Sarhad J. Agric. Vol.24, No.4, 2008

CHEMICAL COMPOSITIONS AND FUNCTIONAL PROPERTIES OF FLAXSEED FLOUR

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ABSTRACT

Roasted and non roasted full fat or partially defatted flaxseed flours (Linum Usitatissimum) were evaluated for their proximate composition, mineral profile and functional properties. Significant increase in the crude protein, crude fiber, ash and mineral contents in the partially defatted flaxseed flours (both roasted and non-roasted) was observed. Partial defattening improved the foam capacity, foam stability and water absorption capacities while roasting decreased the foam stability and capacity of the flours. Mineral profile and proximate composition of the roasted partially defatted flaxseed flours showed that this can be added in the many types of food applications as defattening solves the problem of stability while roasting effectively reduces the antinutritional factors like cyanogenic glycosides contents of the flaxseed. The replacement of roasted partially defatted flaxseed flours upto a level of 16% supplementation in whole wheat flour was found acceptable regarding the sensory attributes of chapattis.

Key Words: Flaxseed, Functional properties, Linum usitatissimum Mineral profile, Proximate composition, Roasting, Sensory

Citation: Hussain, S., F.M. Anjum, M.S. Butt, and M.A. Sheikh. 2008. Chemical composition and functional properties of flaxseed (*Linum usitatissimum*) flour. Sarhad J. Agric. 24(4): 649-653.

INTRODUCTION

The search for novel high-quality but cheap sources of protein and energy has been attaining popularity in developing counties for meeting the challenges of hunger and starvation. The attention has been focused on cheap grains containing relatively high amounts of proteins that can help to enhance the quality of the foods of a large segment of population (APATA, 1990). The flaxseed is one of the grains gaining popularity in this respect. Flaxseed (*Linum Usitatissimum*) is generally cultivated for linen fiber or for oil from its seeds which is also called as linseed oil. The flax has been used as a precious nutritional product and as a traditional medicine from ancient times. Flaxseed is richest source of alpha-linolenic acid, lignans and other nutritional components. The protein content of flaxseed was recorded about 20 per 100 grams of dried grain. Flaxseed has an amino acid profile comparable to that of soybean flour and contains no gluten (Hongzhi *et al*., 2004)**.**

The flaxseed contains both soluble and insoluble fibers. About one-third of the fiber in flaxseed is soluble and it may help to lower cholesterol and to regulate levels of blood sugar. The remaining two-thirds of the fiber in the flaxseed is insoluble which aids digestion by increasing bulk and preventing constipation. (Institute of Medicine, 2002). The commercial utilization of flaxseed proteins in food products depend on its functional properties before its incorporation in various food products. The improvement in a range of functional properties may be achieved either by genetic modification, chemical processing or physical treatment of the proteins (Oomah and Mazza, 1993). The functional properties of different proteins can be employed to figure out the fact that how flour proteins can be used to supplement, fortify, enrich or replace more expensive protein sources which are used traditionally(Akobundu *et al*., 1982)**.**

The functional properties of commonly used plant materials like soybean, cowpea and pigeon pea are studied extensively by many scientists (Narayana and Rao, 1982**)**. However, information on the functional potential of the full fat, defatted, roasted and non roasted seed flour proteins are few. Hence, the purpose of this study was to determine the proximate composition, mineral profile and functional properties of the roasted, non roasted, full fat and defatted flaxseed flours and then utilize the better found flaxseed flour for the production of flaxseed supplemented chapattis.

MATERIALS AND METHODS

Collection of seed samples

Flaxseed grains of "*Chandni" variety* were obtained from the Oil Seed Research Institute, Faisalabad, Pakistan.

Cleaning and Roasting of Seeds

The seeds were cleaned manually, dried in air and half of grains were roasted. Microwave roasting was performed with a household microwave oven with 480W output, under the operating frequency of 2450MHz for 2.5 minutes according to method described by **(**Hongzhi *et al*., 2004)**.**

Milling of Flaxseed Grains

Roasted and raw grains were milled through a "China Grinder" and sieved to obtain full fat flaxseed flours. Partially defatted flours were prepared by extracting the flaxseed oil from half of the both the roasted and non roasted flours through mechanical screw press from the local market. Partially defatted flaxseed meal were ground and passed through a 200-mesh sieve to obtain partially defatted flaxseed flours. All types of flours were packed in polythene bags and stored at room temperature until used.

