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PHYSICOCHEMICAL PROPERTIES OF DIETARY FIBER GELS PRODUCED FROM SOME CEREAL WASTES

BY

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ABSTRACT

Dietary fiber gels for calorie reduced foods were prepared from some cereal wastes and their physicochemical properties were investigated . Dietary fiber gel produced from 100 g of rice straw,corn cobs,barely hulls and corn bran was 51.43,50.56,36.64 and 23.08 g, respectively. Corn cobs and rice straw contained high levels of crude fiber (39.64 and 37.58 %,respectively) and low level of fat (0.94 and 0.42%,respectively).Some increase in total dietary fiber,insoluble dietary fiber, cellulose and hemicellulose and on the opposite side decrease in soluble dietary fiber and lignin were observed as a result of preparing fiber gels from different tested cereal wastes .Insoluble dietary fiber of gels obtained from corn bran,rice straw,corn cobs and barely hulls were 81.23,78.84,86.33 and 73.24%, respectively .Different fiber gels had higher water holding and oil absorption capacity values than the corresponding cereal wastes .Scanning electron microscope was also used to examine the morphological alteration of different cereal wastes and their fiber gels .

Key words: Cereal wastes, Dietary fiber gel, Oil absorption capacity, Scanning Electron Microscopy, Water holding capacity.

INTRODUCTION

Air pollution is produced by the ash, fumes, and toxic organic gases produced by the incineration of rice straw. In Japan, such incineration is now prohibited in rice fields. A certain amount of rice straw waste in Japan is recycled in agricultural and livestock farms, but most is treated as agricultural waste (Kumagai *et al.*, 2007).

Residues from agriculture and agro-industries are the non-product outputs from the growing and processing of raw agricultural products such as rice, corn, bean, and peanut. While such residues may contain valuable materials, their current economic values are less than the apparent cost of collection, transportation and processing for beneficial use. Therefore, they are often discharged as wastes (Bagby and Widstrom, 1987).

Dietary fiber gels are prepared by chemical and physical treatment of dietary fiber substrates until the cellular structures are almost completely disintegrated. The gels are characterized by high viscosities and high hydration capacities and can easily be dried and reconstituted. The gels can be used in a range of foods and non-food compositions and are particularly useful as reduced calorie fat (Inglett, 1997).

A hydrocolloidal fiber composite made from rice bran and barley flour called Ricetrim (used as a fat substitute in Thai foods) was found to have similar rheological properties to coconut cream (Inglett *et al.*, 2004). Fiber gel was also prepared from hulls of corn or oats as reported by Carriere and Inglett (2003).

Dietary fiber (DF) includes cellulose, lignin, hemicellulose, pectins, gums and other polysaccharides and oligosaccharides associated to plant. It is actually defined as "edible parts of plants or analogous carbohydrates that are resistant to digestion and absorption in the human small intestine with complete or partial fermentation in the large intestine" .It is conventionally classified into two categories according to their water solubility: IDF, insoluble dietary fiber (cellulose, part of hemicellulose and lignin) and SDF, soluble dietary fiber (pentosans, pectins, gums mucilage) (Mongeau, 2003).

The hemicelluloses unites a big group of high molecular polysaccharides, are insoluble in water but soluble in alkaline solutions. These polysaccharides are associated with cellulose and lignin and play an important structurally supportive role in building up of plant cell walls (Bidlack *et al.*, 1992 and Nakamura, 2003).

For several years, fat substitutes have been used to partially or fully replace fat. There are three main groups of fat replacers including carbohydrate-based fat substitutes; protein-based fat substitutes and lipid-based fat substitutes (Akoh, 1998). The carbohydrate-based fat substitutes are derived from cereals, grains, and plants that include digestible and non-digestible carbohydrates (starch derivatives and gums). They provide some of the functions of fat by binding water, and providing texture, mouth coating, and opacity (Giese, 1996).

Dietary fibers had been reported to produce numerous benefits to health, such as decreasing cardiovascular and gastrointestinal disease, decreasing blood cholesterol, and also preventing colon cancer, (Burton, 2000)

Properties of the gel from wheat fiber are listed to be colorless, odorless, good mouth feel, low calorie content, high roughage content, thixotropic and pseudo plastic tendency, heat and pH stable, high water binding and retaining capacity, inert and stable and insensitive to electrolytes, (Bollinger, 1995)

The objective of this study was to prepare dietary fiber gels from some cereal wastes (corn bran, rice straw, corn cobs and barely hulls) as a fat replacer for low caloric foods and evaluate their physicochemical characteristics.

