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Acceptability & incorporation of oats in the Indian diet

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Abstract
This article is intended to focus on the incorporation of oats in the Indian diets. Oats have a functional nutritional & therapeutic profile. Intake of oats (soluble fibre, beta glucan) helps in the management of diabetes, cardiovascular diseases & weight management. The health benefits may be attributed to it's physicochemical properties (such as viscosity, molecular weight) which can be affected by extraction methods and its behavior in gastrointestinal tract. Thus it is very important to incorporate oats in the traditional Indian diet & recipes.

Keywords: oats, Indian diets, product development, beta-gulcan

1. Introduction

Oat (Avena sativa), an important cereal crop, is primarily utilized as livestock feed throughout the world (Givens, Davies, & Laverick, 2004) [4]. Due to its dietary benefits, the human consumption has increased. Total dietary fibre & the soluble fibe (b-glucan) contribute to the therapeutic properties of oats such as reduction in postprandial blood glucose and insulin responses and lowering blood lipids, especially serum total and LDL-cholesterol (Cavallero *et al.*, 2002; Kerckhoffs *et al*., 2003) [1, 6]. Moreover, the efficacy of oat b-glucan in reducing the risk of coronary heart disease has been recognised by the Food and Drug Administration (FDA), which allowed the health claim for products containing a minimum of 0.75 g of oat b-glucan per portion (FDA, 1997) [2]. Besides being a rich source of soluble dietary fibre, oats has distinctive nutritional profile. They are also rich in essential amino acids, unsaturated fatty acids, aventhramides (antioxidants), vitamins & minerals (Peterson, 2001) [10]. Yet, oats have been traditionally excluded from the traditional Indian diet.

Archaeological remains in Central Europe (1000 BC) provide evidence of domestication of common oats (Avena sativa) (Zohary & Hopf, 1988) [17] much later than the domestication of wheat or barley (Sampson, 1954) [11]. According to these evidences, oats was introduced in Europe as a contaminant in wheat & barley, and due to its unique adaptability to the temperate & cold climates and moist soil (in Europe) its cultivation began in Europe. During the 1st century AD, oats emerged as a widely grown cereal crop in the favourable cultivation environment of Europe.

The most common & traditional dish made with oats is wet cooked porridge. According to the historic references, in 1st century, oat porridge was consumed by Germanic tribes & in 1755 oats was consumed by people in Scotland (Webster *et al*., 2011) [16].

In India, oats is an introduced crop, though the exact time & place of its introduction cannot be ascertain. However, according to the court historian of Mughal king Akbar, Abul Fazal, oats was cultivated in Ain-I-Akbari, in 1590. In India, large scale oats cultivation started in 19 century, during the British era, when Britishers remounted depots for the Indian army. In the Himalayan region, the extension of its cultivation is comparatively recent. As far as extension of its cultivation in the Himalaya is concerned, it is comparatively recent. Maharaja Hari Singh (the then king of Jammu and Kashmir state, 1925-1947) introduced oats in his farms. The seeds were imported from Europe. During this period, cultivation of Oats remained confined to the King's farms only and local farmers were not using Oats (Source: Director Agriculture Department, Srinagar (Kashmir).

Oats Beta Glucan: An Innovation in Functional Food Sector

With increasing consumer demands for healthy food, the food industry is shifting towards development of (new products) functional foods and ingredients. Introduction of new functional foods is the response of research & development industry to the increased consumer awareness about health & nutrition. "Functional foods besides providing their initial function of satiety & nutrition, also provide other health benefits to the consumers. They may aid in reducing & diminishing the risk of chronic & infectious diseases. They are modified traditional foods, to achieve their favourable health effects which are provided by the non-modified foods. Functional food market is emerging with new & healthy oat products as this grain is packed with nutrition & health benefits (Verschuren, 2002) [15]. Cereal β-glucans are of commercial & nutritional importance due to their physical and physiological properties (Mälkki & Virtanen 2001; Vasanthan & Temelli 2008) [10, 14]. During the last two decades, the increasing interest has been largely due to their acceptance as functional, bio-active ingredients (Cui & Wood 2000). Also, there is a shift in the interest in the purchasing & consuming products, which are considered to be healthy. The product category of cereal based products, with higher concentrations of complex saccharides & fibrous materials is growing and becoming popular.

