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TECHNOLOGICAL AND BIOLOGICAL STUDIES ON JERUSALEM ARTICHOKE TUBERS AND BARLEY

Asma A. El Gindy

Special Foods & Nutrition Research Department, Food Technology Research Institute, Agricultural Research Center, Giza, Egypt.

ABSTRACT: *The present study was carried out to evaluate the effect of partial replacement of wheat flour with either Jerusalem artichoke powder, barley flour and a mixture of both at different levels. Proximate composition and sensory evaluation were determined. Moreover, organoleptic evaluation proved that the substitution of Jerusalem artichoke powder. The barley flour and a mixture of both was the best as it received high scores by the panelists. The present study also aimed to evaluate the biochemical parameters of diabetic rats fed on some functional food mainly Jerusalem artichoke tubers and barley. Glucose level, total cholesterol, liver function, kidney function, total protein, triglycerides, high density lipoprotein (HDL) and low density lipoprotein (LDL) in diabetic rats serum were also estimated. The results indicated that the bread substituted by Jerusalem artichoke powder, barley flour, and a mixture of both induced a significant decrease in serum glucose levels, triglycerides, total cholesterol and LDL-cholesterol of rats in the hyperglycemic groups, in comparison with rats in the positive control group that were fed on different but not the same prepared diet.*

KEY WORDS: Jerusalem artichoke; Barley Flour; Blood glucose; Lipid Profile; Cholesterol

INTRODUCTION

Cholesterol plays a major role in the health of human heart. High cholesterol is a risk factor that can lead to human cardiovascular disease such as coronary heart disease and stroke. Cholesterol can be good for the cardiovascular system if lipoprotein density is high, but it is bad if this lipoprotein' density is low. The desirable level of cholesterol in blood is below 200 mg/dl and 200 to 239 mg/dl is the borderline high for heart disease. Whereas, high blood cholesterol begins at the level of 240 mg/dl. At such level, the person is subjected to have heart disease risk much more than the person whose cholesterol level is 200 mg/dl or below. On the other hand, some kinds of bacteria can change cholesterol in food into coprostanol that cannot be easily absorbed by the body. Therefore, some oral bacteria such as Lactobacillus acidophilus have been commercially available for cholesterol lowering, (Hongbao Ma, 2004). Over the last decades, the consumers' demands for functional foods as an opportunity to improve food product quality have increased enormously. The main characterization of such functional foods is the fortification with dietary fiber, micronutrients, antioxidants, vitamins or minerals that contribute to the benefit of health effects in certain disorders, (Ana, et. al., 2015). For example, Inulin reduces both the cholesterol level and serum lipids, (Niness, 1999). Therefore, inulin, which is obtained from several composites like for example Jerusalem artichoke, artichokes, chicory, dahlias, and dandelions, has been the interest of many food research programs, (van Loo and Her-mans, 2000).

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Studies on nutritive value of Jerusalem artichoke tubers have revealed that they contain many important components, (Praznik, et. al., 1998). It was has been demonstrated that artichoke tubers have between 20.4 and 31.9% of dry matter, in which carbohydrates are the main component, (Chrapkowska, et. al., 1993). The greatest part consists of water-soluble inulin and its concentrations range between (49.5 and 56.4%) of dry matter, which constitutes about (11.3-14.2g/100g) of fresh tuber mass, (Praznik, et. al., 1998). Soluble carbohydrates present beside inulin are its derivatives-fructooligosaccharides, simple sugars (fructose and glucose) and saccharose. Besides, soluble carbohydrates Jerusalem artichoke tubers contain also insoluble food cellulose fractions (cellulose and lignin), pectins and hemicelluloses (soluble cellulose fraction). Also, among the different cereals, barley has been studied in particular as a source of dietary fibre (DF), especially because of its high natural glucan content, non-starch un-branched polysaccharides, composed of (1/4) and (1/3) linked β -D-glucopyranosyl units. In addition, barley is an important source of other bioactive compounds that show marked antioxidant activity, (Liu & Yao, 2007). Consumption of concentrated barley glucan lowers plasma cholesterol because of its soluble dietary fiber nature. The role of molecular weight (MW) in lowering serum cholesterol is not well established. Prior studies showed that enzymatic degradation of glucan eliminates the cholesterol lowering activity; however, these studies did not evaluate the MW of the glucan. The current study was conducted to evaluate whether barley glucan concentrates, partially hydrolyzed to reduce MW, possess cholesterol lowering and antiathero genic activities. The reduced MW fraction was compared with a high MW glucan concentrate from the same barley flour, (Thomas & Rober, 2004). Bread is one of the most popular staple foods in the world. Because of its nutritive value, low price, and simplicity of usage, it has become the basis of all civilizations' diets. Bread consumption provides energy (mainly from starch) and delivers dietary fiber, proteins and a wide range of vitamins and minerals, (Nanditha & Prabhasankar, 2009). Hence, the present investigation was performed to study the effect of the replacement of wheat flour (82% extraction) by different levels of barley flour and Jerusalem artichoke tubers powders on quality physic chemical and nutritional properties of different prepared bread to obtain healthy bread products with high nutritional and biological value. It also aimed to study the health benefits of the best replaced bread as functional food on diabetic and hyperlipidemic rats

