Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2017; 6(4): 956-961
Received: 18-05-2017
Accepted: 19-06-2017

Gadhe KS
Department of Food Science and Technology College of food Technology Vasantrao Naik Marathwada Krishi Vidyapeeth Parbhani, Maharashtra, India

Shere DM
Department of Food Science and Technology College of food Technology Vasantrao Naik Marathwada Krishi Vidyapeeth Parbhani, Maharashtra, India

Jarupla Surendar
Department of Food Science and Technology College of food Technology Vasantrao Naik Marathwada Krishi Vidyapeeth Parbhani, Maharashtra, India

Correspondence
Gadhe KS
Department of Food Science and Technology College of food Technology Vasantrao Naik Marathwada Krishi Vidyapeeth Parbhani, Maharashtra, India

Studies on exploration and characterization of dietary fiber extracted from sugar beet (*Beta vulgaris* L.) and it's incorporation in cookies

Gadhe KS, Shere DM and Jarupla Surendar

Abstract
The application of fibers from various sources in food production is increasing due to their beneficial effects on human health. The aim of this paper is to investigate the effects of non-modified and modified sugar-beet fibers on dough and cookie shelf life, cookie texture and cookie crumb quality. Dry sugar-beet fibers were ground, sieved through a laboratory sieve and a fraction with particles less than 95 µm was used for further treatment. It was hydrated for 24 h and pressed for removing excess water. In such a way, hydrated but non-modified fibers were obtained. Part of the non-modified fibers was exposed to a further treatment with H_2O_2, at the pH values: 3.5, 7 and 11 for the additional 24 h. Treated blends were neutralised, washed with tap and distilled water, pressed and blended to a homogenous mass with fine particles. In such a way modified fibers were obtained. Dough and cookie were made from white flour, powdered vital gluten, salt and yeast (as it is used in regular cookie production), without fibers, with non-modified fibers and with modified fibers. Experiments were planned so that the quantity of the applied fibers in the blends varied from 0% to 15%, while gluten quantity varied from 0% to 5%. An enrichment of cookie with less than 10% of non-modified fibers, accompanied with a few percent of gluten, is highly recommended.

Keywords: Exploration, characterization, dietary fiber extracted, sugar beet (*Beta vulgaris* L.), incorporation, cookies

Introduction
Sugar beet (*Beta vulgaris* L.) belongs to Chenopodioideae family, this is a native of the temperate climate but its cultivation has extended to subtropical countries and is being successfully grown in Iran, Iraq, Algeria, Egypt, Afghanistan and Pakistan. Sugar beets grow exclusively in the temperate zone in contrast to sugarcane, which grows exclusively in the tropical and subtropical zones. The sugar beet has a conical, white, fleshy root (a taproot) with a flat crown. The plant consists of the root and a rosette of leaves. Sugar is formed by photosynthesis in the leaves and is then stored in the root.

Sugar beet cultivated from *Beta vulgaris* is a plant which contains a high concentration of sucrose. Sugar can represent from 15 to 20 percent of root's total; however, the sugar content in sugar beets can vary from 12 percent to more than 20 percent. Nearly 75 percent of sugar beet is water and 25 percent of its dry matter included 20 percent of total dry matter contains sucrose and soluble solids in water and the remaining 5 percent contains insoluble solids.

The term "dietary fibre" was coined by 'Hipsley' in 1953, to refer to the non-digestible constituents of plants that make up the plant cell wall. 'Dietary Fibre' is a generic term that covers a wide variety of substances with different physical properties and various physiological effects. The occurrence of the fibre depends on the sources, for example- in vegetables, fibre is mainly concentrated on the skin but rarely in the rind too, while in cereals it is mainly found in the bran portion, whereas in fruits it is not only present in the skin but also in the fruity portion i.e. the mesocarp. Generally, the fibre in the dressed, trimmed or processed material is the one considered.

Importance of nutritional significance of dietary fibre in human body:
Dietary fibre includes polysaccharides, oligosaccharides, lignin and associated plant substances. Dietary fibre promotes beneficial physiological effects including laxation, and/or blood cholesterol attenuation, and/or blood glucose attenuation". These unavailable carbohydrates fall into two major groups, based on the structural components. It covers a wide variety of substances that are broken down extensively but incompletely digested in the large intestine by the symbiotic bacteria yielding fatty acids and thus not supplying the host with carbohydrates the principal characteristic of dietary fibre, responsible for cholesterol lowering

and that this effect is due to increased excretion of cholesterol from body. The health benefits coupled with functional properties such as hydration capacity have created a renewed interest in research work on dietary fibre.