Due to its excellent rheological properties, oats β-glucans have high viscosity at relatively low concentrations (Butt *et al*. 2008). Therefore, the water soluble fibre can be used as a food ingredient in the form of hydrocolloids (Lazaridou *et al*. 2004; Lee *et al*. 2009) [7, 8] or as powder through microparticulation (Hunter *et al*. 2002) [5]. β-glucans not only enhance the

nutritional but also improve the sensory and gustatory properties of the final product (Gajdošová *et al*. 2007) [3], like in the beverages (Lyly *et al*. 2003) [9], where the expansion in the functional drink sector has been tremendous over the last few years (Sloan 2002) [13].

Product Development with Oats: Value Added Products

With increased consumer awareness about health benefits of fibre, intake of high fibre products has increased, also the demand for oats based products have increased. Oat is an excellent source of water soluble dietary fibre β-glucans. Thus food industry is using the functional properties in formulating new products such as breakfast cereals (oatmeal porridge, muesli), beverages (oat milk, oats based probiotic drink), snacks (breads, biscuits & cookies) & infant food. Oat β-glucan can be used as a stabilizer in ice creams. Aventhramides, antioxidants present in oats are useful in stabilizing milk and meat products sensitive to fat oxidation during storage (Rasane *et al*., 2015). Oat proteins, due to their emulsifying properties & viscous nature have been used in food products including heat resistant chocolates (Zwer, 2004) [18]. The incorporation of oats in the conventional formulations has been found to improve the overall quality of such products. Sanchez-Pardo *et al*. (2010) [12] reported enhanced textural characteristics for pound cake made with 25 % (*w/w*) of oat fibre than the conventional product.

Throughout the world, bread is an important part of daily diet for a vast population. Flander *et al*. (2007) formulated an oats based bread with nutty, mild and pleasant flavour. The water soluble fractions of dietary fibre helps in excellent moisture retention property in breads & maintain the freshness for a longer duration (McKechnie, 1983). Retardation in staling rates in breads has been reported with the addition of oats starch & oats lecithin (Zhang *et al*. 1998). But, oats can only be partially replaced in bakery products its proteins are susceptible to denaturation by heat treatment resulting in poor baking properties. Oats also lack in gluten essential for visco-elastic property of flour used for bread making.

Yilmaz and Daglioglu (2003) have reported use of oat bran as a fat substitute in meat balls. Meat balls formulated with 20% oat bran is reported to have highest protein, salt and ash content. They also showed high sensory acceptability. In the recent times, oats based breakfast cereals have received considerable attention. They are not only rich in functional ingredients such as β-glucan but also have bioactive components which are known to reduce serum and plasma cholesterol levels and postprandial glycemic response (Ryan *et al*., 2011).

Pastas formulated with oats starches (and their modified products) were found to be organoleptically comparable to conventional formulations (Chillo *et al*. 2009; Hager *et al*. 2013). Low fat & higher fibre granola bars are also formulated with resistant starched derived from oats performs dual roles; acts as a binder & imparts health benefits (Aigster *et al*. 2011). Oat dextrin is hydrolysed product of oat starch consisting of α (1→ 4) and α (1→ 6) linked D glucose polymer and/or oligomers with a dextrose equivalent (DE) value less than 20. Oat dextrin can be used in powder form since they possess different physicochemical properties including (solubility and viscosity) (Sun *et al*. 2008). Oatrim, a powder consisting of oat dextrin and soluble *β*-g1ucan is a non-sweet starch hydrolysate fat substitute. It stabilises substantial amount of water in gel like matrix, resulting in lubricant and flow properties similar to that of fats (Inglett *et al*. 1994; Shen *et al*. 2011). Along with oat bran, these are also been reported to be used in food industry as fat substitutes such as in meat products (Crehan *et al*. 2000), dairy products (Liu and Wang 2006) and bakery products such as cakes (Lee *et al*. 2005).

However in India oats are not that popular, probably due to the palatability & taste profile of oats, as the Indian population has not developed the taste for oats. Oats needs to be fitted in the Indian evergreen food items such as chapattis, idlis, dosas, dhoklas, milk, upma, biscuits, etc. Thus the present project was undertaken to incorporate oats in the traditional Indian diet by developing healthy recipes with oats & its constituents like oat bran.