MATERIALS AND METHODS

1 . Materials

Corn bran was obtained from Egyptian Company of Starch and Glucose, Mustorod, Cairo, Egypt. Barley hulls were obtained after milling the barley seeds using a universal type laboratory rice mill, from Food Technology Research Institute, Agriculture Research Center, Giza, Egypt. Rice straw was mainly obtained from a farm in Agriculture Research Center, Giza, Egypt. Corn cobs were collected from a farm in Monofia, Egypt. Heat stable amylase.-A-0164, protease.-Fiberzym Kit 7367503, and amyloglucosidase. Fiberzym Kit 7367503, were obtained from Sigma Chemical Co.

2 . Methods

2. 1 Preparation of dietary fiber gels

Dietary fiber gel of rice straw, corn bran, corn cobs and barley hulls, were prepared according to the method described by Carriere and Inglett (2003). In a 20 L plastic tank, one kg of fine ground fiber source was mixed with 11 L of water for the first stage of treatment. Approximately 10 ml of a 50% sodium hydroxide solution (sp.gr. 1.52 13.3% alkali concentration) was added to adjust the pH to 6.8.After heating the slurry to 90-94C°, 2.4 ml of(heat stable α-amylase 55.2 U/mg) was added to the mixture. The mixture was sheared in autoclave (Vision KMC 1221 made in Korea) at 90-98 C°. After 15 min, 175 ml of a 50% sodium hydroxide solution was added to adjust the pH>12 and the shearing was continued for 45 min .The solids were washed two times with 200 L of deionized water in a 300 L vat before collecting the solids on a 25-μm filter bag .The pH of the solids was approximately 7. In the second stage of treatment, the wet solids (volume amount 6 L) were adjusted to approximately pH 10 using a 50% sodium hydroxide solution. To this mixture, 500 ml of 30% hydrogen peroxide solution was added. And the mixture was autoclaved at 90-98 C° for 45min. The slurry was stirred with mild aggitation for 36 hr and the wet solids were collected on a 25μ m filter bag. The resulting gel was then dried to yield a powder of dietary fiber gel.

2.2 Chemical composition

Proximate analysis of cereal wastes and their fiber gels for moisture, protein, fat, ash and Crude fiber contents were determined according to A.O.A.C (2000) and for total dietary fiber (TDF), Soluble dietary fiber (SDF) and insoluble dietary fiber (InSDF) were determined according to the method described by A.A.C.C (1990). Cellulose matter and hemicellulose were determined according to Myhre and Smith (1960). Lignin was determined according to Martion (1964).

2.3 Water holding and oil absorption capacity

Water holding and oil absorption capacities were determinated according to Knuckles and Kohler (1982) .Water holding capacity is expressed as weight of water bound per g dry sample .Oil absorption capacity is expressed as g oil bound per g dry sample.

2.4 Scanning electron microscopy (SEM)

Scanning electron microscopy (SEM) was used to examine the morphological alteration of different cereal wastes and their fiber gel. Different samples were taken and immediately fixed in gluterdehyde (2.5%) for 24 h at 4 C°, then post fixed in osmium tetraoxide (1% OsO_4) for one hour at room temperature (Harley and Fergusen, 1990). The samples were dehydrated with pathing through ascending concentrations of acetone, then dried till the critical point and, finally, the sample were sputter coated with gold .The examination and photographing were donc through a jeol Scanning Electron Microscope (T.330 A) in the Central Laboratory of the Faculty of Agriculture, Ain Shams University.

2.5 Statistical analysis

The excremental data were analyzed using analysis of variance (ANOVA) followed by Duncan's multiple range test ($P \leq 0.05$) to determine a significant difference among samples. The data were analyzed according to User's Guide of Statistical Analysis System (SAS, 1996) at the Computer Center of Faculty of Agriculture. Ain Shams University.

RESULTS AND DISCUSSION

1. Chemical composition of some cereal wastes

Table (1) presents the chemical composition of some cereal wastes used to prepare fiber gel. It can be observed that different tested cereal wastes differed significantly ($P \leq 0.05$) in their chemical composition. Corn bran contained low crude fiber and ash (16.38%and2.42%, respectively) high fat and carbohydrates contents (2.74 and 70.22%, respectively) compared to the other cereal wastes. Corn cobs and rice straw had a high crude fiber (39.64% and 37.58%, respectively) and less fat than the other tested samples. Barely hulls and corn bran significantly contained more protein than other cereal wastes .Rice straw had a higher content of ash (16.42%) followed by barely hulls. Similar results were obtained by El-Amry (2006) and Sosulski and Wu (1988) that they have been worked.

Table (1): Chemical composition of some cereal wastes (on dry weight basis).*

Ceareal wastes	Moisture (%)	Protein (%)	Fat (%)	Ash (%)	Crude fiber (%)	Carbohydrates** (%)
Rice straw	6.41^c	4.22^b	0.42^d	16.42^a	37.58^b	41.36^d
Corn bran	4.22^d	8.24^a	2.74^a	2.42^d	16.38^d	70.22^a
Corn cobs	7.42^b	1.84^c	0.94^c	3.45^c	39.64^a	54.13^c
Barely hulls	7.83^a	8.53^a	1.67^b	9.23^b	21.64^c	58.93^b

* Means in a column showing the same letter are not significantly different (p>0.05).
**calculated by difference.

