g)

Organoleptic Evaluation

Organoleptic evaluation was performed in order to evaluate the desirable texture of the product so as to facilitate the further processing step. Ten trained panelist were asked to perform the evaluation specific to analyzing the appearance, odour and texture of all variation of extracted oats milk product. The scores were allocated to the attributes based on a 9-point hedonic scale ranging from 1 (dislike extremely) to 9 (like extremely). Scores were based on a hedonic scale of 1 to 9 where: 1 = dislike very much and 9 = like very much (Wichchukit and O'Mahony, 2014).

RESULTS AND DISCUSSION

From the results obtained it was observed that 25 g of oats gave good yield of extracted milk, soaking for either 8 hrs or 12 hrs found to get blended well and maximized the yield, whereas 4 hrs of soaking time did not feature desirable result. The observations specific to soaking time was consistent with the results obtained in previous studies (Pushpa Devi and Narayanasamy Sangeetha, 2012). The results pertaining to the total yield of extracted milk with respect to the type of oats and variations adopted prior to soaking are given in the Figure 1.

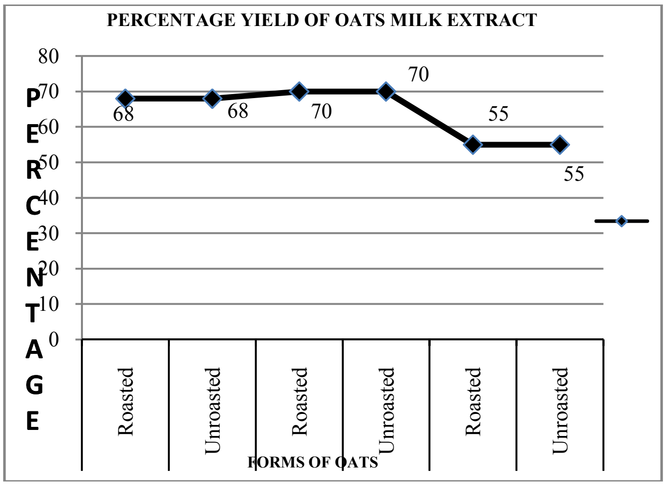

Figure1 Yield analysis of the oats milk extract

Maximum of 200 ml (70 %) of oats milk extract was yielded from both roasted and unroasted split oats grain. In absence of similar literatures the results with yield analysis could not be compared. The purview of physicochemical characteristic of the extracted oats milk is presented in the Table 1. pH (4.38) and titrable acidity (0.33 %) remained the same in all the variations, total solids and viscosity was high (10.15%, 11.31% and 4.5cPS, 5.0cPS respectively) in milk extracted with oats meal(OM)., Protein content (0.87g%, 0.89 g%) and *β*-Glucan content (0.86g%, 0.86g%) was found to be high in milk extracted from both roasted and unroasted split oats grain respectively. *β*-Glucan content in oat ranged from 2.3 to 8.5/100 g as stated by Flander (2008), the quantity found to match with the *β* Glucan content of 1.72g in 200 ml oat milk extract prepared from 25 g of spilt oats grain, and thereby contains 6.88 g in 100 g of spilt oats grain or 800 ml of oat milk extract Table 2. In a study by Nirupama Gangopadhyay (2015) states that the *β*-glucan yield or the total percentage recovered from oats was 61%. The major storage proteins in oats are globulins known as avenalins and it make up to 80% of the total oat protein. In oats, β- glucan has the mixed-linkage (1-3, 1-4)-β-D-glucan and it is the major component of the endosperm cell walls. The physiological effects are probably related to the gel forming properties of β-glucan, which increase viscosity of intestinal chime, the increased viscosity disturbs micelle formation, which inhibit cholesterol absorption, slow cholesterol transfer across the unstirred layer, and increase bile acid excretion by inhibiting bile acid reabsorption (Upasana Gaggat *et al.,* 2014).

