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Effect of domestic methods of processing on nutrient composition of oat *(Avena sativa)* flour

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ABSTRACT

Food cereals are widely consumed all over the world as these are good sources of protein, carbohydrates, fat, crude fibre, vitamins and minerals. Common domestic methods like germination, parboiling, autoclaving etc. enhance the digestibility and nutritional value of cereals. The aim of the present study was to analyse the effect of domestic methods germination (12 and 24h), Parboiling (15-20 and 20-25min) and alkali treatment (20 and 30%) on nutrient content of oat (*Avena sativa*). The study was focused on important feature to make use of processed oat seed flour as it is regarded as super food, contain protein, iron, antioxidant, essential fatty acids and soluble dietary fibre (β- *Glucan*). The study revealed that amongst the treatments higher protein content was observed in parboiled oat flour (23.3±0.07g100 g^{-1}) as compared to unprocessed oat flour. The maximum decrease in crude fibre content was observed in parboiling sample (54-62%) which was followed by germination and alkali treatment (50-47%). All the minerals (Ca,P,Fe) were significantly decreased at 0.05 and 0.01 level. Based on the results germination, parboiling and alkali treatment for oat grains should be popularized as a simple process for naturally fortifying food with nutrients could be suggested for processed oat flour based food preparation.

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Key Words : *Avena sativa* Oat, Germination, Parboiling, Alkali treatment, Nutrients

INTRODUCTION

Health and nutrition is the most demanding and challenging field in this era and would continue to be in the future as well. Maintaining and increasing the nutritional quality of food during food processing is always a potentially important area for research (Guy and Gamlath, 2007). The different agro-climatic conditions in India give rise to the production of food articles. Out of these, cereals grains are the staple food consumed by the human race from the *Asian* times. The most important cereals for food used are wheat, rice and a number of course grain like maize, sorghum, bajra, ragi, barley and small millets like proso, finger and foxtail (Pragti, 2006). Cereals like wheat, rice, maize etc are the major component of the diets consumed in India. These coarse grains are mostly used for food purpose especially by the people of lower income groups.

Avena sativa is the scientific name of grass commonly known as Oat. It is annual grass, which is cultivated for its edible grain. It grows 2 to 4 feet with pale green narrow, flat leaves. The showing season is extended from October to December. The crops mature in about four and a half to five months for fodder. Two and half cutting is taken January to march (Jain, 2002). Oats are generally considered 'healthy' or a health food being touted commercially as 'nutritious'. The discovery of the healthy cholesterol lowering properties has led to wider appreciation of oat as human food. Oat contains cereal protein *globulin* and also legume protein *avenalin*, as the major protein (80%) (Hann *et al*., 1990). It is twice richer in protein, four times richer in calcium as compared to other grains (Gopalan *et al.,* 1997). Oats are the major source of protein, fibre, carbohydrate and micronutrients and thus having a positive impacts on individual's health (Thathola, 1999). It provides many health benefits such as serum cholesterol lowering (Anderson and Chen, 1986), reduced coronary heart diseases (Berg *et al*., 2003) and diabetic mellitus (Pick *et al*., 1996) reduced blood pressure (Kestin *et al*., 1990) and cancer prevention in humans. Primary health beneficial oat component is β-Glucan, an enriched oat hydrocolloid (OH) ingredient with 5-50 per cent β-Glucan content (dry basis) commercially available (Lee *et al*., 2005). It can be adopted by the person on a crash diet for loosing weight. Another health benefit of oat is that it has high protein and fibre content, which is comparable to the pulse and wheat. Thus the easily available are consumed for increasing the nutrition as well as safe guarding against possible deficiencies.

Now a days nutritionists have recognized the importance of dietary fibre in maintaining health in the population and are the view that there is current surge of interest in fibre. There is need to develop some recipes or food products rich in fibre.