Products

For purpose of incorporation of oats in the Indian diets, following products were selected:

- Oats Missi Roti
- Oats Upma
- Oats Veggie Idlis
- Fruity Oats Smoothie
- Oats Rice Pulao

Materials & Methods

For the preparation of control sample & standardisation of the modified variants all the raw materials used were procured from the local markets.

Sensory Evaluation

Product samples (variations & control) coded with different numbers and were presented to 50 trained panelists. A five point Hedonic rating scale (1- Unsatisfactory to 5- Excellent), was used. Panelists were asked to rate each sensory attribute; appearance, color, texture, taste, aftertaste and overall acceptability for the control & the modified variant of these products.

Results

Standardization of Oats Missi Roti

Missi Roti was prepared by partially replacing wheat flour with oats flour. 3 variations with oats flour (50%, 25%, 12.5%) & a control were prepared. All the 3 variants were compared with the control for textural & sensory characteristics. Based on the inputs of the sensory panel, addition of oat flour upto 50% was considered acceptable in the missi roti formulation. Though if the roties are not consumed hot, they tend to turn hard but upon reheating, the texture of the roties is retained. Formulation & ingredient variations of Oats Missi Roti are described in table 1. The method of preparation for oats missi roti is described in figure 1.

Table 1: Control & Modified Recipes of Oats Missi Roti

Ingredients & Variations (% replacement with oat flour)	Whole Wheat Flour (g)	Bengal Gram Flour (g)	Oat Flour (g)	Mint Leaves(g)	Coriander Leaves(g)	Carom Seeds (g)	Oil(g)
Control	40	20	-	25	25	1/4t	1/2t for greasing
Modified 3 (50%)	20	20	20	25	25	1/4t	1/2t for greasing
Modified 2 (25%)	30	20	10	25	25	1/4t	1/2t for greasing
Modified 1 (12.5%)	35	20	5	25	25	1/4t	1/2t for greasing

Yield – 3-4 Chappatis

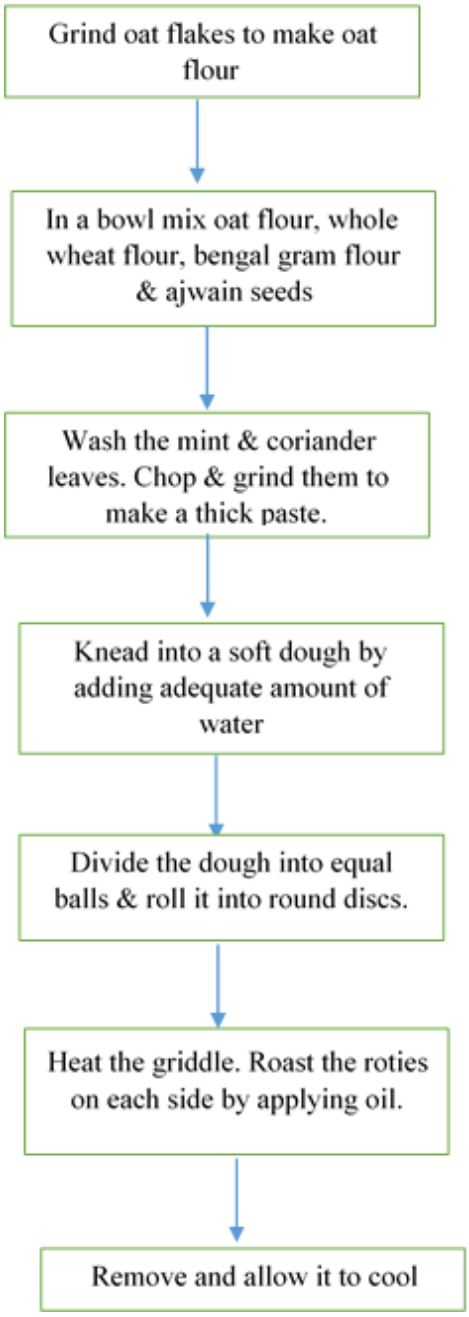

Fig1: Method of preparation of Oats Missi Roti

2. Standardisation of Veggie Oats Idlis

Veggie Oats Idlis was prepared by partially replacing semolina with oats bran. 3 variations with oats bran (50%, 25%, 12.5%) & a control were prepared. All the 3 variants were compared with the control for textural & sensory characteristics. Based on the inputs of the sensory panel, addition of oat bran upto 50% was considered acceptable in the Veggie Oats Idli formulation. Formulation & ingredient variations of veggie oats idlis is described in table 2. The method of preparation for veggie oats idlis is described in figure 2.