Research have been done on many fibre supplements which are obtained from by-products resulting from the processing of fruits, vegetables, spices, legumes and other food products. Increased use of fibre supplementation would therefore no-t only improve the health benefits and functional properties of many foods, but could also provide ecological benefits to food producers (Makee and Latner, 2000) [11]. However, in view of increasing importance of dietary fibre in human nutrition, the United States Food and Drug Administration and the National Advisory Committee in Great Britain have both recommended a dietary fibre intake of 20-35 g/person/day. Addition of sugar beet fibre to semolina increased dietary fibre content but adversely affected color and cooking loss of spaghetti (Ozboy and Koksel, 2000) [13]. Owing to its high pectin content (15-30%) on dry weight basis, and its availability in large quantities.

Materials and Methods

Materials

Sugar beet (PA 86-2530) was obtained from fruit and vegetable research station and Dry land research station and cotton research Centre, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani.

Methods

Different characteristics of raw material and final products were determined and adopted methods for the same are summarized under following suitable headings and sub-headings:

Physical properties of sugar beet tuber

Physical properties such as length and diameters were determined in millimeter with the help of a vernier caliper. The weight of whole tubers was measured using satorious digital balance.

Chemical Composition

Chemical composition of whole sugar beet tubers, sugar beet pulp, sugar beet powder, dietary fibres and cookies is determined as follows:

Moisture

The moisture content was determined according to method No. 44-15 A of (AACC, 2000) [1].

$$\text{Moisture \%} = \frac{\text{Initial weight} - \text{final weight}}{\text{Total weight of sample}} \times 100$$

Crude Protein

The crude protein was determined by the Micro Kjeldhal's method as described in method No. 46-10 of (AACC, 2000) [1].

$$\% N = \frac{\text{Sample-Blank)} \times N \text{ of } H_2SO_4 \times 0.014 \times \text{D.F.}}{\text{Aliquot taken x Weight of sample (g)}} \times 100$$

Total Protein = % Nitrogen × 6.25

Crude Fat

The crude fat was determined by Soxhlet extraction as described in method No. 30-10 (AACC, 2000) [1]. Fat percentage was calculated according to the following formula.

$$\text{Crude fat (\%)} = \frac{\text{Final weight of flask} - \text{Empty weight of flask}}{\text{Weight of sample}} \times 100$$

Total Ash

The ash was determined as a total inorganic matter by incineration of the samples at 600 ºC according to method No. 08-01 of AACC (2000) [1].

The ash of sample was calculated through following formula.

$$\text{\% Ash} = \frac{\text{Weight of crucible with ash} - \text{Weight of empty Crucible}}{\text{Total weight of sample}} \times 100$$

Crude Fiber

Crude fiber was determined by following the method No. 32-10 as described in (AACC, 2000) [1]. The crude fiber percentage was calculated by using the following formula.

$$\text{Crude fiber (\%)} = \frac{\text{Weight of residue} - \text{Weight of ash}}{\text{Weight of sample}} \times 100$$

Extraction of dietary fibre from sugar beet

Sugar beets washed, thinly sliced, and the sugar extracted from the beets by hot water. The remaining beet pulp was pressed through grinder, sieved, controlled and dried at different temperatures and further ground and stored in HDPE pouches until further use.

Drying Kinetics

Drying kinetics is necessary to determine the rate of drying of product with different intervals of time (Borah *et al.*, 2015) [6]. of sugar beet dietary fibre at different temperature is determined by determination of moisture content at the interval of 1h for 8 hours. The moisture content was determined according to method No. 44-15 A of (AACC, 2000) [1]. 5g of sample was taken in tarred crucible and dried in a hot air oven at 100 ± 5 ^{0}C to a constant weight. The moisture content was calculated by the formula given below.

$$\text{Moisture \%} = \frac{\text{Initial weight} - \text{final weight}}{\text{Total weight of sample}} \times 100$$

Dietary fibre profile

Total dietary fibre was estimated in fibre samples and processed products using method of Asp *et al.* (1983) [5]. Sample (1 g) was taken in Erlenmeyer flask, 25 ml of 0.1 M sodium phosphate buffer (pH 6.0) added to suspended uniformly. Termamyl (100 mg) was added and incubated in a boiling water bath for 15 min, cooled and 20 ml of distilled water added and pH adjusted to 1.5 with 4 N hydrochloric acid. Pepsin (100 mg) was added and incubated at 40 ºC with agitation for 60 min, cooled, 20 ml of water added and pH adjusted to 6.8 with 4 N sodium hydroxide. Thereafter, 100 mg of pancreatin enzyme was added and incubated at 40 ºC with agitation for 60 min, cooled and pH was adjusted to 4.5 with 4 N hydrochloric acid. The solution was filtered through the dry celite as the filter aid.

