

## **EFFECT OF USING SEED COATS ON HYPOGLYCEMIC IN RATS**

**Sandak, R.N.; A.S. I. El- Shazely and E. R. Sheashea**  
**Food Techno. Inst., Agricultural Research Center, Giza- Egypt.**

### **ABSTRACT**

Celluloses fiber substances were prepared from wheat and hull less barley bran. Sodium hydroxide solution was used and the precipitate was centrifuged and washed by water several time to remove the color in first stage followed by peroxidation in the second stage. The products were washed to pH 6.0 + 0.5 and dried using warm air in an electric oven.

The chemical and physical properties of the raw materials and celluloses fiber from all bran are characterized. The results showed that the highest cellulose and insoluble dietary fiber contents found in the celluloses fiber compared with native brans. Also, the water and oil holding capacity were found in the same trend in celluloses fiber. Moreover, the anti-nutrition factors were the lowest in both wheat and barley celluloses fiber.

Celluloses fiber from wheat and hull-less barley used as hypoglycemic agent in rats fed on balady bread contained on 5, 10, 15, 20% celluloses seed coats. The results showed that incorporated different levels of celluloses wheat and hull-less barley bran used in balady bread which significant decreased the glucose level in rats from 145.0 to 106.0 mg/100ml in cellulose wheat bran and 151.0 to 110.0 mg/100ml in cellulose barley bran, respectively. Moreover, lipid fractions, i.e. cholesterol, triglyceride and total lipids were significant decreased when the levels of celluloses wheat and hull-less barley bran increased.

From the above results, it could be recommended that the balady bread made from 15 and 20% celluloses wheat and barley bran are hypoglycemic agent and reduced lipid fractions in diabetic rats.

### **INTRODUCTION**

Cereals bran are important ingredients providing dietary fiber. Wheat bran is one of the most common raw materials for increasing the level of insoluble dietary fiber which influences the digestibility and bioavailability of nutrients and phytochemicals. The outer layers of grain contain cellulose and lignin which influence both the taste and mouth feel of the bran (Ross *et al.*, 2004).

Moreover, the diet contain large amounts of dietary fiber tend to be bulky and have low energy density. Therefore, in individuals with a limited appetite, such as very young or very old persons, such diets will potentially satisfy appetite to readily and therefore make it difficult to achieve adequate in takes of energy and nutrients. However, in many health adults the consumption of fiber- rich foods is self limiting due to their bulking character. This characteristics applies to a lesser extent to foods enriched with fiber and much less to fiber supplements (Gry,2006).

Consumption of foods rich in whole grains and cereal fibers has in epidemiological studies shown to reduce the risk of chronic diseases such as diabetes, cardiovascular disease and certain cancers, as reviewed by Larsson *et al.* (2005).

**Sandak, R.N. et al.**

Celluloses fibers are prepared from a variety of low coast agricultural such as hull and bran seed costs. It absorbs large amounts of water to give a gelatin, like product without giving calories and increasing fiber content. By using celluloses fiber, food are designed to give desirable taste and mouth feel properties similar to the usual full fat food. The gelatin like material is suitable for hamburger, meats, cheeses and some baked food. Large calorie reductions in the diet are possible by using celluloses fiber ( Inglett and Carriere , 2001 and Carriere *et al.*, 2003 ) or Nu- Trim X ( Hallfrisch *et al.*, 2003 ).

During recent years, epidemiological observation has led to belief that fibers may play an essential role in maintaining man's health. The ingestion of dietary fibers have been shown beneficial effects on coronary heart disease, obesity, diabetes, breast cancers and other bowel disorders ( FDA, 2001).

The objective of this study was to determine the chemical and physical properties of insoluble celluloses product made from wheat, and hull-less barley bran. Moreover, the insoluble celluloses were applications as celluloses fiber on hyperglycemic rats.

## **MATERIALS AND METHODS**

### **Materials :**

Hull- less barley (*Hordeum vulgare* L.,)variety Giza 30 and wheat (*Triticum astivum* L.,)variety Sakha 69 were obtained from Field Crops Res. Inst.,Agric. Res.Center,Giza, Egypt.

Hull- less barley and wheat grains were milled in a laboratory Qndramate to a fine powder. The different whole meal were passed on different meshes to give bran .