MATERIALS AND METHODS

Materials

Plant Material

The following materials were used:

- Jerusalem artichoke tubers (Helianthus tuberosus) harvested in december 2014 were obtained from the Experimental Station, Agricultural Research Center, El- Dokki, Giza, Egypt.
- Naked barley (Hordeum vulgaris) variety Giza 130 was obtained from Barley Research Department Field Research Institute, Agriculture Research Center, and Giza, Egypt.
- Wheat flour (Triticum aestivum) of (82% extraction) was obtained from Cairo Co,. The study of active dry yeast fariman manufactured was purchased from local market at Giza, Egypt

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Chemical material

The ingredients used in chemical analysis and kit ,Bread-making such as (wheat flour extracting rate 82%, instant yeast, and salt,), starch and oil were purchased from local market at Giza. Casein, minerals, vitamins and cellulose were purchased from El-Gomhoria Pharm and Chem. Ind. Company, Cairo, Egypt. All kits for biochemical analysis were purchased from Biodiagnostic Co., Dokki, and Giza, Egypt. All chemicals used for analysis were of analytical grade

Preparation of barley flour

Clean barley grains were milled to barley flour. Flour obtained was sieved through a 960 mm) mesh size to a powder particle size, to obtain barley flour (82% extraction).

Preparation of Jerusalem artichoke tuber powder

Jerusalem artichoke tuber was rinsed with running tap water, and cut into small pieces and dried in a fan oven at (40 $_{C}^{\circ}$), then dried Jerusalem artichoke tuber were powdered using a hammer mill and sieved through 40-mesh sieve. The obtained Jerusalem artichoke tuber powder was kept in the fridge at (18 $_{C}^{\circ}$) until use.

Preparation of different bread formulas

Bread was prepared as formula presented in table (1) by mixing the formula components with other ingredients, which are instant yeast, salt (sodium chloride) and water. The ingredient were eleven formulas were prepared as described in table (1). The ingredients were mixed in a mixer for (25) minutes. The resulted dough was left to ferment for one hour at (30$_{C}$°) and (85%) relative humidity. After that, the dough was divided into pieces of (160 g) each. The pieces were then arranged at a wooden board previously sprinkled with the same flour and left to ferment for about (45) minutes at (30$_{C}$°) and (85%) relative humidity. The fermented dough pieces were flattened to about (20) cm diameter and (0.5) cm. thickness by hands. The flattened loaves were then baked at (450-500$_{C}$°) for (1.5-2) minutes. The baked bread loaves were allowed to cool on wooden racks for (30) minutes at room temperature before evaluation dried bread loaves were fed to the group of rats. The basis of straight dough bread making methods **A.A.C.C. (1983**) was used to produce baldy bread as shown in Table (1)

Table 1: Formulas composition of balady bread

Formula	%	For. No.	*WF	JATP	BF	Ins. yeast	Sodium chloride	Water	Total
Control bread	-	1	1000	-	-	15	10	800	1825
*(JATP)	10%	2	900	100	-	15	10	800	1825
	20%	3	800	200	-	15	10	800	1825
	30%	4	700	300	-	15	10	800	1825
*BF	10%	5	900	-	100	15	10	800	1825
	20%	6	800	-	200	15	10	800	1825
	30%	7	700	-	300	15	10	800	1825
(JATP) + BF)	10% JATP	8	800	100	100	15	10	800	1825

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+10% BF								
20% JATP + and 10% BF	9	700	200	100	15	10	800	1825
15% JATP + and 15% BF	10	700	150	150	15	10	800	1825
10 JATP + and 20% BF	11	700	100	200	15	10	800	1825

*** JATP: J**erusalem artichoke tuber powder bread ***BF:** Barely Bread

*** WF:** Wheat Flour

Chemical Composition

Moisture, crude protein, crude fat, crude fiber and carbohydrate (by difference) of Jerusalem artichoke tuber powder, barley flour and baldy bread formulas were done according to the standard**, A.O.A.C. method (1990).**

Sensory evaluation of balady bread

Sensory evaluation of balady bread was carried out according to the method of Fairdi & Rulenthaler (1984)

Biological experiment

Thirty (30) male albino rats (30 rats) weighting between (167-179g) each were used in this experiment. Animals were housed in cages under normal health laboratory conditions house at Food Technology Research Institute, Giza, Egypt. These rats were allowed to be acclimatized to laboratory condition for (10) days prior to the experiment and fed on basal diet (Casein 10%, Corn oil 10%, Vitamin mixture1%, Cellulose5%, Starch70% and Salt mixture 4%). After the adaptation period, the rats were fed. Fasting blood samples obtained from retro orbital plexus (Superficial blood sample). after that rates were divided into (5) groups with 6 rats in each group and fed on diets for (28) days as follows: group (2) was fed on basal diet only and used as control negative, groups (1,3,4 & 5) were fed on high cholesterol diet as shown in table (2). Diabetic rats in the first group were fed on high cholesterol diet and were used as the content positive group.