2. Yields of dietary fiber gel produced from some cereal wastes

Yield of dietary fiber gel produced from corn bran, rice straw, corn cobs and barely hulls, is given in Table (2) .Rice straw and corn cobs recorded the highest yield (51.43% and 50.56% respectively) of fiber gel, reflecting the predominance of insoluble dietary fiber (cellulose and lignin) in these fiber sources .The results showed also that corn bran had the least yield of fiber gel (23.08%) compared to the other tested samples. Also, barely hulls yield moderate fiber gel (36.64%). Carriere and Inglett (2003) found that the yield of corn fiber gel was 41%.

Table (2): Yields of dietary fiber gel produced from some cereal wastes.

Cereal wastes	Yield (%)
Rice straw	51.43
Corn bran	23.08
Corn cobs	50.56
Barely hulls	36.64

3. Chemical composition of different dietary fiber gels

Table (3) shows the chemical composition of dietary fiber gel prepared from different cereal wastes .Rice straw gel contained higher crude fiber (50.33%) but lower moisture and fat contents compared with the other fiber gel. Oppositely,corn bran gel contained the highest content of carbohydrates,fat and protein. Corn cobs gel presented a moisture content (6.44%) higher than different samples. The higher ash content was recorded for barely hulls gel (8.46%).

The major modification in cereal wastes composition after pretreatment with alkaline hydrogen peroxide to produce dietary gel was a decrease in ash,due to removal of high amount of silica reaction with sodium hydroxide in the pretreatment resulted in soluble silicates,that were eliminated during the washing procedure (Houston, 1972).

A reduction in protein and fat content also occurred .Soluble proteins and saponified fatty acids (due to the alkaline pH) were probably lost during washing (Chen and Houston, 1970 and Nawar, 1985) .Minor causes, like fatty acid oxidation by oxidryl and superoxide radicals formed during decomposition of hydrogen peroxide should be also considered (Jacks and Hensarling,1989).Total fiber should relative increase that could be attributed to the decrease of other components. In this respect Inglett and Carriere (2001) found similar decrease in fat, protein, and minerals in corn bran gel as a result of such treatment.

4. Dietary fiber fractions

The polysaccharides were divided into three fractions depending on their solubility in water and alkali. These fractions were pectin substances, (soluble in water), hemicellulose (insoluble in water but soluble in dilute alkali) and cellulose (insoluble in a strong alkali) .The major polysaccharide was cellulose which is a linear beta-linked glucan of high molecular weight, ranging between 500.000 and 1 million Dalton (Candido and Campos, 1996).

Table (3): Chemical composition of fiber gel produced from some cereal wastes (on dry weight basis)*.

Samples	Moisture (%)	Protein (%)	Fat (%)	Ash (%)	Crude fiber (%)	Carbohydrates** (%)
Rice straw gel	2.74^{d}	0.94^{b}	0.45^{b}	6.45^{b}	50.33^{a}	41.83^{d}
Corn bran gel	5.72^{b}	2.54^{a}	1.72^{a}	0.43^{d}	23.64^{d}	71.67^{a}
Corn cobs gel	6.44^{a}	0.64^{c}	0.68^{b}	2.74^{c}	42.17^{b}	53.77^{b}
Barely hulls el	4.73^{c}	0.82^{bc}	0.53^{b}	8.46^{a}	39.93^{c}	50.26^{c}

*Means in a column showing the same letter are not significantly different ($p>0.05$).

**calculated by difference.

Total dietary fiber (TDF) of some cereal wastes and their fiber gel, soluble dietary fiber (SDF) and insoluble dietary fiber (InSDF). The latter including cellulose, hemicellulose and lignin are given in Table (4).

Results indicated that the values of TDF, SDF, InSDF, cellulose, hemi-cellulose and lignin were changed after treatment of cereal wastes to prepare a fiber gel .This changes were recorded an increase in TDF, InSDF, cellulose, and hemi-cellulose and a decrease in SDF and lignin. These means that preparation process of fiber gel from fiber samples led to an increase in the insoluble dietary fiber and a decrease in SDF .For example, InSDF values of rice straw, corn bran, corn cobs and barely hulls were 72.23%, 60.68%, 78.47% and 45.72% respectively and they increased to 78.84%, 81.23%, 86.33% and 73.24% for the corresponding gels. On the other hand SDF reduced from 12.87%, 5.61%, 8.73% and 18.04% for corn bran, rice straw, corn cobs and barely hulls to 7.84%, 6.75%, 5.45% and 9.43% for their gels respectively. In concl-usion corn cobs gel characterized by the highest contents of TDF, InSDF and cellulose and the lowest value of SDF.