### **Methods:**

#### **Preparation of celluloses fiber:**

The cellulose fiber was prepared from wheat and hull less barley bran according to Inglett (1997). Firstly, the brans were soaked in sodium hydroxide solution at pH 9 for one hour at 100° C. This treatment was carried out to fractionate the fibers into soluble and insoluble compounds which are highly colored. The mixture was centrifuged and washed to remove the colored materials.

The solids obtained from the final washed step of the first treatment were resuspended in water at about 15% solid contents and it were subjected to the second treatment at pH 8.In the second treatment , the solids were bleached using hydrogen peroxide ( 10% V/V) at room temperatures ranging from 50 to 70°C for 100 min. The wet solids were centrifuged and the solids were washed to pH 6.0+ 0.5. the wet bleached celluloses fiber were dried using warm air in an electric oven to give dried powder insoluble celluloses fiber .

#### **Chemical analysis:**

The chemical analysis were determined in wheat and hull- less barley bran and their celluloses fiber. Protein, oil, ash and total hydrolyzable

carbohydrates were determined according to A.O.A.C. (2000). Total phenolic compounds and tannin as tannic acid were determined colorimetrically as described by Valverde *et al.* (2002) and Burn (1971).

The fiber content, cellulose and hemicellulose were determined according to the methods by Chahal *et al.* (1979). Whereas, total dietary fibers, soluble and insoluble dietary fibers were determined according to Prosky *et al.* (1988).

#### **Physical Properties :**

The physical properties of native wheat and barley bran celluloses fiber were determined as water holding capacity (WHC) and oil holding capacity (OHC) according to Childs and Abajian (1979) and Racper (1979).

#### **Preparation of balady bread using celluloses fiber:**

Balady bread was prepared from celluloses wheat and barley bran at different levels 5,10,15,20%, respectively, and wheat flour 72% extraction. The loaves baked at 450-500 C for 2.0 min. and bread loaves were allowed to cool at room temperature according to Faridi and Rbenthaler (1984). The loaves were packed in polypropylene bags and stored in refrigerator at 5.0 C to be used in nutrition experiments .

#### **Nutrition experiments :**

Male albino rat (60 rats) weight ranging between 140-150 g. were obtained from Helwan Experimental Animal Station, Egypt. The basal diet, consisting of corn starch 70%, casein 10%, corn oil 10%, salt mixture 4%, vitamin mixture 1% and cellulose 5% according to A.O.A.C.(2000). Experimental rats were fed the basal diet for eight days, then randomly divided into two main groups (6 rats) was fed the basal diet and was considered as the control group (control A). The other two main groups (54 rats) were injected with alloxan solution (150 mg/kg body weight) to induce hyperglycemia (Buko *et al.*, 1996). After forty eight hours, the main groups were subdivided into nine subgroups (6 rats each). The first diabetic subgroup (control B) was fed the balady bread free addition. The rats of second, third fourth and fifth subgroups were fed on balady bread containing 5,10,15 and 20 % celluloses wheat bran. Also, the rats of sixth, seventh, eighth and ninth subgroups were fed on balady bread made from celluloses hull-less barley bran at levels 5, 10, 15 and 20%, respectively. Finally, the hyperglycemic rats were fed on basal diet containing 20% from balady bread made from celluloses wheat and hull-less barley bran. The body weight and food consumption were recorded weekly for five weeks. At the end of experiment, the blood samples were withdrawn from the orbital plexus and centrifuged at 1500 r.p.m. to obtain the sera and kept in a deep freezer at -20 C until their analyses.

#### **Estimation of some serum constituents:**

Serum constituents (glucose levels, triglycerides, total lipids and total cholesterol) were determined according to Titez (1986), Royer (1969), Knight *et al.* (1972) and Hewitt and Pardue (1973), respectively.

#### **Statistical analyses :**

All results from nutrition experiments were statistically analyzed using the method reported by Steel and Torri (1980).

## RESULTS AND DISCUSSION

### Chemical composition :

A number of by products especially that contained high fiber contents, was utilized for hypoglycemic in rats. Such replacement aims to reduce caloric intake by using cellulosic fiber prepared from wheat and hull-less barley brans. The chemical composition of wheat and hull-less barley bran and its powder celluloses fiber are shown in Table (1). The results represented in Table (1) show that the total protein and oil content gave higher amounts for wheat and barley bran (7.50 and 6.10%) than their celluloses fiber (1.54 and 1.12%). Also, ash and total fiber were the parallel trend. Moreover, the total phenol and tannins in celluloses fiber were reduced amounts from 35 to 40% .