Proximate Composition of Flaxseed Flours

The crude protein (method No. 46-10), moisture (method No. 44-15A), crude fat (method No.30-10), total ash (method No.08-01) and crude fiber (method No. 32-10) contents of flaxseed flours were determined according to their respective methods described in AACC (2000). The nitrogen free extract (NFE) was calculated by difference method.

Estimation of Cyanogenic Glycosides

The determination of cyanogenic glucosides in flaxseed flours was done through the colorimetric method of (AOAC, 1990).

Mineral Profile of Flaxseed Flours

Minerals including, calcium, magnesium, iron, zinc, copper, manganese, sodium and potassium were determined using an Atomic Absorption Spectrophotometer, AAS (Model 372, Perkin- Elmer, Beaconsfield, UK) by wet digestion according to procedure of the AOAC (1990).

Functional Properties Of Flaxseed Flours

Water and Oil Absorption Capacities

The determinations of water and oil absorption capacities were carried out according to the method as described by Sosulski *et al*. (1976). After mixing a 10 ml distilled water or oil with 1 g flaxseed flour, the contents were allowed to rest at 30± 2°C for 30 minutes and then centrifuged at 200g for 30 minutes and finally the water and oil absorption capacities of the flours were expressed as grams of water or oil absorbed by 1 g of flaxseed flour.

Foaming Capacity (FC) and Foam Stability (FS)

The method of Narayana and Narasinga Rao (1982) was used to determine the foam capacity and stability of flaxseed flours. Fifty mL water was taken in a cylinder, into which two grams of flour samples were mixed keeping the temperature at 30± 2 ^{0}C. The suspension was properly shaken to foam, and the volume of the foam after 30 seconds was recorded in mL as foam capacity while the foam volume (mL) recorded after 1 h of whipping was recorded as foam stability.

Bulk Density

It was determined according to the method of Okaka and Potter (1979)**.** 50 g flaxseed flour was taken into a 100 mL volumetric cylinder. The cylinder was tapped several times on a laboratory bench to attain a constant volume. The bulk density (g/ cm^3) was then calculated as weight of flaxseed flour (g) divided by flour volume (cm^3).

Preparation and Evaluation of Flaxseed Flour Supplemented Chapattis

The chapattis (unleavened flat breads) were prepared from whole wheat composite flours supplemented with 0, 4, 8, 12, 16 and 20% PDFR according to the method explained by Haridas *et al.* (1986). The dough was prepared by mixing 200 g of whole wheat flour with predetermined quantity of water for 3 minutes and allowed to rest for 30 minutes. A dough piece weighing 80 g was rolled on a sheet of 2 mm thickness with a wooden roller pin on a specially designed wooden platform and cut into circle of 17 cm diameter. The unleavened flat breads were baked on thermostatically controlled hot plate at a temperature of 210 °C for 1.5 minutes. To assess the quality and acceptability, the chapattis were presented to a panel of six judges and the evaluation for sensory parameters such as color, taste, aroma, chewing ability, foldability and overall acceptability characteristics were carried out using a 9 point hedonic scale according to methods described by Land and Shepherd (1988).

RESULTS AND DISCUSSION

Statistical Analysis

The data obtained from all the parameters was statistically analyzed by performing analysis of variance technique (Steel *et al*., 1997) and interpreted according to Duncan's Multiple Range Test at 5% level of probability