Table 2: Control & Modified Recipes of Veggie Oats Idlis

Ingredients & Variations (% replacement with oat flour)	Curd (g)	Semolina (g)	Oat Bran (g)	Onions (g)	Green chilli paste (g)	Bell Peppers (g)	Baking Soda	Mustard Seeds (g)	Washed Black Gram Dal(g)	Bengal Gram Dal(g)	Salt (g)	Oil (g)
Control	100	80	-	15	2.5	15	¼ t	2	5	5	To taste	5
Modified 3 (50%)	100	40	40	15	2.5	15	¼ t	2	5	5	To taste	5
Modified 2 (25%)	100	60	20	15	2.5	15	¼ t	2	5	5	To taste	5
Modified 1 (12.5%)	100	70	10	15	2.5	15	¼ t	2	5	5	To taste	5

Yield – 7-8 Idlies

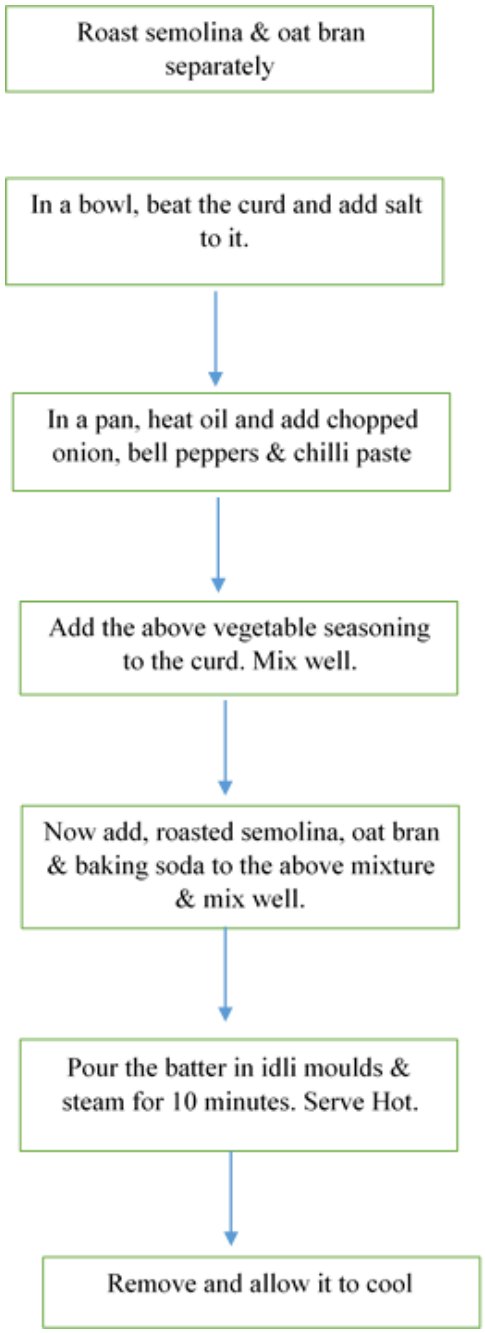

Fig 2: Method of Preparation of Veggie Oats Idles

3. Standardisation of Oats Upma

Oats upma was prepared by partially replacing semolina with oats bran. 3 variations with oats bran (50%, 25%, 12.5%) & a control were prepared. All the 3 variants were compared with the control for textural & sensory characteristics. Based on the inputs of the sensory panel, addition of oat bran upto 50% was considered acceptable in the oats upma formulation. Formulation & ingredient variations of Oats Missi Roti is described in table 3. The method of preparation for oats upma is described in figure 3.