To make India hunger free, nutritionally secured and economically strong, food processing and value addition are the two major area concerns. Processing is the value addition activity to agricultural produce. It also adds value to the by products, co products and residue that also have considerable economic usage. It improves palatability, nutritional value and shelf life of raw food materials. At every stage of processing, value is added to the product by simple processing methods like germination, parboiling and alkali treatment etc. Malting is the process of germination and subsequent drying of grain. As a result, the complex proteins are degraded to be readily available at lower molecular weight fraction and also increase the protein and starch digestibility of the grains. Malted grains have been used in the formulation of low viscosity value added food products, the agricultural produce can be used in diversified ways by converting them into a variety of nutritious fortified food products, after processing methods (Sultan *et al*., 1989).

There are different domestic methods such as germination, fermentation etc. have been reported to be beneficial for enhancing the nutritional value of oat. So, there is need to increase the consumption of processed oat. Due to the limited research on oat the aim of the present study was to develop the processed flour with different methods such as germination, parboiling and alkali treatment and to investigate its effects on nutritional composition of processed oat flours.

METHODOLOGY

Sample collection:

Oat (*Avena sativa*) grains were collected from the Krishi Vigyan Kendra of Banasthali University, district Tonk, Rajasthan, India. Grains were cleaned for wholesomeness after discarding broken hull grain, Shriveled grains having of colour and foreign materials. The grains were washed and sundried to prepare them to develop their flour.

Processing:

After cleaning and sun dried the grains have been undergone different processing methods such as germination (12 and 24h), parboiling 15-20 and 0-25 min)

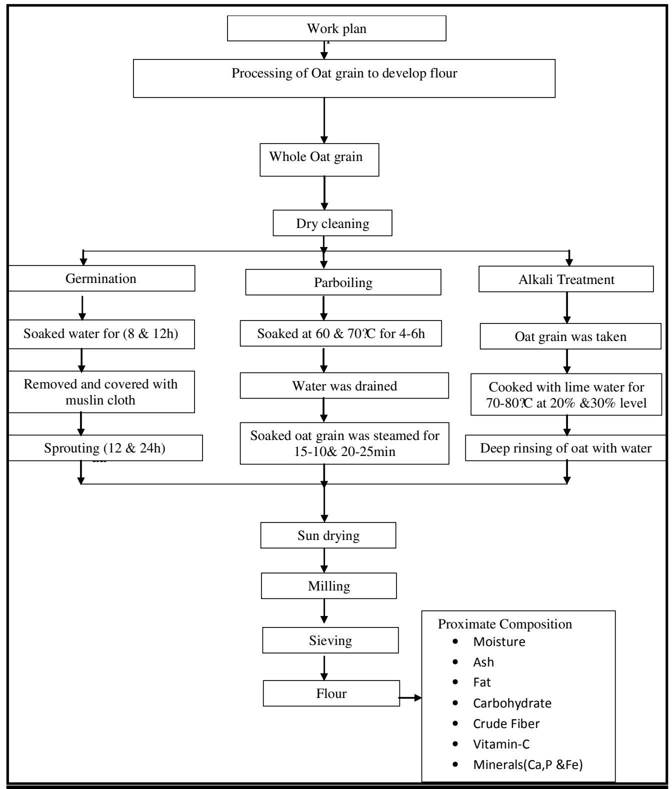

Fig. a: Flow chart for processing of oat grain to develop flour

and alkali treatment 20 and 30 per cent to observe the nutritional variation as affected by these treatments. After various processing, grinding was done using domestic grinder to develop the flour. Unprocessed and processed oat grain flour were analysed for proximate composition analysis with standard method.

Proximate composition analysis:

Protein was estimated by Lowry *et al.* (1951) , the moisture content was determined by hot air oven method, crude fibre, moisture, carbohydrate were determined by standard method procedures by AOAC (1984). Vitamin –C and minerals, calcium (Titrimetric method), Iron by Wongs method (NIN) and phosphorus by ammonium molybdate and ANSA reagent (Fiske Subbarow method). The data were analysed by following standard statistical procedure (Mean, S.D., Paired t-Test).