Similar result was obtained by Inglett and Carriere (2001) who found that corn bran gel contains 86.21% TDF. Sandak (2004) found the same increasing in TDF, InSDF, and cellulos when prepared fiber gel from soy bean hull and broad bean hull.

Table (4): Dietary fiber fractions of some cereal wastes and their dietary fiber gel (on dry weight basis)*.

Components (%)	Cereal wastes			
	Rice straw	Corn bran	Corn cobs	Barely hulls
Total dietary fiber (IDF)	77.82^b	73.53^c	87.19^a	63.75^d
Soluble dietary fiber (SDF)	5.61^d	12.87^b	8.73^c	18.04^a
In soluble dietary fiber (In SDF)	72.23^b	60.68^c	78.47^a	45.72^d
Cellulose	39.81^b	29.24^c	49.14^a	26.12^d
Hemicellulose	19.41^c	21.93^a	21.25^b	16.82^d
Lignin	17.34^a	3.63^d	9.33^b	7.34^c
	Dietary fiber gel			
	Rice straw	Corn bran	Corn cobs	Barely hulls
Total dietary fiber (IDF)	85.53^c	89.03^b	91.72^a	83.20^d
Soluble dietary fiber (SDF)	6.75^c	7.84^b	5.45^d	9.43^a
In soluble dietary fiber (In SDF)	78.84^c	81.23^b	86.33^a	73.24^d
Cellulose	48.05^c	45.13^d	57.95^a	51.58^b
Hemicellulose	32.05^a	29.63^b	24.13^c	17.14^d
Lignin	4.65^{ab}	0.94^c	5.03^a	4.13^b

*Means in a raw showing the same letter are not significantly different ($p>0.05$).

5. Water holding capacity.

Water holding capacity (WHC) is the ratio of moisture retained in sample to the initial moisture content,so higher percentage indicates release of less moisture (Pietrasik and Duda, 2000) .

Water holding capacity of some cereal wastes and their fiber gel was given in Fig (1) The water holding capacity increased from 4.42, 3.75, 4.18 and 2.43 g water /g fiber for rice straw, corn bran, corn cobs and barely hulls to 7.67, 6.34, 8.24, 6.34 for the corres-ponding gels, respectively. These increased value may be due to the result of removal of ash, (silica) and lignin solublization (Tables 3 and 4). Houston (1972) described rice hulls as containing a resistant structure formed by lignin and silica. The destruction of this rigid structure could increase the size of interstitial spaces within the cell wall material and facilitate the hydration of cell wall components. According to various authors (Gould 1984; Gould *et al.*, 1989a and Jasberg *et al* ., 1989), alkaline hydrogen peroxide removed lignin by solublization, while at the same time modifying cellulose crystallinity and increasing water absorption. Ning *et al.* (1991) stated that the modification of water absorption capacity may be partially due to the swelling of the physical structure of the fiber by alkaline.

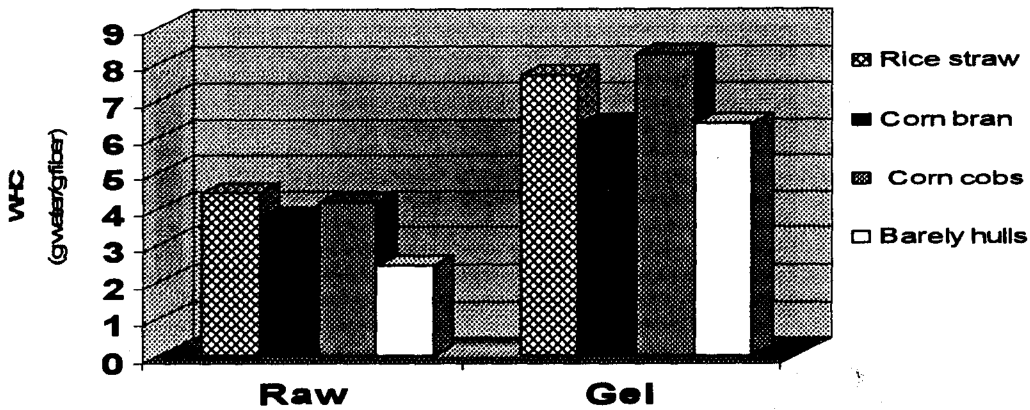

Fig. (1): Water holding capacity (WHC) of some cereal wastes and their fiber gel (g water/g fiber).

The water holding capacity in high dietary fiber sources depend on their chemical and physical structure Mongeau and Brassard (1982) and Gould *et al.*, (1989b) indicated that this increase may be attributed to the increases in the amount of interstitial space within the particles, that will be seen in the scanning electron micrographs . These results are in agreement with that published bySosulski and Gadden (1982) who found that the WHC was increase by increasing the contents of cellulose. Also, cellulose has the ability to stabilize large quantities of water by the formation of gel with lubricant and flow properties similar to in at happened by the lipids and cellulose gel which was used as a fat replacer (Candido and Campos, 1996) .