Chemical Composition

The chemical composition of full fat (roasted and non-roasted) and partially defatted (roasted and non roasted) flaxseed flour samples are presented in Table I. Moisture content of different flour samples showed that full fat non roasted (FFNR) flaxseed flour is significantly higher (4.53%) in moisture content as compared to the other three types of flaxseed flours. Partial defattening has significantly affected the crude protein content of flaxseed flours while roasting showed a non significant effect on the protein contents. The crude fat content of the FFNR flaxseed flour (38.76 %) and full fat roasted (FFR) flaxseed flour (38.53%) were non-significantly affected as a result of microwave roasting. Sanni and Jaji (2003) reported that drying and roasting has not affected the protein and fat content of fufu (wet paste from cassava) samples. Ash content of the partially defatted non roasted (PDFNR) and partially defatted roasted (PDFR) flaxseed fours is significantly higher (5.61% and 5.66 %, respectively) as compared to the FFNR (3.47%) and FFR (3.48%). The HCN decreased from 19.75mg/100g (PDFNR) to 2.54mg/100g (PDFR) and from 14.57mg/100g (FFNR) to 2.05mg/100g in FFR flaxseed flour. Feng *et al*. (2003) showed that microwave roasting of flaxseed results in the reduction of the HCN content by 83.3%.

Table I. ***Chemical analysis of different flaxseed flours***

	Full fat roasted (FFR)	**Full fat non roasted (FFNR)**	**Partially defatted roasted (PDFR))**	**Partially defatted non roasted (PDFNR)**
Moisture %	4.23±0.16 b	4.53±0.12 a	3.96±0.10 c	4.13±0.09 bc
PROTEIN %	21.27±0.68 b	21.23±0.53 b	34.55±0.78 a	34.48±0.87 a
FAT %	38.53±1.32 a	38.76±1.28 a	5.51±0.03 b	5.35±0.02 b
ASH %	3.48±0.10 b	3.47±0.13 b	5.66±0.21 a	5.61±0.17 a
FIBER %	8.12±0.32 b	8.02±0.27 b	12.39±0.45 a	12.31±0.38 a
NFE %	24.37±0.85 b	23.99±0.91 b	37.93±1.63 a	38.12±1.55 a
HCN mg/ kg	20.58±0.87 c	145.72±5.21 b	25.42±0.73 c	197.57±7.65 a

Mineral Profile

Table II shows the effect of roasting on the mineral contents of full fat and defatted flaxseed flour samples. The results showed that roasting has not significantly affected the mineral contents of the flaxseed except iron, zinc and copper which was affected significantly in PDFR samples. Iron content of different flours ranged between 10.96 mg/100 g in PDFNR to 6.01 mg/100g in FFR flaxseed flour. Partial defattening resulted in a significant increase in the mineral content of the flaxseed flours. Highest significant values of K, Mn, Mg Na, Ca, Cu and Zn (1369.31, 4.73, 713.04, 58.16, 398.21, 3.45 and 7.86 mg/100g, respectively) were found in PDFNR flaxseed flour. Based on the recommended daily intakes and on the values showed in Table II, it is clear that flaxseed flour could be important in contributing to the overall daily dietary intake of essential elements especially the micronutrients whose deficiency is widespread in Pakistan.

Table II. ***Mineral profile of different flaxseed flours (mg/100g)***

	Full fat roasted (FFR)	**Full fat non roasted (FFNR)**	**Partially defatted roasted (PDFR)**	**Partially defatted non roasted (PDFNR)**
Fe	6.01±0.23 c	6.10±0.19 c	9.65±0.37 b	10.96±0.33 a
Zn	4.43±0.18 c	4.51±0.14 c	7.11±0.28 b	7.86±0.22 a
Cu	1.90±0.09 c	1.96±0.06 c	3.01±0.15 b	3.45±0.10 a
Ca	236.40±7.26 b	240.80±8.31 b	384.38±13.44 a	398.21±14.11 a
Na	30.12±1.04 d	32.43±1.11 c	48.10±1.82 b	58.16±2.06 a
Mg	422.50±15.22 b	430.54±15.89 b	685.33±22.97 a	713.04±24.06 a
Mn	2.73±0.10 c	2.76±0.12 c	4.14±0.17 b	4.73±0.13 a
K	822.10±29.98 b	826.32±28.25 b	1326.40±43.57 a	1369.31±45.08 a