Preparation of Cookies
Hydrogenated fat, powdered sugars were creamed. The dry ingredients i.e. Maida, fibres powder, baking powder, sodium bicarbonate, ammonium bicarbonate etc. were mixed together. The dry mix and homogenous paste of sugar and fat were mixed thoroughly. It was thoroughly kneaded manually by adding required amount of water. It is kneaded for five minutes. The dough so prepared was rolled in a uniform shape and of 6 mm thickness and were cut into round shape cookies with the help of cutter. These cookies were baked at 175 ^{0}C for 15 minutes in oven. The process is summarized in Figure-1

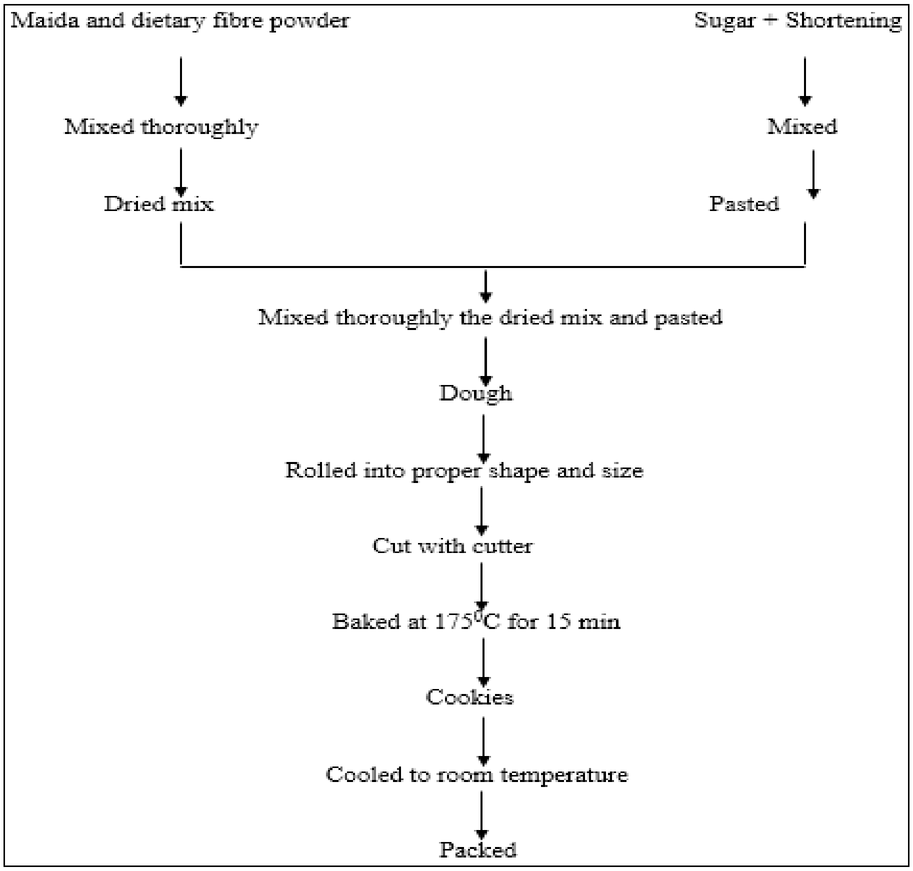

Fig 1: Flow sheet for preparation of Cookies

Organoleptic evaluation
The optimized dietary fibre based functional foods were evaluated in relation to the sensory preference using 9-point hedonic scale with anchor points, 1 (dislike very much) and 9 (like very much). A semi-trained panel of 10 judges evaluated the samples which were randomly presented initially and periodically for organoleptic evaluation on a nine point hedonic scale. In this nine point hedonic scale, '6' was considered as the cutoff point for a stable and well accepted product.

Textural Analysis Profile of Cookies
Stable Micro System *TAXT2 plus* Texture Analyzer was used for texture profile analysis (TPA) of cookies prepared by different treatments. The test was configured so that the seven TPA parameters, hardness, cohesiveness, springiness and chewiness, were calculated at the time of the test by determining the load and displacement at predetermined points on the TPA curve. Hardness (H) was the maximum load, expressed in kg, applied to the samples during the first compression.