6. Oil absorption capacity

Fig (2). showed that the oil absorption capacity was increased from 4.17, 2.09, 2.83 and 3.01 g oil /g fiber for rice straw, corn bran, corn cobs and barely hulls to 5.96, 3.78, 5.42 and 5.63 g oil /g fiber for the corresponding gels. These results are in agreement with that published by (Sosulski and Gadden, 1982) who found that the OAC was increase by increasing the contents of cellulose.

7. Scanning electron microscopy (SEM)

The numerous applications of dietary fiber are based on their distant fiber morphology. Thus, there may be a relation between the surface feature and the properties of dietary fiber .In order to attain a better understanding of the effect of gel preparation, a microscopic study was carried out using scanning electron microscopy (SEM). Representative SEM micrograph, taken at the magnification of 500x of some cereal wastes and their gels with water was shown in Fig (3).

SEM micrographs of different tested cereal wastes and their fiber gels with water clearly indicate that the differences in microstructure of various samples are significant as shown in Fig (3) Also, different examined samples were characterized by several unique structural properties. Rice straw and barely hulls (Fig 3 A and D) have a smooth and compact surface. However, there are slight pitting and cracking or crazing on the surface of corn bran and corn cobs (Fig 3B and C).

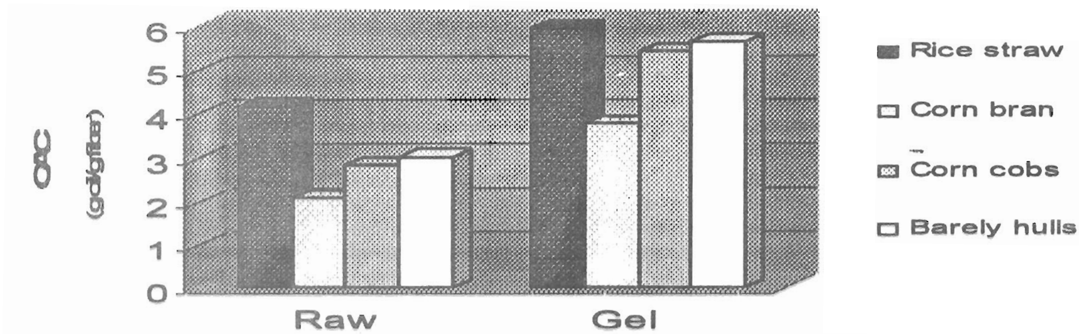

Fig . (2): Oil absorption capacity (OAC) of some cereal wastes and their fiber gel (g Oil /g fiber).

The micrographs of dietary fiber gels are in sharp contrast to the initial cereal wastes before processing into gels .Using magnification of 500x, there is visual evidence of rough morphological cell-wall material, along with some porosity and spherical structures of dietary fiber gels This structure, more open than the cereal wastes could facilitate water penetration and absorption, improving functionality related with these properties (Fig 3 E, F, G and H).

Results of SEM confirmed that dietary fiber gels, in sharp contrast to cereal wastes, had the ability to retain large amount of water in smooth deformable particles and porosity structure as can be seen in Fig (1). These results are in accordance with Larrea *et al* . (1997), Inglett and Carriere, (2001), Colom *et al*. (2003), Xie *et al* ., (2007) and Yin *et al*. (2007).