Functional Properties

Some functional properties of different flaxseed flours are presented in Table III. The bulk density of a good material is important in relation to its packaging. As shown in Table III, the bulk density was lowest (0.77 g/cm^3) in PDFR and highest (0.83 g/cm^3) in FFR. It is obvious from the results that roasting significantly increased the bulk density of flours while defattening in non roasted flaxseed flour decreased the bulk density. The bulk density values reported in this work showed that it increases with roasting which is also supported by Sharma *et al.* (2004). Similarly, Egbekun and Ehieze (1997) reported that bulk density of the flours decreases as a result of defattening process. The highest water absorption capacity (2.34 g/g) was found in PDFR. The fat absorption capacity is a prominent factor in food formulations because it improves flavour and increase the mouth feel of foods. In this study fat absorption capacities were higher in roasted full fat (1.31g/g) and roasted defatted (1.27 g/g) flaxseed flours. The results of the foam capacity and stability of the different flour samples showed that foam capacity and stability decreased in roasted flours as compared to non roasted flours. Partially defatted flaxseed flour samples were found to be higher in these parameters. Giami and Bekebian (1992) and Egbekun and Ehieze (1997) have supported that the foam of the defatted flour was more stable than that of the full fat samples.

Table III. ***Functional properties of different flaxseed flours***

	Full fat roasted (FFR)	Full fat non roasted (FFNR)	Partially defatted roasted (PDFR)	Partially defatted non roasted (DFNR)
Bulk Density g/ml	0.83±0.05 a	0.78±0.03 b	0.80±0.04 ab	0.77±0.04 b
Water Absorption g/g	1.83±0.08 c	1.48±0.06 d	2.34±0.09 a	2.20±0.07 b
Fat Absorption g/g	1.31±0.05 a	1.20±0.04 b	1.27±0.03 a	1.04±0.05 c
Foam Capacity (ml)	9.10±0.35 d	14.60±0.45 b	13.70±0.41 c	17.40±0.53 a
Foam Stability (ml)	6.60±0.24 b	8.80±0.33 a	6.80±0.26 b	9.00±0.32 a

Sensory Evaluation of Chapattis

The sensory parameters of chapattis supplemented with partially defatted roasted flaxseed flours in the present study were affected significantly due to supplementation levels of flaxseed flour into whole wheat flour (Table IV). The results of the present study are supported by the earlier findings of Maheshwari and Devi (2005) who reported that addition of flaxseed in chapattis caused unacceptable changes in flavor, taste, and texture ultimately decreased overall acceptability scores of chapattis as the similar trend in scores for sensory attributes was observed in the present results. It may be concluded from the present study that chapattis from 16% PDFR and lower levels supplemented whole wheat flour (WWF) were assigned scores above 5. The supplementation of flaxseed into WWF can produce chapattis not only acceptable from the sensory standpoint but also will provide more nutrition and health benefits. This provides an opportunity to explore supplementation of flaxseed flour in whole wheat flour for the production of functional chapattis which is a staple food in Pakistan.

Table IV. ***Effect of roasted partially defatted flaxseed flour supplementation on the sensory attributes of chapattis***

Supplementation (% Flaxseed flour)	Colour	Taste	Chew ability	Foldability	Overall acceptability
100% wheat flour	7.94 a	7.72 a	7.89 a	8.06 a	8.06 a
4	7.11 b	6.89 b	7.33 ab	7.50 a	7.17 b
8	6.78 bc	6.22 c	6.61 bc	6.72 b	6.72 c
12	6.33 cd	6.00 c	6.17 bc	6.28 bc	6.11 d
16	6.00 d	5.44 d	5.78 c	5.72 cd	5.33 e
20	5.22 e	5.11 d	5.50 c	5.28 d	4.61 f

CONCLUSION

It can be concluded from the findings of present research that roasting of flaxseed prior to de-fattening results in the reduction of cyanogenic glycosides and improvement of functional properties of flaxseed flours. The improvement in the functional properties of flaxseed flour ultimately increases its suitability for its utilization in a number of food products. The acceptable chapattis can be prepared from 16% and lower levels of roasted partially defatted flaxseed supplemented whole wheat flours.

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