OBSERVATIONS AND ASSESSMENT

A change had been noticed in the proximate composition of oat flour after different processings as depicted in Table 1 and Fig. 1-3. The moisture content of unprocessed oat flour was 8.21±0.02 $g100^{-1}$. During germination, it was found that 14.6±0.01 (12h) and 15.4±0.06 g100 g^{-1} in (24h), when compared with

Table 1: Effect of different processing treatments on nutrient composition of oat flour

Nutrients	Unprocessed oat flour	Processing					
		Germination		Parboiling		Alkali treatment	
		12h	24h	15-20 min	20-25 min	20%	30%
Moisture $(g100^{-1})$	8.21±0.02	14.6±0.01[ab]	15.4±0.06[ab]	13.2±0.09[ab]	14.9±0.12[ab]	12.7±0.03[ab]	15.1±0.10[ab]
		(78%↑)	(87.5%↑)	(61%↑)	(81.4%↑)	(55%↑)	(84%↑)
Ash $(g100g^{-1})$	2±0.01	2.6±0.02[ab]	(2.6±0.07[ab]	2.6±0.6[ab]	2.7±0.09[ab]	2.7±0.0[ab]	3±0.08[ab]
		(30%↑)	(40%↑)	(30%↑)	(35%↑)	(35%↑)	(50%↑)
Protein $(g100g^{-1})$	16.89±0.12	18.5±0.011[ab]	20.5±0.14[ab]	20.2±0.16[ab]	23.3±0.07[ab]	21.5±0.09[ab]	22.8±0.08[ab]
		(9.5%↑)	(21.3%↑	(19.5%↑)	(38%↑)	(35%↑)	(36%↑)
Fat $(g100g^{-1})$	7±0.17	3.4±0.11[ab]	3.25±0.09[ab]	6±0.07[ab]	4.75±0.13[ab]	5.12±0.12[ab]	4.5±0.9[ab]
		(51%↓)	(53.3%↓)	(14.2%↓)	(32.1%↓)	(27%↓)	(35.7%↓)
Crude fibre $(g\ 100g^{-1})$	10.5±0.09	5.6±0.10[ab]	6.2±0.11[ab]	4.0±0.03[ab]	4.8±0.07[ab]	5.4±0.09[ab]	5.2±0.04[ab]
		(46.6%↓)	(40.9%↓)	(62%↓)	(54.2↓)	(46.8%↓)	(50.4%↓)
Carbohydrate $(g100g^{-1})$	66.03±0.12	53.3±0.15[ab]	50.85±0.14[ab]	51±0.10[ab]	49.55±0.14[ab]	52.58±0.16[ab]	44.4±0.0[ab]
		(19.2%↓)	(23%↓)	(23%↓)	(24.9%↓)	(20.36%↓)	(33%↓)
Vitamin-C $(mg100g^{-1})$	Negligible	1.1±0.5	1.3±0.7	1.7±0.9	1.3±0.3	1.5±0.01	1.6±0.11
		(↑)	(↑)	(↑)	(↑)	(↑)	(↑)
Phosphorus $(mg100g^{-1})$	523±0.02	265±0.04[ab]	270±0.06[ab]	310±0.08[ab]	330±0.09[ab]	280±0.07[ab]	285±0.06[ab]
		(49%↓)	(48.3%↓)	(41%↓)	(37%↓)	(46.4%↓)	(45.5%↓)
Iron $(mg100g^{-1})$	4.7±0.5	3.4±0.1[a]	3.7±0.09[a]	2.5±0.08[ab]	3±0.12[ab]	3.5±0.03[a]	4.2±0.10[a]
		(28%↓)	(21.4%↓)	(47%↓)	(36.3%↓)	(26%↓)	(11%↓)
Calcium $(mg100g^{-1})$	53±0.09	30.02±0.03[ab]	33.26±0.09[ab]	31.02±0.04[ab]	32±0.08[ab]	34±0.07[ab]	35.03±0.06[ab]
		(43.3%↓)	(37.2%↓)	(41.2%↓)	(39.6%↓)	(35.8%↓)	(33.9%↓)