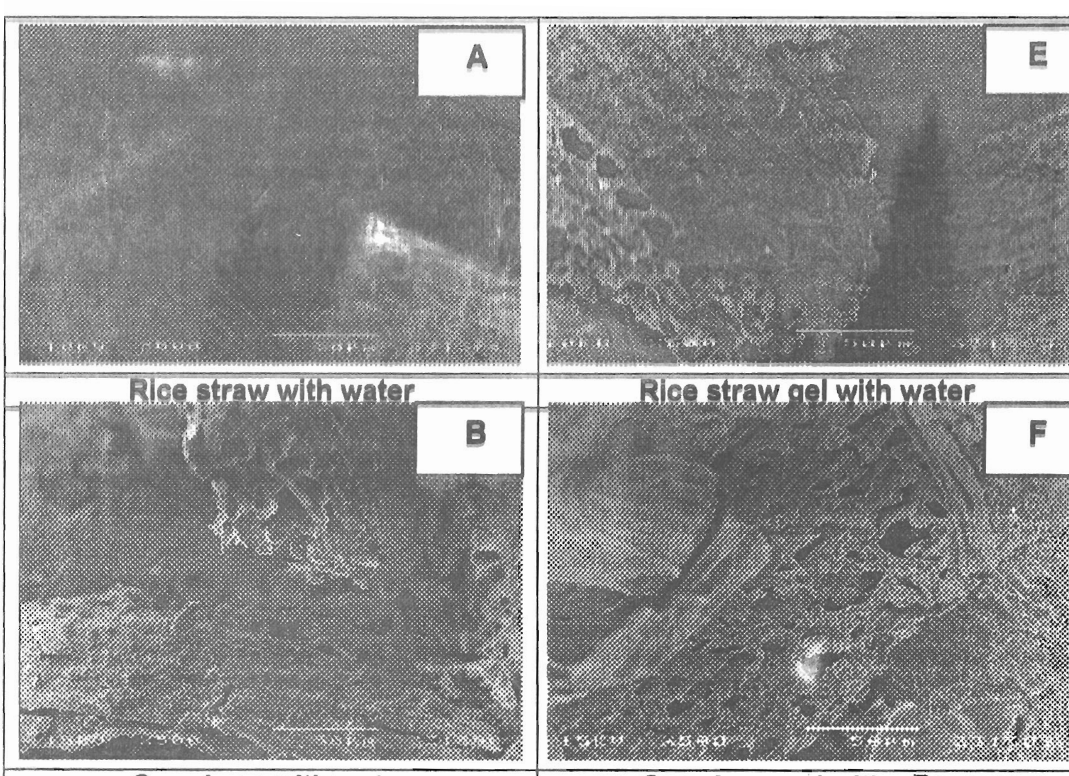

Fig (3): SEM scanning electron micrographs (500x) of some cereal wastes samples (A-D) and their fiber gel (E-H), mixed with water and air dried on surface

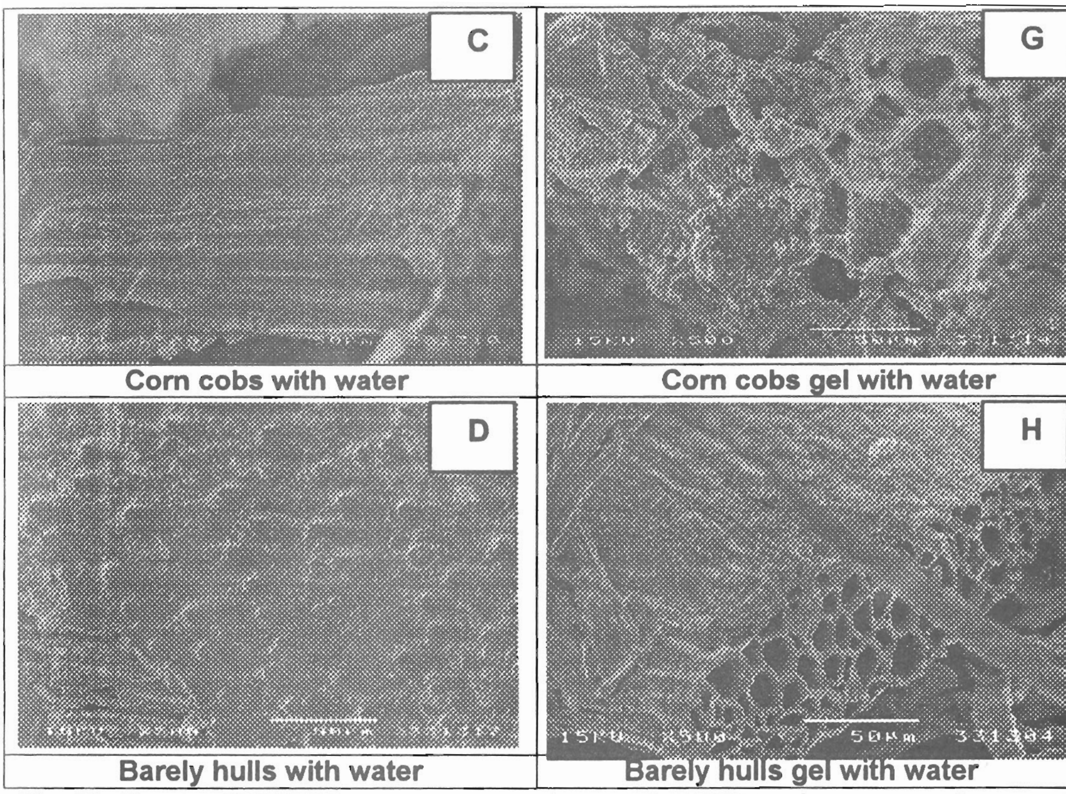

Fig (3) Count.: SEM scanning electron micrographs (500x) of some cereal wastes samples (A-D) and their fiber gel (E-H), mixed with water and air dried on surface

REFERENCES

A.A.C.C. (1990). American Association of Cereal Chemists. Approved Methods 12th Ed. Pup. Univ. of Fam. St. Paul, Minn, USA.