Table 3: Control & Modified Recipes of Oats Upma

Ingredients & Variations (% replacement with oat flour)	Semolina (g)	Oat Bran (g)	Onions (g)	Carrot(g)	Lemon juice	Bengal Gram Dal(g)	Washed Black Gram Dal(g)	Curry Leaves	Mustard Seeds (g)	Oil (g)	Salt (g)	Peanuts (g)
Control	50	-	20	20	½ t	5	5	Few	2	5	To taste	7
Modified 3 (50%)	25	25	20	20	½ t	5	5	Few	2	5	To taste	7
Modified 2 (25%)	37.5	12.5	20	20	½ t	5	5	Few	2	5	To taste	7
Modified 1 (12.5%)	43.75	6.25	20	20	½ t	5	5	Few	2	5	To taste	7

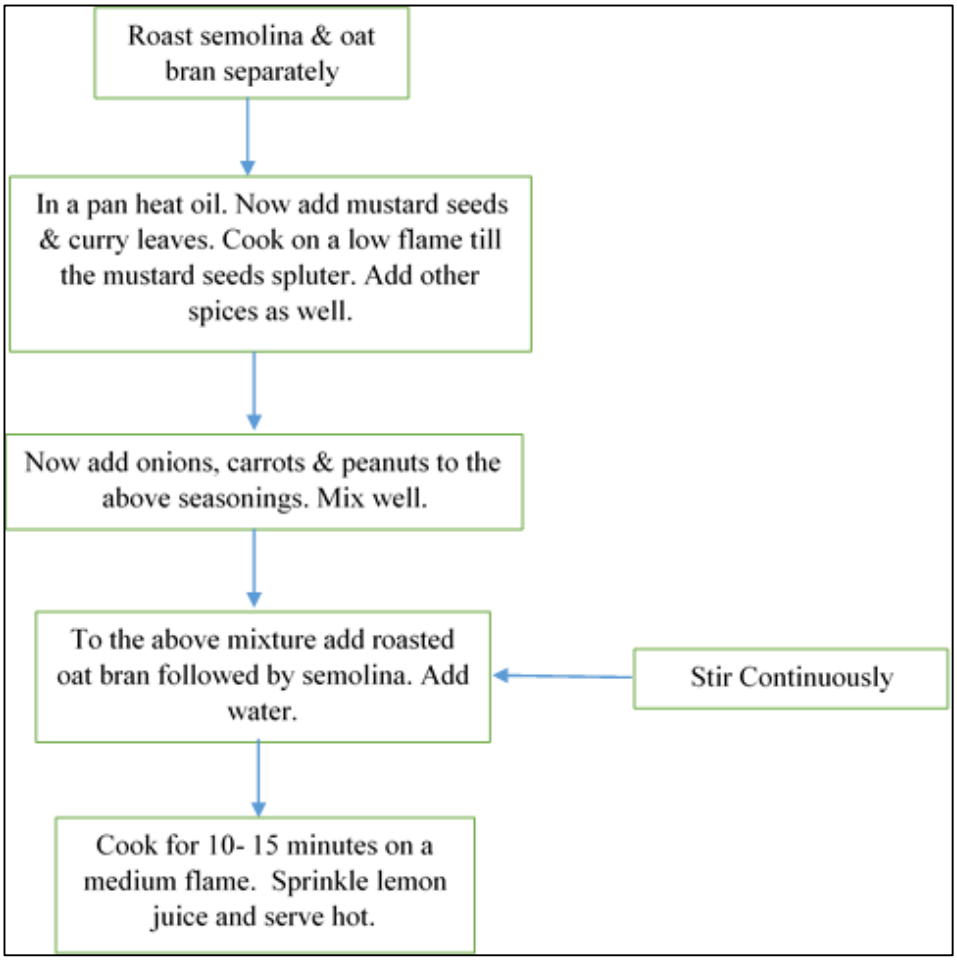

Fig 3: Method of Preparation of Oats Upma

Standardisation of Fruity Oats Smoothie

Fruity oats smoothie was prepared by adding oats to the milk & fruit mixture. 3 variations with oats (40g, 30g, 20g) & a control were prepared. All the 3 variants were compared with the control for textural & sensory characteristics. Based on the inputs of the sensory panel, addition of oat bran upto 40g was considered acceptable in the fruity oats smoothie formulation. Formulation & ingredient variations of Oats Missi Roti is described in table 4. The method of preparation for fruity oats smoothie is described in figure 4.