Values represent mean ±SD of three independent determinations
(a-Significant at P≤0.01 level, b-Significant at P≤0.05 level), (↑-indicates percentage increase, ↓-indicates percentage decrease)

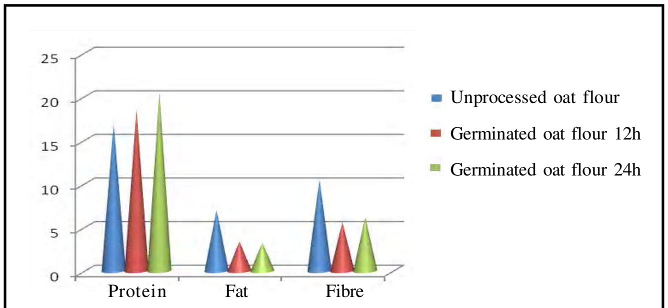

Fig. 1: Effect of germination on protein, fat and fibre content $(g100g^{-1})$ of oat flour

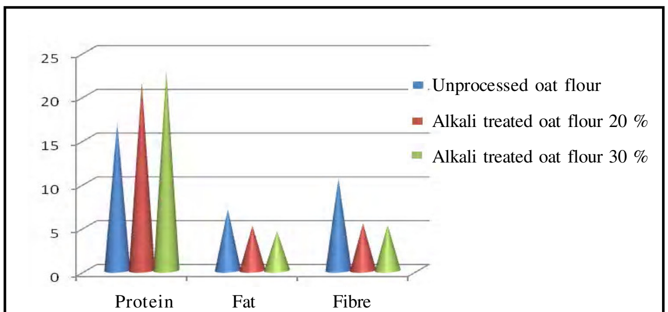

Fig. 2: Effect of Alkali treatment on protein, fat and fibre content $(g100g^{-1})$ of oat flour

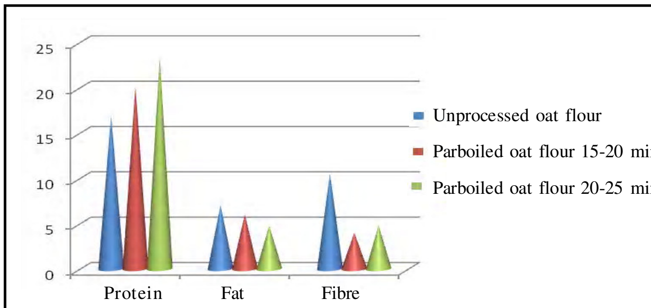

Fig. 3: Effect of parboiling treatment on protein, fat and fibre content $(g100g^{-1})$ of oat flour

unprocessed sample. It was observed that the data were increased by 78 per cent and 88 per cent, respectively. On parboiling it was found that 13.2±0.09 (15-20 min) and 14.9±0.12 (20-25 min) $g100g^{-1}$. The values were increased by 61 per cent and 81 per cent, respectively. In alkali treatment, the values were 12.7±0.03 and 15.1±0.10g100 g^{-1}, respectively as compared to unprocessed flour. The result of alkali treatment was found to be increased by 55 per cent and 84 per cent, respectively. The maximum increased was seen in 24 h germination (88%) and this was followed by 30 per cent alkali treatment (84%) and 20-25min parboiling (81.4%).

Statistically result indicates that all the values of test samples were found to be increased at both levels *i.e.* (P= 0.05 and P=0.01). Kakati *et al.* (2010) reported that moisture content of both green gram and black gram was obtained highest data in pressure cooking followed by soaking, germination and control. Similar trends have been reported by several workers in legumes and pulses (Bhagya *et al.,* 2007).