A.O.A.C. (2000). Association of Official Analytical Chemists. Official Methods of Analysis. 17th Ed., Arlington Virginia 22201. USA.

Akoh, C.C. (1998). Fat replacers. Food Technol. 52 (3): 47–53.

Bagby, M.O and Widstrom N.W. (1987). Biomass uses and conversions. In: Corn: Chemistry and Technology,, pp. 575-590 Watson, S.A and P.E. Ramstad, (eds.). American Association of Cereal Chemists, St. Paul, MN.

Bidlack, J.; Malone, M. and Benson, R. (1992). Molecular structure and component integration of secondary cell walls plant. Proc. Okla. Acad. of Sci. 72: 51–56.

Bollinger, H. (1995). Wheat fiber gel in the food industry. Food-Marketing & Technol. 9 (5): 4-6.

Burton, B. (2000). Symposium: dietary composition and obesity: do we need to look beyond dietary fat?. The Journal of Nutrition, 130 (25): 272–274.

Candido, L.M.B. and Campos, A.M. (1996). Alimentos parafins especiais: Dieteticos, p.500 Livraria Varela Sae Paulo,Brasil .c.f. Sandak (2004).

Carriere, C.J. and. Inglett, G.E (2003). Constitutive analysis of the non linear viscoelastic properties of cellulosic fiber gels produced from corn or oat_ hull .Food Hydrocolloids 17:605-614.

Chen, L.A. and Houston, D.F. (1970). Solublization and recovery of protein from defatted rice bran .Cereal Chem. 46:72-79.

Colom, X.; Carrasco, F.; Pages, P. and Canavate, J. (2003). Effects of different treatments on the interface of HDPE/ lignocellulosic fiber composites. Composites Sci. and Technol. 63:161- 169.

El-Amry, H.G. (2006). Utilization of some graminea by-products as hypoglycemic agent. J. Agric. Sci. Mansoura Univ.Egypt, 31(6): 4077-4086.

Giese, J. (1996). Fats, oils, and fat replacers. Food Technol. 50(4): 78–83.

Gould, J.M.(1984). Alkaline peroxide delignification of agricultural residues to enhance enzymatic saccharification. Bio-technol. and Bioengineering 25:157-172.

Gould, J.M.; Jasberg, B.K.; Dexter, L.B.;Hsu, J.T.; Lewis, S.M.and Fahey, G.C. (1989a). High fiber, noncaloric flour substitute for baked foods. Properties of alkaline peroxide treated lignocellulose. Cereal Chemi. 66:201-205.

Gould, J.M.; Jasberg, B.K. and Cote, G.L. (1989b). Structure function relationship of alkaline peroxide-treated lignocellulose from wheat straw. Cereal Chem. 66 (3): 213-217.

Harley, M.M. and Ferguson, I.K. (1990). The role of SEM in pollen morphology and plant systemic.In: Scanning Electron Microscopy Studies in Toxonomy and Functional Morphology Changer D. (Ed). Systemics Association. Special Volume, 41:45-68, Clarendon Press, Oxford U.K.

Houston, D.F. (1972). Rice hulls . In: Rice Chemistry and Technology, 1st Ed. pp 301-352 Houston, D. F. Ed .American Association of Cereal Chem. St. Paul, MN, USA.

Inglett, G.E. (1997). Development of a dietary fiber gel for calorie reduced foods Cereal Foods World. 42 (5): 382-385.

Inglett, G.E. and Carriere, C.J.(2001). Cellulosic fiber gels prepared from cell wall of maize hulls Cereal Chem. 78 (4): 471-475.

Inglett, G.E; Carriere, C.J.; Maneepun, S. and Tungtrakul, P. (2004). A soluble fiber gel produced from rice bran and barley flour as a fat replacer in Asian foods. International J. Food Sci & Technol 39 (1): 1-10.

Jacks, T and Hensarling, T. (1989). Effect of hydrogen peroxide concentration on oil seed protein solubility .J. American Oil Chem. Society 66:137-138

Jasberg, B.K; Gould, J.M.and Warner, K.(1989) High fiber, noncaloric flour substitute for baked foods .Alkaline peroxide treated lignocellulose in chocolate cakes.Cereal Chem 66:209-213.

Knuckles, B.E. and Kohler, G.O. (1982). Functional properties of edible protein concentrate from alfalfa. J. Agric. Food. Chem. 30: 748-752 .

Kumagai, S.; Noguchi, Y.;Yasuji, B.K and Koichi, A.T.(2007). Oil adsorbent produced by the carbonization of rice husks Waste Management 27(4):554-561.

Larrea, M.A.; Grossmann, M.V.; Beleia, A.P. and Tavares, D.Q. (1997). Changes in water absorption and swollen volume in extruded alkaline peroxide pretreated rice hulls. Cereal Chem. 74 (2): 98-101.