Table 4: Control & Modified Recipes of Fruity Oats Smoothie

Ingredients & Variations (g of oats added)	Milk (ml)	Oats (g)	Apricot (g)	Banana (g)	Honey (g)	Dates (g)	Almonds (g)
Control	125	-	100	37	5	15	5
Modified 3 (40g)	125	40	100	37	5	15	5
Modified 2 (30g)	125	30	100	37	5	15	5
Modified 1 (20g)	125	20	100	37	5	15	5

Yield – 1 Tall Glass

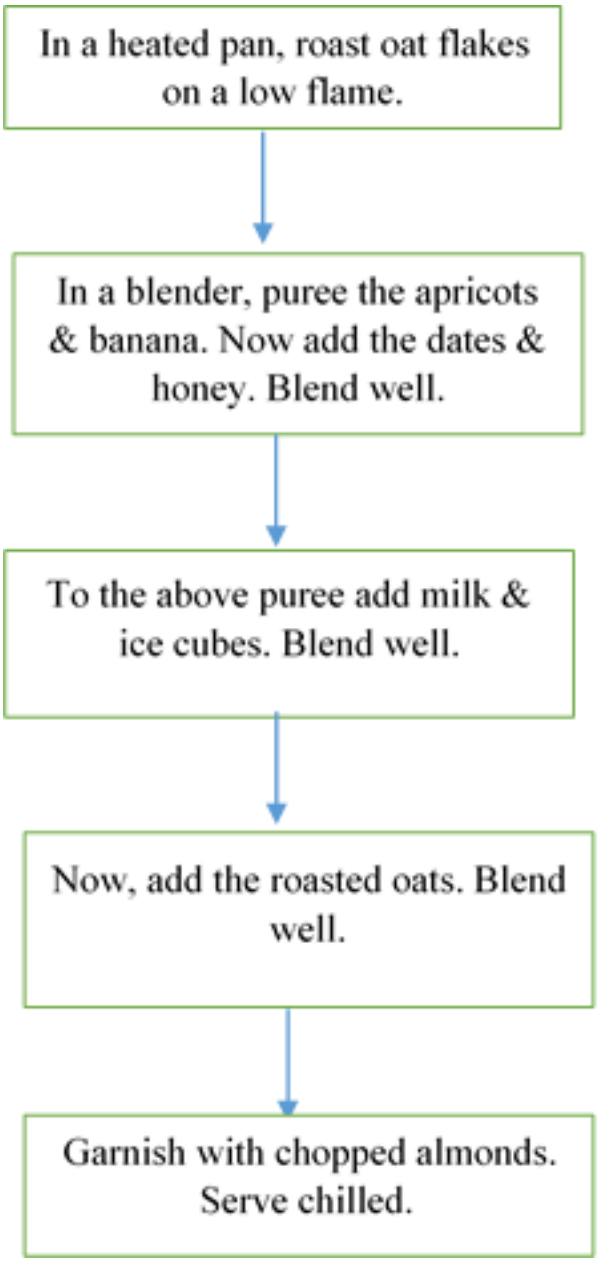

Fig 3: Method of Preparation of Fruity Oat Smoothie-

Oats Rice Pulao

Oats rice pulao was prepared by partially replacing white rice with oats. 3 variations with oats bran (50%, 33.3%, 16. 6%) & a control were prepared. All the 3 variants were compared with the control for textural & sensory characteristics. Based on the inputs of the sensory panel, addition of oats upto 50% was considered acceptable in the oats rice pulao formulation. Formulation & ingredient variations of Oats Rice Pulao is described in table 5. The method of preparation for oats rice pulao is described in figure 5.