Results and Discussion
Sugar beet (*Beta vulgaris* L.) is a plant whose root contains a high concentration of sucrose and it is grown commercially for sugar production. The sugar beet has a conical, white, fleshy root (a taproot) with a flat crown. Sugar is the primary value of sugar beet as a cash crop. The pulp, insoluble in water and mainly composed of cellulose, hemicellulose, lignin, and pectin, is used in animal feed. The by-products of the sugar beet crop, such as pulp and molasses, add another 10% to the value of the harvest.

Preparation of sugar beet dietary fiber
The mode of isolation and preparation of these fibers is presented in Material and Methods. The data pertaining to drying kinetics, chemical composition, particle size distribution, and effect of particle size on dietary fiber content functional properties of sugar beet dietary fiber and SEM of sugar beet powder, fiber and cookies is summarized under following suitable sub-headings:

Drying Kinetics of Sugar beet dietary fiber at different temperatures
The rate of drying is generally dependent on raw material as well as the temperature employed. It is also important to avoid the thermal abuse of the food materials so that functional characteristics can be protected. Thus, the drying kinetics of the fiber sources was planned and studied. The data pertaining to drying curves of sugar beet dietary fiber at different temperatures (*viz.* 60 ^{o}C, 70 ^{o}C and 80 ^{o}C) is tabulated in Table-8 and graphically presented in Figure-1.

Table 1: Effect of different temperatures on rate of drying of sugar beet dietary fibers

Sr. No.	Drying time (hr)	Drying Temperatures		
		60 °C	70 °C	80 °C
1	0	76.3	76.3	76.3
2	1	73.23	72.15	71.34
3	2	75.97	74.23	70.16
4	3	73.76	71.94	67.86
5	4	67.39	66.76	65.12
6	5	39.23	34.17	32.18
7	6	18.39	15.42	12.34
8	7	5.37	4.34	3.4
9	8	4.87	3.23	3.17

From the results of rate of drying of sugar beet dietary fiber, it was observed that after 3h, sudden decrease in the moisture content was observed while it became almost constant from 7 to 8h.

Chemical composition of sugar beet dietary fiber

After preparation of sugar beet dietary fiber, it was analyzed for chemical composition and the data obtained is presented in Table-2 and graphically represented in Figure-2.

Table 2: Chemical Composition of Sugar beet dietary Fiber

Sr. No.	Parameter	Sugar Beet Dietary Fiber	% of dry matter (Calculated values)
1	Moisture content (%)	8.8	---
2	Dry matters (%)	91.2	100
3	Ash content	4.23	4.64
4	Crude protein	8.62	9.45
5	Crude fat	1.21	1.33
6	Total Fiber	71.64	78.55
7	Sugar	5.50	6.03

* Each value is an average of three determinations

The results revealed that moisture content of these screened fiber samples found to be 8.8%. Miguel and Belloso (1999) [12] have reported that the moisture of dietary fiber concentrates depends primarily on the intensity of the pulp dehydration during the processing of dietary fiber concentrates. The ash content, which reflects not only the minerals but also shows the processing quality of the food, depends on the source which is found to be 4.23%. The protein content was highest 8.62% which clearly showed that sugar beet dietary fiber is a good source of protein. The fat content was very less (1.21%). Total fiber content was found to be 71.64%. Saura-Calixto *et al.* (2000) [15].

Functional properties of sugar beet dietary fiber

Particle size is a very critical parameter for maintaining homogeneity of the products. It affects the functional properties, which has paramount importance in development of food products and also in human physiology. It has been reported that incorporation of finely ground wheat bran in a low-fiber diet causes severe constipation in human subjects. Schneeman (1989) [14] also explained that if the cell wall is completely intact, digestive enzymes may penetrate and release the nutrients from the food slower than if the cell wall has been disrupted by grinding. Firstly, the quantity of isolated fiber fractions i.e. soluble and insoluble fractions is important. Secondly, the functional properties of dietary fiber such as, hydration capacity, swelling capacity, oil/water binding capacity and cation exchange capacity, reflects on its action in the food products. Thirdly, antioxidant activity and phenolic compounds support the health promoting activities. Thus, varied properties govern the strength and usefulness of the natural fibers.