Martion, I . (1964) .Extraction of lignin . J .Tappi, 47: 714 .

Mongeau, R. (2003). Dietary fiber. In: Encyclopedia of Food Science and Nutrition, pp1362– 1387. Macrae, R., R.K. Robinson and M.J. Sadler (eds.). Academic Press, New York USA .

Mongeau, R. and Brassard, M. (1982). Insoluble dietary fiber from breakfast cereals and brans, bile salt binding and water holding capacity in relation to particle size. Cereal Chem 56 (5):413-417.

Myhre, D.V. and Smith, F.J. (1960). Constituents of the hemicellulose of alfalfa (Medicago satira).Hydrolysis - of hemicellulose and identification of neutral and acidic compounds J Agric. Food Chem. 8:359-364.

Nakamura, S. (2003) Structure and function of a multiplidomain alkaline xylanase from alkaliphilic Bacillus sp. strain 41M-1. Catalysis Surveys from Asia 7 (2-3):157–164.

Nawar, W.W. (1985) Lipids. in Food Chemistry p.139.Fennma, O. R ed,Marcel Dekker: New York. USA.

Ning, G.L.; Villota, R. and Artz, W.E. (1991). Modification of corn fiber thorugh chemical treatments in combination with twinscrew extrusion. Cereal Chem. 68:632-636.

Pietrasik, Z. and Duda, Z. (2000) Effect of fat content and soy protein I. carragenan mix on the quality characteristics of comminuted, scalded sausage. Meat Sci 56:181-188.

Sandak, R.N. (2004). Low calorie biscuits production using fiber gel. The Second Conferences on the Role of Biochemistry in Environment and Agriculture. pp134-142. Fac.Agric. Cairo,Univ., Giza, Egypt. February 24-27.

SAS. (1996). Statistical Analysis System. SAS. Users Guide Release 6.04 Edition Statistics SAS Institute Inc. Editors, CARY, N.C.

Sosulski, F.W. and Gadden, A.M. (1982). Composition and physiological properties of several sources of dietary fiber. J. Food Sci. 47:1472-1477.

Sosulski, F.W. and Wu, K.K. (1988). High fiber breads containing field pea, hulls, wheat, corn and wild oat bran. Cereal Chem . 65(3): 186-191.

Xie, K.; Hou, A. and Sun, Y. (2007). Chemical and morphological structure of modified novel cellulose with triazine derivatives containing cationic and anionic groups. Carbohydrate Polymers 70:285-290.

Yin, C.; Li, J.; Xu, Q.; Peng, Q.; Liu, Y. and Shen, X. (2007). Chemical modification of cotton cellulose in supercritical carbon dioxide: Synthesis and characterization of cellulose carbamate. Carbohydrate Polymers 67:147-154.

الخصائص الفيزيوكيماوية لچل الألياف الغذائية الناتج من بعض مخلفات الحبوب

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تم تحضير چل (gel) الألياف الغذائية من بعض مخلفات الحبوب لإنتاج أغذية منخفضة السعرات الحرارية وكذلك دراسة الخصائص الفيزيوكيماوية له . ووجد أن كمية چل الألياف الغذائية الكلية الناتجة من ١٠٠ جم قش الأرز، قوالح الذرة،قشرة الشعير وردة الذرة بلغت ٥١,٤٣ ، ٥٠,٥٦ ، ٣٦,٦٤ و٢٣,٠٨ جم على التوالي. وأظهرت النتائج إرتفاع محتوى قوالح الذرة وقش الأرز من الألياف الخام (٣٩,٦٤ و ٣٧,٥٨٪ على التوالى) وإنخفاض محتواها من الدهن (٠,٩٤ و ٠,٤٢ ٪ على التوالى) ، ولوحظ وجود زيادة فى كل من الألياف الغذائية الكلية والألياف الغذائية غير ذائبة والسليلوز والهيميسليلوز، وإنخفاض في كل من الألياف الغذائية الذائبة واللجنين نتيجة تحضير چل الألياف الغذائية من مخلفات الحبوب تحت الدراسه. وبلغت الألياف الغذائية غير الذائبة فى الچل المتحصل عليه من ردة الذرة، قش الأرز، قوالح الذرة وقشرة الشعير ٨١,٢٣ ، ٧٨,٨٤ ، ٨٦,٣٣ و ٧٣,٢٤ ٪ ، على التوالى . وتميز چل الألياف الغذائية الناتج بارتفاع القدرة على الأحتفاظ بالماء وإمتصاص الزيت لمخلفات الحبوب تحت الدراسه المحضر منها. كما تم إستخدام الميكروسكوب الإلكترونى الماسح لفحص التغيير (التعديل) المورفولوجي لمخلفات الحبوب المختلفة وچل الألياف المحضر منها.