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Table 2: Composition of high cholesterol diet

Type of diet	Cholesterol amount
Casein	10
Corn oil	6
Vitamin mixture	1
Cellulose	4
Starch	54
Salt mixture	4
cholesterol	1
Fat tail sheep	20

* Group1: Control (+), group (2): Control (-), group (3): rats were fed on bread that contained (20%) BF, group (4) rats were fed on bread contain (20%) JAT. Rats in group (5) were fed on bread contain (%10) BF + (10%) JAT. Groups (3,4 & 5) only were fed on high cholesterol diet and experimental diets but group (1) was fed on high cholesterol diet only, and group (2) was fed on basal diet only.

After that group (1 and 2) of rats were fed on basal diet. Group (2) only was control negative and group (1) was control positive. While group (3) of rats were fed on diet that contained 50% basal diet (Casein10%, Corn oil 10%, Vitamin mixture1%, Cellulose5%, Starch70% and salt mixture 4%) + 50 % bread (contained barley flour 20%). Group (4) was fed on diet containing (50%) basal diet + 50 % bread that contained Jerusalem artichoke tubers powder 20%). Group (5) was fed on diet containing 50 % basal diet + 50 % bread that contained JATP 10% + BF 10%). Blood samples collected at 14 days for analysis. The biological experiment lasted for (56) days.

Biological Evaluation

At the end of trials, the animals were slaughtered, under ether anaesthetized and blood samples were collected in clean dry centrifuge tube from hepatic portal vein. Serum was separated by centrifugation at (4000 r.p.m.) for (10) minutes at room temperature then kept in plastic vials at (20 c° until analysis.

Biochemical Analysis

Blood glucose was analyzed by the method of Tietz (1995). Determination of triglycerides in serum was determined calorimetrically according to Fossatip and Prancipel (1982). Total cholesterol was determined by colorimetric method according to Allain (1974). HDL Cholesterol was determined according to Castell (1977). Total lipid was determined by colorimetric method according to Schimit (1964). Calculation of LDL and VLDL in mg/dl according to Lee & Nieman (1996).

LDL cholesterol = Total Cholesterol – (HDL + T.G / 5) mg / dl.

VLDL cholesterol = Triglycerides /5.

Creatinine was determined by the method reported by Henry (1974). Urea in serum was determined according to the method the described by Patton & Crouch (1977). Enzyme activities of alanine amino transferees (ALT) and aspartate amino transferees (AST) were determined colorimetrically according to the method of Retiman & Frankel (1957). Total protein was determined in serum according to the method described by Tietz (1995).

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Albumin (A) concentration were determined by the method of Doumas (1971).

Statistical analysis

The results expressed as mean ± SD, arid performing using student (t) test. The obtained results will be analyzed to determine the degree of significances between different groups ($p \leq 0.05$) using one way analyzing of various ANOVA (SAS, 1986).

RESULTS AND DISCUSSION

Proximate composition of dried Jerusalem artichoke tubers powder, Barley flour (82%) extraction and wheat flour (82%) extraction are shown in Table (3). Jerusalem artichoke tubers powder contained (74.57±3.1 %) total carbohydrates. The present results were similar to that obtained by Abd El-Lateef (2000), who reported that Jerusalem artichoke tubers powder contained (83.6%) total carbohydrate. At the same time Jerusalem artichoke tubers powder contained (5.12±.4, 3.81±.1, 7.60±.7 and 1.58±.03 %) for Ash, Crude fiber, Crude protein and Ether extract respectively. While, Barley flour (82%) extraction contained (67.36) total carbohydrate, and (3.30±.1, 4.17±.1, 13. 85±.8 and 2.36±.04 %) for Ash, Crude fiber, Crude protein and Ether extract respectively. However, wheat flour (82%) extraction contained (69.15±2.3) total carbohydrate, and (1.34±.3, 2.39±.05, 12.69±1 and 2.18±.02 %) for Ash, Crude fiber, Crude protein and Ether extract respectively.