Table 1 Physicochemical characteristics of the oats milk extract

Parameters	Whole grain		Split Grain		Oat Meal	
	Roasted	Unroasted	Roasted	Unroasted	Roasted	Unroasted
pH	4.38	4.38	4.38	4.37	4.37	4.37
Titrable acidity (%)	0.33	0.33	0.33	0.34	0.33	0.33
Total Solids (%)	7.31	7.39	8.01	8.11	10.15	11.31
Viscosity (cPS)	3	3	3	3	4.5	5
Moisture g (%)	92.69	92.65	91.90	91.99	86.09	86.17

Value given for 100 mL of the product

Table 2 Proximate analysis of the oats milk extract

Parameters	Whole grain		Split Grain		Oat Meal	
	Roasted	Unroasted	Roasted	Unroasted	Roasted	Unroasted
Energy (Kcals)	30.18	30.18	32.96	32.96	16.09	16.13
Carbohydrate (g %)	6.75	6.75	7.34	7.34	3.56	3.58
Protein (g %)	0.79	0.78	0.87	0.89	0.55	0.53
Fat (g %)	0.35	0.35	0.35	0.37	0.21	0.21
Dietary Fiber (g %)	4.59	4.67	4.48	4.48	2.39	2.34
β-Glucan (g %)	0.57	0.57	0.86	0.86	0.49	0.49

Value given for 100 mL of the product

Table 3 Microbial load testing of the oats milk extract

Parameters	Whole grain		Split Grain		Oat Meal	
	Roasted	Unroasted	Roasted	Unroasted	Roasted	Unroasted
Bacteria (CFU / g)	430	450	400	450	460	530
Mould (CFU / g)	150	170	140	170	140	190

Value given for 100 mL of the product

Table 4 Mean organoleptic evaluation scores of the oats milk extract

Parameters	SCORES					
	Whole grain		Split Grain		Oat Meal	
	Roasted (M ± SD)	Unroasted (M ± SD)	Roasted (M ± SD)	Unroasted (M ± SD)	Roasted (M ± SD)	Unroasted (M ± SD)
Appearance	8.4 ± 1.30	8.2± 1.64	8.5 ± 1.36	7.0 ± 1.95	6.7 ± 0.15	6.7 ± 1.42
Odour	8.3± 0.87	7.7 ± 1.12	8.7 ± 0.50	8.3 ± 1.73	8.3 ± 1.66	7.5 ± 0.87
Texture / Consistency	8.6 ± 1.15	8.6 ± 1.37	8.8 ± 1.10	8.8 ± 1.25	5.6 ± 1.59	5.3 ± 1.56

The microbial load analysis reveals that the bacterial load was < 550 CFU / g and yeast and mold count was < 200 CFU /g in all the variations (Table 3). The microbial load countered similar to the permissible levels as mentioned in the GRAS specifications for oats prescribed by Laura Tarantino, 2008 stating the value to be < 5000 CFU/g for standard plate count and< 200 /g for yeast and mold. The mean scores obtained for organoleptic evaluation of the oat milk extract samples indicate that the variation with both roasted and unroasted split oats grain recorded highest scores of 7.7, 8.7 and 8.8 in the respective attributes of appearance, odour and texture / consistency (Table 4). The scores indicate that the extracted oats milk was found to categorize as Like moderately (Score 7) to Like very much (Score 8).

Many epidemiological studies and biologically plausible mechanisms, scientific evidence has shown that consumption of oats provide health benefits in terms of reduced rates of oxidative stress, chronic age related diseases and various forms of cancer. They may also help regulate blood glucose levels. The observation implies the need for more *invivo* studies to rule out the efficacy of the bioactive component of oats namely the β-glucan and determination of the bioavailability of these oats based antioxidants in the body.

CONCLUSION

Split oats grain extract both with and without roasting was found to have maximum yield, high functional component *β*-glucan and desirable consistency suitable for further fermentation process and to serve as a vehicle for delivering probiotic organisms. However, further studies on evaluating the fermenting ability of the extract are warranted. More information is required on the complex mechanisms involved in the protective ability of this cereal which promotes strong and convincing arguments for an increased consumption of oats and to provide better information about their health benefits and to develop new health claims in the future.

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