The effect of particle size on the functional properties of selected fiber samples have been presented in Table 3. Hydration properties have been widely studied in food functionality, due to their importance in foods. It is the major mechanism by which dietary fiber increases stool output. It provides more information on the fiber, which will help to understand the behavior of fiber in foods or during gut transit (Adiotomre *et al.*, 1990; Guillon and Champ, 2000) [2].

Table 3: Effect of different particle size on functional properties of sugar beet dietary fiber

Sr. No.	Particle size	WHC (g/g)	WBC (g/g)	Swelling capacity (ml/g)	OBC (g/g)	Particle Density (g/cm^3)	Cation Exchange Capacity (Meq/g)
1	30 (250 to 410 µm)	12.67	17.91	25.92	2.31	1.14	0.92
2	60 (140 to 230 µm)	10.87	14.32	23.78	2.14	1.21	0.87
3	100 (40 to 110 µm)	9.53	11.72	19.37	1.72	1.29	0.84

* Each value is an average of minimum 3 determinations

Optimization of fiber rich cookies

Generally, the products are developed by permutation combination method, wherein the products are developed by optimizing the major ingredients, studying the important physicochemical properties and by the acceptability of the product. The ingredient composition, considering the functionality was chosen along with the responses based on the type of the product. However, sensory evaluation was taken as a constant response for all the developed products.

Fiber rich cookies were developed using fibers at different percentage i.e. 5-20%. These cookies were evaluated to determine difference in their hardness, physicochemical parameters and organoleptic properties, which varied with percentage of incorporation in the product. The effect of baking was observed on the dietary fiber profile of the optimized product, which was further evaluated for its storage stability.

Physical Properties of fiber rich cookies
The data regarding diameter, thickness, spread ration, bulk volume, weight and bulk density of cookies is presented in Table-14.

Table 4: Effect of sugar beet dietary fibers on physical parameters of cookies

Sample Code	Diameter (cm)	Thickness (cm)	Spread ratio	Bulk volume (ml)	Weight of cookies (g)	Bulk density (gm/ml)
T_0	5.05	0.695	7.266	16.4	10.70	0.652
T_1	5.30	0.691	7.670	16.32	10.69	0.655
T_2	5.34	0.687	7.773	16.28	10.65	0.654
T_3	5.37	0.675	7.955	16.19	10.65	0.657
T_4	5.42	0.667	8.126	16.1	10.72	0.665

*Each value is a mean of three determinations.

It could be observed from the Table-14 that the weight of cookies decreased as the concentration of dietary fiber is increased. However at 20% dietary fiber incorporation it is found to be increases and highest (10.72g). Diameter of cookies significantly increased with increasing incorporation of dietary fiber while the thickness of cookies is found to decrease. The results obtained in the present study are in agreement with those reported by Leon *et al.* (1996) [10]

Proximate composition of fiber rich cookies
Proximate composition of food products gives the picture on the major nutrients in the product. The proximate compositions 15% sugar beet dietary fiber incorporated cookies is compared with the samples prepared with no fiber addition i.e. control samples and the results are presented in Table-5.

Table 5: Proximate composition of fiber rich cookies (control cookies and cookies with 15% sugar beet dietary fiber incorporated cookies)

Sr. No.	Parameter	Control Cookies	Cookies with 15% sugar beet dietary fiber
1	Moisture content (%)	2.16	2.46
2	Total ash (%)	1.17	1.51
3	Crude protein (%)	5.80	4.10
4	Total fat (%)	21.88	22.34
5	Carbohydrate (Calculated)	68.96	69.56

* Each value is an average of three determinations

The moisture content and ash content in all the fiber rich products ranged from 1.51 to 3.03 and 1.17 to 2.36%, respectively. It was observed that the fiber rich products retained relatively more moisture than the control sample. It may be due to increased water absorption capacity by the fiber powders, which are hydrophilic in nature. Ajila *et al.* (2008) also noted that, during mixing the water required to prepare the cookie dough increased in presence of fiber.

Organoleptic evaluation of cookies
Standard method was followed for preparation of cookies and different samples were prepared by incorporating varying levels of prepared sugar beet dietary fibers at the concentration of 0, 5, 10, 15 and 20 percent. The effects of dietary fiber incorporation on organoleptic characteristics of cookies are presented in Table-12.