Table 5: Control & Modified Recipes of Oats Rice Pulao

Ingredients & Variations	White Rice (g)	Oats (g)	Onion (g)	Beans (g)	Carrots (g)	Peas (g)	Oil
Control	120	-	60	60	60	40	10
Modified 3 (50%)	60	60	60	60	60	40	10
Modified 2 (33.3%)	80	40	60	60	60	40	10
Modified 1(16.6%)	100	20	60	60	60	40	10

Yield – 1 Medium Bowl

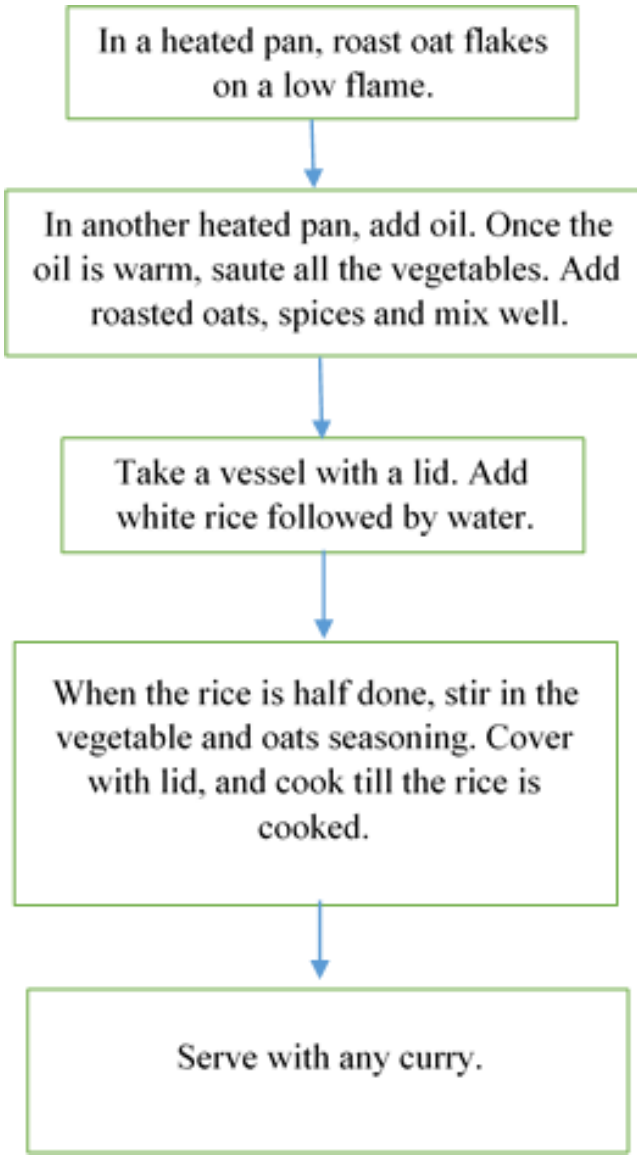

Fig 3: Method of Preparation of Oats Rice Pulao-

Conclusion

Oats is considered a super grain. It is high in water soluble fibre (beta-glucan) which is reported to have therapeutic properties which aid in the management of diabetes, hypercholesterolemia, hypertension & weight management. Table 6 summarizes the versatile usage & function of different oat components in varied food products.

Table 6: Functions & Usage of different oat components

S.No.	Oat Component	Function	Products Usage
1.	Oat Flakes	Ingredient	Formulation of multigrain/oat based products – Breads, Breakfast Cereals, Snacks, Infant foods
2.	Oat Bran	Coating agent	Oat bran can be used as a replacement for bread crumbs & semolina – Cutlets, Kebabs, Sausages
3.	Oat Bran	Thickening agent	Oat bran can be used as a replacement for cornflour – soups, gravies, curries & pulses
4.	Oat Flour	Ingredient	Oat flour can be used as a replacement or in addition for/to refined/whole wheat flour- chapatties pancakes, pizza bases
5.	Oat Bran	Seasoning mix	Oat bran can be added to the seasoning mix/spice mix & can be sprinkled over pizzas, pastas, breads
6.	Oat Grain	Ingredient	Whole oat grains can be used as a partially substituted for white rice Broken oat grains can be used as broken oat porridge in partial replacement with broken wheat porridge or as such

Thus a standardised experiment was carried out for incorporation of Oats & Oats products in the Indian diet. It can be concluded that Oats can easily be incorporated in Indian breads (chapatties, missi roties), Breakfast items (Upma, Poha), Snacks (Biscuits) & Drinks (Smoothies & Shakes). With upto 50% partial replacement with oats (& its components) the modified traditional products had acceptable sensory & textural characteristics.

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