The results reported in the same Table (1) show that the total and insoluble dietary fiber and cellulose found higher in wheat bran and its cellulosic fiber than barley bran and its celluloses. Whereas, insoluble dietary fiber and cellulose had contained the highest amount of celluloses wheat and barley bran (69.98-60.86% ) and (54.27-47.17 % ).

The major polysaccharide was cellulose which is a linear beta linked glucan of high molecular weight, ranging 500.000 and 1 million daltons (Candido and Campos , 1996 ). On the other hand, the large insoluble fibers are usually resistance to fermentation in the colon and so increases fecal dry matter (Johnson and Southgate, 1994).

**Table (1): Chemical analysis of native and celluloses fiber from wheat and barely bran on dry weight bases.**

Chemical analysis	Wheat bran %	Barley bran %	Fiber %	
			Wheat	Barley
Protein	7.50	6.10	1.54	1.12
Oil	2.72	1.41	0.85	0.42
Ash	11.10	10.15	17.32	15.61
Total dietary fiber	55.15	47.34	73.15	70.27
T. H. C.	80.38	83.32	7.14	12.58
Tannin mg / 100 g	110.22	150.19	66.31	97.95
Total phenolic mg/100 g	143.14	170.19	90.74	105.72
I.D.F	46.08	32.27	69.98	60.86
S.D.F	6.07	15.07	3.17	6.41
Cellulose	35.72	23.12	54.27	47.17
Hemicelluloses	9.54	7.31	11.39	10.72

T.H. C. Total hydrolysable carbohydrates

I.D.F : Insoluble dietary fiber S.D.F : Soluble dietary fiber

### Physical properties :

The physical properties , water and oil holding capacity for native wheat and barley brans and their cellulosic fiber were determined and the results are represented in Table(2).The results showed that the physical properties were increased in celluloses wheat and barley fiber. The water holding capacity found increased from 3.00 ml/g at 10°C for 30 min to 4.90 mg/g at 66° C for 150 min in barley fiber and also in wheat fiber had highly increased from 3.00 ml/g at 10°C for 30 min to 5.10 ml/g at 66°C for 150 min. The water and oil holding capacity had almost the same trend. These results

are in agreement with that published by Nyman and Svanberg (2002) showed that physiological effects of dietary fiber are greatly dependant on physico-chemical properties of the ingested material, e.g. the water-binding capacity, the molecular distribution and the viscosity.

Also, in the same table, it could be noticed that the celluloses wheat bran had the highest value of oil holding capacity 2.50 g/g at 66 C for 150 min. followed by celluloses hull-less barley bran contained 2.30 g/g at the same condition. The increases in these results may be due to the content of celluloses and insoluble dietary fibers in all samples.

**Table (2): Physical properties of native brans and their cellulosic fiber**

Materials	WHC. ml/g.			OHC. g/g		
	30 min10°C	90 min38°C	150 min66°C	30 min10°C	90 min38°C	150 min66°C
<b>Barley bran</b>	2.50	3.00	3.70	1.40	1.70	1.90
<b>Barley fiber</b>	3.00	3.50	4.90	1.80	2.00	2.30
<b>Wheat bran</b>	2.60	3.20	3.90	1.60	1.90	2.20
<b>Wheat fiber</b>	3.00	3.20	5.10	1.80	2.10	2.50

WHC Water holding capacity      OHC Oil holding capacity

**Biological evaluation :**

The results concerning the body weight gain, food intake and food efficiency ratio at the end of experiment (35 day) are recorded in Table (3). The results revealed that the body weight gain of diabetic rats in control B and the feed different proportions of celluloses wheat and barley bran in balady bread were significantly less than control A. Food intake in diabetic rats (control B) and other treatments were parallel trend. Decrement in feed intake may be due to the presence of high amount contents of fiber in wheat and barley bran, which led to fill the rats stomach and reduce the food intake) (Morite *et al.*,1997) . This led decrease the feed efficiency ratio in diabetic rats which was significantly lower than the normal rats (control A).