Table 6: Effect of fiber on organoleptic quality cookies

Sample Code	Sugar beet fiber (%)	Colour and Appearance	Taste	Texture	Overall Acceptability	Browning Index, OD at 420 nm
T0	0	7.9	8.0	7.8	8.0	0.18
T1	5	7.8	8.0	7.8	8.0	0.21
T2	10	7.6	8.0	7.7	7.9	0.24
T3	15	7.5	8.0	7.5	7.8	0.28
T4	20	6.0	7.5	5.2	6.0	0.31
Mean		7.36	7.9	7.2	7.54	0.244
SE±		0.7432	1.1096	0.6348	0.5778	0.0096
CD at 5%		2.2373	3.3401	1.9111	1.7394	0.0289

* Each value is average of ten evaluations

It is learnt from the results that fiber in the cookie formulation significantly ($p \leq 0.05$) affected the acceptance of the product. The product was acceptable only till 10% level, as further sugar beet dietary fiber incorporation led to increased browning in the product. No significant change in observed in cookies up to 15% of concentration of dietary fiber. The texture acceptability of cookies decreased with increase in concentration up slightly up to 15%, however drastic reduction in textural acceptability was observed in sample containing 20% of sugar beet dietary fiber.
The colour darkening may be attributed to Millard reactions between sugars and amino acids, due to higher percentage of protein and sugar content in fiber rich cookies (Arshad *et al.*, 2007) [4]. Chaudhary and Awasthi (2009) [7] also reported a decrease in the appearance scores of biscuits with increased level of bran. Thus, considering the acceptance, browning and the level of fiber, sugar beet cookies with 15% fiber incorporation stood as the optimized product.

Textural Analysis Profile of fiber rich cookies
Texture is very important to the consumer in the determination of food quality. The most important textural characteristic in cookies is its hardness which can be evaluated by the force required to puncture or fracture a sample (Gaines, 1991) [8]. The Textural Profile of Cookies is determined by using TA-XT Texture Analyzer and the results obtained are depicted in Figure – 10.

References

1. AACC. Official Methods of Analysis of AACC International, American Association of Cereal Chemists, Washington DC, 2000.
2. Adiotomre J, Eastwood MA, Edward CA, Brydon AG. Dietary fibre: in vitro methods that anticipate nutrition and metabolic activity in humans. American Journal of Clinical Nutrition. 1990; 52:128-134.
3. Ajila CM, Leelavathi K, Rao UP. Improvement of dietary fibre content and antioxidant properties in soft dough biscuits with the incorporation of mango peel powder. Journal of Cereal Science. 2008; 48:319-326.
4. Arshad MU, Anjum FM, Zahoor T. Nutritional assessment of cookies supplemented with defatted wheat germ. Food Chemistry. 2007; 102:123-128.
5. Asp NG, Johansson CG, Hallmer H, Siljestrom M. Rapid enzymatic assay of insoluble and soluble dietary fibre. Journal of Agriculture and Food Chemistry. 1983; 31:476-488.
6. Borah A, Hazarika K, Khayer SM. Drying kinetics of whole and sliced turmeric rhizomes (*Curcuma longa* L.) in a solar conduction dryer. Information Processing in Agriculture. 2015; 2(2):85-92.
7. Chaudhary A, Awasthi P. Quality evaluation of biscuits containing parboiled rice bran. Journal of Food Science and Technology. 2009; 46(1):83-34.
8. Gaines CS. Instrumental measurement of the hardness of cookies and crackers. Cereal Food World. 1991; 36(12):989-996.
9. Guillon F, Champ M. Structural and physical properties of dietary fibre and consequences of processing on human physiology. Food Research International. 2000; 33:233-245.
10. Leon AE, Rubiolo A, Anon MC. Use of triticale flours in cookies: Quality factors. Cereal Chemistry, 1996; 73:779-784.
11. Makee LH. Latner KC. Underutilized sources of dietary fibre; A review. Plant Foods for Human Nutrition. 2000; 55:285-304.
12. Miguel NG, Belloso OM. Comparison of dietary fibre from by-products of processing fruits and greens and from cereals. Lebensm-Wissenschaft-und-Technologies. 1999; 32:503-508.
13. Ozboy O, Koksel H. Effects of sugar beet fibre on spaghetti quality, Zuckerindustrie. 2000; 125:248-250.
14. Schneeman BO. Dietary Fibre. Food Technology. 1989, 133-139
15. Saura-Calixto F, Garcia-Alonso A, Goni I, Bravo L. *In vitro* determination of the indigestible fraction in foods: An alternative to dietary fibre analysis. Journal of Agriculture and Food Chemistry. 2000; 48:3342-3347.