The protein content of unprocessed flour was 16.89±0.12 g100 g^{-1}. After 12 and 24h germination, the values were 18.5±0.11 and 20.5±0.14 g100 g^{-1}, respectively, and were increased by 10 per cent and 21 per cent. During 15-20 and 20-25 min parboiling the values were 20.2±0.16 and 23.3±0.07 $g100g^{-1}$ as increased by 20 per cent and 38 per cent, respectively and again same result was found in alkali treatment. The maximum increased was seen in 20-25min parboiling (38%) and was followed by 30 per cent alkali treatment (36%) and 24h germination (21.3%). The result indicates that all the samples were found to be increased significantly at both level (P=0.05 and P=0.01). The increase in the protein content of the sprouted flour samples was mainly due to breakdown of complex protein into simpler form and breakdown of nutritionally undesirable constituents during germination process (Chavan and Kadam, 1989). The metabolic activities of resting seeds increase as soon as they are hydrated during soaking. The complex biochemical changes that occur during hydration and sprouting lead the protein constituents being broken down by enzymes into simple compounds (Mubarak, 2005). According to Morgan *et al.* (1992), the absorption of nitrate facilitates the metabolism of the nitrogenous compounds from carbohydrate reserves; thus increasing crude protein levels.

The Fat content of unprocessed oat flour was 7.0±0.17 $g100^{-1}$. After all the treatments (germination, parboiling and alkali), it was found that the data were decreased by 53 per cent, 32 per cent, and 27 per cent, respectively. The maximum decrease was seen in germination (52%) and this was followed by parboiling (14-32%) and alkali treatment (27-35%). The result indicates that all the values of test samples were found to be decreased significantly at both levels *i.e.* (P=0.05 and P=0.01).Osman (2007) also stated in his study that the different processing such as germination and alkali treatment on fat content of some lentils decreases as compared to untreated seeds. This reduction in fat content may be related to high biolytic enzyme activity which breakdown triglyceride to simple fatty acids sterol esters and polar lipids (Purseglove, 1968). Same report has been given by Fagbemi (2007) that significant (P=0.05) reduction in the fat content of germinated fluted pumpkin seed flour. These decreases could be attributed to the use of fat as an energy source to start germination.

The crude fibre content in unprocessed flour was10.5±0.09$g100g^{-1}$.During germination it was found that the values were 5.6±0.10 $g100g^{-1}$ in 12h and 6.2±0.11 $g100g^{-1}$ in 24h, the values were decreased by 47 per cent and 41 per cent, respectively. During 15-20min and 20-25min parboiling it was found that the values were 4.0±0.03 $g100g^{-1}$ and 4.8±0.07 $g100g^{-1}$, respectively, it decreased by 62 per cent and 54 per cent. In 20 per cent and 30 per cent alkali treatment it was found that the values were 5.4±0.09 $g100g^{-1}$ and 5.2±0.04 $g100g^{-1}$ and was decreased by 47 per cent and 50 per cent, respectively as compared to unprocessed flour. The maximum decreased was seen in 20-25min parboiling (54%) and this was followed by 30% alkali treatment (50.4%) and 12h germination (47%). On statistical analysis, the results were found to be decreased significantly at both level *i.e.* (P=0.05 and P=0.01). The similar result was reported by Harper (1958) that processing reduce the crude fibre content in soaking for a period of time followed by boiling, germination and parboiling resulted in decrease in the crude fibre content of the *Mucuna flagellipes* flour with soaking for 24h followed by boiling for 90min, germination for 24h and parboiling for 20 min giving product with the least crude fibre content (10.10%). According to Ukachukuwu and Obioha (2000) who reported a decrease in crude fibre content of *Mucuna cochinchinensis* as boiling time was increased. Soaking, boiling and autoclaving also reduce the crude fibre content of *Mucuna flagellipes* and *Mucuna cochinchinensis* as stated by Udensi *et al.* (2010).