The effect of administrating balady bread samples on blood glucose of hyperglycemic rats are illustrated in Table (4). The blood glucose level of healthy rats (control A) was 103.0 mg/ 100.ml after 35 day of being fed the basal diet .Whereas, the blood glucose level was increased in diabetic rats (control B) 193.0 mg/100ml fed on balady bread made from wheat flour 72% extraction. Incorporation of 5.10.15 and 20% of celluloses wheat and barley bran used in balady bread which showed that significantly decrease the glucose level after 35 day from 145.0 to 106.0 mg/ 100ml in celluloses wheat bran and 151.0 mg/ 100ml in celluloses barley barn, respectively. This hypoglycemic effect due to the high insoluble fiber and cellulose in these diets which have been useful in regulating blood glucose and insulin response factors that factors that are responsible for the prevention and treatment of coronary heart diseases and diabetes (Drzikova *et al.*, 2005).

**Table (3): Mean of body gain weight, food intake and feed efficiency ratio of diabetic rats fed on different diets for five weeks.**

Diets	Initial weight (g)	Final weight (g)	Body gain weight (%)	Total food intake (g)	Feed efficiency ratio
Control A	149.15 ±5.38	181.1 ±4.67	42.09	455.5 ±9.88	9.24 ±0.64
Control B	142.08 ±5.67	162.86 ±5.35	20.78	420.05 ±7.07	4.95 ±0.15
Wheat bran celluloses 5	147.28 ±4.43	164.81 ±2.81	17.53	402.25 ±9.75	4.35 ±0.29
10	140.7 ±2.45	152.91 ±5.59	12.21	367.50 ±8.65	3.35 ±0.45
15	150.08 ±3.59	157.62 ±2.21	7.54	332.50 ±6.51	2.27 ±0.21
20	143.55 ±2.33	146.17 ±3.12	2.62	301.0 ±7.31	0.87 ±0.31
Barley bran celluloses 5	143.55 ±3.82	159.39 ±2.89	15.84	395.5 ±8.32	4.01 ±0.52
10	145.43 ±3.89	156.13 ±3.68	10.70	357.0 ±8.21	3.03 ±0.36
15	145.43 ±4.26	150.65 ±4.43	5.32	325.5 ±8.65	1.63 ±0.72
20	149.13 ±5.24	150.33 ±2.96	1.20	294.0 ±6.45	0.41 ±0.64

The effect of administrating of balady bread samples on serum cholesterol, triglycerides, total lipids contents of alloxan diabetic rats were determined and the results are given in Table (4). In the diabetic rats hypercholesterolemia was secondary to diabetes. Since bread samples made from wheat flour and its mixed with celluloses wheat and hull-less barley bran contain a great portion of insoluble dietary fiber and cellulose influencing hypoglycemia, the decrease of cholesterol level may be affected by improving diabetes, which have been provoked hypercholesterolemia in these rat. This is clear from the very high serum cholesterol level in control B, 193.0mg/dl. Versus occurred reductions in cholesterol level of diabetic rats to 133.59, 128.97, 112.80 and 105.57 mg/dl in rats fed on cellulose wheat bran and 140.46, 138.22, 121.27 and 109.25 mg/dl in rats fed on cellulose hull-less barley bran at 5, 10, 15 and 20%, respectively at the end of experimental.

Not only cholesterol, but also triglycerides and total lipids were significant reduced in the serum of rat groups fed of high fibers content. Lipid fractions i.e., cholesterol, triglycerides and total lipids were decreased significantly as the level of cellulose wheat and hull-less barley bran increased. These results are in agreement with Hallfrisch *et al.* (2003) .

From the above results, it could be recommended that the celluloses wheat and hull-less barley bran can be used at level 15 and 20% with wheat flour 72% extraction to hypoglycemic and reduced lipid pattern in diabetic rats.

**Table (4): Means of blood glucose levels and total lipids pattern in hyperglycemic rats after five weeks.**

Diets	Blood glucose levels (mg/100ml)	Total serum lipids (mg/dl)	Total serum Cholesterol (mg/dl)	Serum triglycerides (mg/dl)
Control A	103.0 ±5.44	297.96 ±15.84	81.30 ±5.52	81.57 ±3.10
Control B	193.0 ±2.73	581.55 ±12.57	193.29 ±12.71	242.33 ±7.86
Wheat bran celluloses 5	145.0 ±6.39	455.12 ±43.82	133.59 ±5.77	134.72 ±8.32
10	134.0 ±6.28	415.04 ±39.08	128.97 ±3.98	125.20 ±12.49
15	120.0 ±7.51	342.0 ±42.83	112.80 ±6.49	116.23 ±10.58
20	106.0 ±6.31	316.79 ±35.17	105.57 ±5.31	95.83 ±11.73
Barley bran celluloses 5	151.0 ±7.32	469.97 ±41.84	140.46 ±6.82	145.17 ±5.54
10	142.0 ±5.71	423.85 ±38.13	138.22 ±4.01	133.32 ±7.02
15	127.0 ±4.87	385.55 ±40.89	121.27 ±9.00	127.06 ±8.08
20	110.0 ±6.59	332.12 ±43.82	109.25 ±7.18	102.61 ±9.56

## REFERENCES

- A.O.A.C.(2000).Association of Official Analysis Chemists. Official Methods, 17<sup>th</sup> Ed. Washington., D.c., USA.
- Burn , R.E. ( 1971). Methods for estimation of tannin in grain sorghum. *Agrom. J.*63:511-513
- Buko, V., O. Lukivskaya, V. Nikitin, Y. Tarasov, L. Zavodnik, A. Borodass, S. B. Goren, B. Janz and K. J. Gunderman (1996). Hepatic and pancreatic effects of poly enoylphatysyl choline in rats with alloxan-induced diabetes. *Cell Biochem. Funct.*, 14: 131-137.
- Candido, L.M.B.and Campos .,A.M.( 1996) .Alimentos parafins especiais : Dieteticos, p.500 Livraria Varela SaoPaulo, Brasil.
- Chahal, D.S, Moo-young, M.and Dhillon, G.S.( 1979). Bioconversion of wheat straw and wheat straw components into single- cell protein. *Canadiam of Microbiology* , 25: 793-797.
- Childs , E. and Abajian ,A. ( 1976). Physico – chemical characterization of peanut hulls a potential fiber additive.*J. Food Sci.*, 41: 1235-1236.
- Carriere , C.J , Scholfield , D.J and Behall, K.M.( 2003).Physiological responses of men and women to barley and oat extracts ( Nu- trim X). II.Comparison of glucose and insulin responses. *Cereal Chem.*, 80( 1) : 80-83.

- Drzikova, B., G. Dongowski, E. Gebhardt and A. Habel (2005). The composition of dietary fiber-rich extrudates from oat affects bile acid binding and fermentation in vitro. *Food Chem.* 90:18/1-192.
- Farid, H. A. and G. I. Rubenthaler (1984). Effect of baking time and temperature on bread quality starch gelatinization and staling of balady bread. *Cereal Chem.*, 61(2) :154-161.
- F.D.A. ( 2001). Claims that can be made for conventional foods and dietary supplements. Center for Food Safety and Applied Nutrition. Office of Nutritional Products. Labeling and Dietary supplements. CFR101.810 Appendix C.GPO: Washington , DC.
- Gry. J. (2006). Dietary fiber. International Life Science Institute ( ILSI) Europe Concise Monograph Series.
- Hallfrisch , J., Schofield , D.J. and Behall , K.M. ( 2003). Physiological responses of men and women to barley and oat extracts ( Nu trim X). II. Comparison of glucose and insulin response. *Cereal Chem.*, 80(1) : 80-83.
- Hewitt, T. E. and H. L. Pardue (1973). Kinetics of the cholesterol sulphoric acid reaction. A fast kinetic method for serum cholesterol. *Clin. Chem.*, 19:1128-1134.
- Inglert , G.E ( 1997) . Development of a dietary fiber gel for calorie- reduced foods. *Cereal Food World.* 42 ( 5) : 382-384.
- Inglert, G.E. and Carriere , C.J. ( 2001) . Cellulosic fiber gels preparation from cell walls of maize hulls. *Cereal Chem.*,78(4) : 471-475
- Johnson , I.T. and Southgate. A.T.( 1994) .Dietary fiber related substances. Chapman & Hall, London , Glasgow, Weinheim, N.y , Tokyo, Melbourne, Madras,p.60-65
- Knight, J. A., A. Shanna and M. R. James (1972). Chemical basis of the sulphophospho-vanillin reaction for estimating total serum lipids. *Clin. Chem.*, 18(3) :199-202.
- Larsson, S.C., Giovannucci, E., Bergkvist, L. and Wolk, A. (2005). Whole grain consumption and risk of cholesterol, cancer: a population-based cohort of 60.000 women. *Br. J. Cancer* 92, 1803 – 1807.
- Morita, T., A. Oh-Hashi, K. Takei, M. Ikai, S. Kasaoka and S. Kiriya (1997). Cholesterol-lowering effects of soybean, potato and rice proteins depend on their low methionine contents in rats fed a cholesterol-free purified diet. *J. Nutr.* 127:470-477.
- Nyman, E. M. and M. S. Svanberg (2002). Modification of physico-chemical properties of fiber in carrot by mono and divalent actions. *Food Chem.*, 76:373-280.
- Prosky, L., Asp , N.G.,Schweizer , T.F.,Devries., J.W, and Furdal. I . ( 1988). Determination of insoluble and soluble and total dietary fiber in food products: Inter laboratory study.*J. Assoc . Off . Anal. Chem*71: 1017-1023
- Rasper , V.F.( 1979) . Chemical and physical properties of dietary fiber. *Food Tech.* 40-44.
- Ross, A., Kamal El-Dein, A. And Aman, P. (2004). Dietary alkyl resorcinols: wheat and rye-rich foods. *Nut. Rev.* 62, 81 -95.