Carbohydrate content of unprocessed oat flour was 66.03±0.12 $g100^{-1}$. During germination the values were 53.3±0.0.15 and 50.85±0.14 $g100g^{-1}$ in 12 and 24h and decreased by 19 per cent and 23 per cent, respectively. During parboiling, values were 51.0±0.10 and 49.55±0.14g $100g^{-1}$ in 15-20 min and 20-25 min, respectively and were decreased by 23 and 24.9 per cent, respectively. In 20 and 30 per cent alkali treatment it was seen that the values were decreased by 20 per cent and 33 per cent, respectively. The maximum decrease was seen in 30 per cent alkali treatment (33%) and this was followed by 20-25 min parboiling (25%) and 24h germination (23%). The result indicates that all the values of test samples were found to be decreased significantly at both levels *i.e.* (P= 0.05 and P=0.01). The Highest level of carbohydrates was recorded in untreated seeds of green gram (57% and 57%, respectively) and black gram cultivars (42% and 41 %, respectively) as compared to soaking, and germination and parboiling. Comparison among three different processing methods, the loss of starch over the control was highest during germination (Ramakrishna *et al.,* 2006). This result was in agreement with the findings of Mubarak (2005), which showed that sprouting resulted to a reduction in the carbohydrate content of mungbean.

The iron content of processed flour was decreased ranged 2.5 mg100 to 3.7 mg100g^{-1}.The maximum reduction was seen in parboiling (15-20 min) *i.e.* 47 per cent which is followed by 12 h germination (28%), 30 per cent alkali treatment(11%). The similar study was depicted that a significant decrease in iron content after different processing methods likes germination, soaking and parboiling due to the leaching off is decreased in K and Fe (Magdi and Osman, 2007).The losses amounted to 38 per cent P, 49 per cent K and 54 per cent Na (Haytowitz and Matthews, 1983) reported that cooking in boiling water, germination and parboiling caused losses in K and Fe.

The values of calcium content of processed flours were 30.02±0.03mg100^{-1} (12h) and 33.26±0.09mg100g^{-1} in (24h) germination, 31.02±0.04mg100g^{-1} (15-20min) and 32±0.08mg100g^{-1} (20-25min) in parboiling and 34±0.07 mg100g^{-1} (20%) and 35.03 ± 0.06mg100g^{-1} (30%) in alkali treatment. All the values of processed flours were significantly decreased at both levels (P=0.05 and P= 0.01).The similar results were seen in phosphorous content. It was seen that a significant decrease in calcium content due to the leaching after different processing methods like germination, soaking and parboiling. Similarly study on kidney beans cooked by conventional and microwave methods, had different retention rates of minerals. Germinated mung bean seeds showed slight increases of K, Ca, P, Mg and Fe. These results agree with those reported by Khalil (2001) for guar and faba bean. The same result was seen in phosphorous content Cunha *et al.* (2009) has stated that processing like germination and pressure cooking also decreases the mineral content. The minerals drained substantially in cooked germinated seeds possibly due to increased seed permeability.

Conclusion:

The results obtained in the present study showed that amongst the various processing methods, parboiling was found to be most effective, followed by germination and alkali treatment in retention of the nutrients. Processing like germination and parboiling brings out the hydrolysis of carbohydrates and protein to certain extent of food grains, thus result in reduced cooking time, improve digestibility, protein efficiency ratio of the bran and improve the bioavailability of some nutrients. The beneficial effect of alkali treatment could not be attributed to the correction or prevention of an amino acid imbalance but not only to the release of niacin from an unavailable form. It also contains some phytochemicals and inositol which have been associated with protection from chronic diseases which are prevalent in community. It has a very important component *β-glucan* (soluble dietary fibre) which helps in reducing weight. Therefore it may provides health benefits in metabolic disorders such as coronary heart diseases, diabetes mellitus etc. Thus processed oat flour are easily available to be consumed for increasing the nutrition as well as safeguarding against possible deficiencies.

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