- Royer, M. E. (1969). A simplified semi-automatic assay for plasma triglyceride. Anal. Biochem., 29:405-409.
- Steel. R.G. and Torri, J.H. ( 1980) ,Principal and Procedures of Statistical Biochemical Approach. McGraw Hill Book Company 2<sup>nd</sup> Ed.
- Titez, N. W. (1986). Textbook of Clinical Chemistry. W. B. Saunders Co., London Philadelphia, p. 796.
- Valverde , I.M.,perago. M, Provan, G. And chesson , A. ( 2002). Phenolic comopounds , lycopene and antioxidant activity in commerical varrieties of tomato ( Lycopersic un esculentum). J.Sci. Food Agric. 82: 323-330

تأثير استخدام أغلفة الحبوب على خفض سكر الدم في الفئران  
رأفت نجيب سندق، عبد المنعم صالح إبراهيم الشاذلي و عماد الدين راغب شعيشع  
معهد بحوث تكنولوجيا الأغذية - مركز البحوث الزراعية - جيزة

تم تحضير سليولوز الألياف من أغلفة القمح والشعير العاري وذلك باستخدام محلول الصودا الكاوية لمدة ساعة علي درجة حرارة ١٠٠° م ثم اجري للمترسب طرد مركزي والغسيل بالماء لعدة مرات وذلك لإزالة اللون في المرحلة الأولى تم استخدام الهيدروجين بيروكسيد وفي المرحلة الثانية تم الغسيل بالماء حتي تصل درجة pH ٦ والتجفيف باستخدام هواء جاف في فرن كهربائي.

تم تقدير التركيب الكيميائي والفيزيقي في أغلفة القمح والشعير العاري وسليولوز الألياف الناتج منهم أوضحت النتائج ارتفاع نسبة السليولوز والألياف الغير ذائبة في سليولوز جيل الألياف مقارناً بالأغلفة وأيضاً وجد أن سعة امتصاص الماء والزيت ترتفع في الألياف عن الأغلفة .

سليولوز الألياف الناتج من أغلفة كل من القمح والشعير العاري استخدم كعامل خافض لسكر الدم في الفئران المغذة على الخبز البلدي المصنوع من، ٥٠ و ١٠ و ١٥ و ٢٠% من سليولوز ألياف أغلفة الحبوب .

النتائج أوضحت ان سليولوز ألياف القمح والشعير المستخدمة في الخبز البلدي عملت على خفض جلوكوز سكر الدم في الفئران من ١٤٥ الى ١٠٦ ملجرام / ١٠٠ مل لسليولوز ألياف القمح ومن ١٥١ الى ١١٠ ملجرام / ١٠٠ مل لسليولوز الياف الشعير العاري ونزيد على ذلك ان كلا من الكوليستيرول والتراى جلسريد واللييدات الكلية انخفضت في الفئران بزيادة نسبة سليولوز اغلفة الحبوب .

من النتائج السابقة يمكن ان نوصى باستخدام الخبز البلدي المصنوع من ١٥، ٢٠% سليولوز الياف القمح والشعير كعامل خافض للسكر ولييدات الدم فى الفئران المصابة بارتفاع سكر الدم