Table 3: Chemical composition of raw dried Jerusalem artichoke tubers, wheat flour (82%) extraction and Barley flour (82%) extraction

	Components					
Samples	**Moisture %**	**Ash %**	**Crude fiber %**	**Crude protein %**	**Ether extract %**	**Total carbohydrates %**
dried Jerusalem artichoke tubers (JAT)	7.32±.2	5.12±.4	3.81±.1	7.60±.7	1.58±.03	74.57±3.1
wheat flour 82% extraction	12.25±1	1.34±.3	2.39±.05	12.69±1	2.18±.02	69.15±2.3
Barley flour 82% extraction	8.96±.5	3.30±.1	4.17±.1	13. 85±.8	2.36±.04	67.36±3

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Table 4: Content of inulin of Jerusalem artichoke tuber and Content of b-glucan of Barley flour 82% extraction

Content of inulin (%) of Jerusalem artichoke tuber	Content of B-glucan (%) of Barley flour 82% extraction
70.79± 3.45	4.2±.3

Table (4) reveals that the content inulin of Jerusalem artichoke tuber was (70.79± 3.45). This result is in line with those of Sahar (2003) who reported that contents of inulin of Jerusalem artichoke, was (71.78). In addition, these results are in agreement with those reported by Cieslik, et. al. (2005).While content Barley flour (82%) extraction of b-glucan was (4.2±.3 %). These results in agreement with those by Bhatty (1997) that found that β -glucan contents ranged from (3.70 to 5.77%). As previously reported it is therefore becoming an important cereal crop from a nutritional and functional point of view. Barley is now going renewed interest as of a functional food ingredient because of act that barley grains are a rich source of β-glucan, Soares, et. al. (2007).

Table 5: Chemical composition of balady bread producing from wheat flour substitute with different levels of Jerusalem artichoke tubers powder and Barley flour 82% and their mixes

Bread groups	Constituents (%)					
	Moisture	Ash	Protein	Fat	Crude fiber %	Total carbohydrates %
1	30.32±1.2	1.86±.01	12. 96±1.01	1.78±.02	3.23±.07	49.85±2
2	35.25±1.5	2.08±.02	12.40±.8	1.74±.03	3.25±.04	45.28±3
3	36.76±2	2.50±.03	11.84±.6	1.71±.01	3.32±.1	43.87±2
4	37.24±1.3	2.80±.01	11.32±.5	1.68±.03	3.38±.1	43.58±1.5
5	34.95±2.4	1.91±.01	12.85±.9	1.71±.04	3.32±.03	45.30±2.5
6	36.20±3	1.43±.03	13.10±1	1.85±.03	3. 38±.06	44.04±2
7	37.10±1.5	1.35±.02	13.15±1.2	1.91±.04	3.47±.1	43.02±1.6
8	35.86±2.4	2.24±.05	12.45±2	1.75±.02	3.31±.02	44.39±2.1
9	37.29±1.7	2.29±.04	11.94±2.1	1.81±.03	3.38±.07	43.29±2.2
10	36.30±3.1	2.24±.04	11.09±1	1.80±.04	3.01±.04	45.56±1
11	36.20±2.1	2.43±.02	12.55±1.5	1.84±.03	3.42±.05	43.56±2.5

1:Control bread,2: 10% (JATP) bread,3: 20% (JATP) bread ,4: 30% (JATP) bread,5: 10% (BF) bread ,6: 20% (BF) bread,7: 30% (BF) bread ,8: 10% JATP +10% BF bread,9: 20% JATP+ and10% B bread F,10: 15% JATP+ and 15% BF bread,11: 10 JATP+ and20% BF bread

Chemical composition of balady bread (BB) is wheat flour (82%). The extraction rate and substitute with different levels of Jerusalem artichoke tubers powder and Barley flour 82% are shown in Table (5). Table (5) illustrates that bread content like moisture, ash and crude fiber %) increased with the increase in the level of substitute of Jerusalem artichoke tubers powder and Barley flour (82%). While the bread content like fat and total carbohydrates %) were decreased with an increase in the level of substitute of Jerusalem artichoke tubers powder and barley flour 82%. Hussein, et. al. (2006) revealed that adding barley extractions and different types of barley flour to wheat flour improved the protein, ash, crude fiber, β-

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glucan and arbinoxylans contents were higher than the control. Ereifej, et. al., (2006) revealed that bread mixed with barley flour has a higher protein, fat, fiber, and ash content, but a lower carbohydrate content.

Sensory evaluation is important criteria in evaluating bread quality and bread acceptability. These sensory properties included Crust color, Crumb properties, Texture, Taste, Flavor and Overall acceptance. Data of Table (6) shows that substitute of wheat flour of 82% with Jerusalem artichoke tubers powder and Barley flour had increased the overall acceptability score to reach the maximum value with 20%(of Jerusalem artichoke tubers powder , Barley flour and Jerusalem artichoke tubers powder 10%+ Barley flour 10%). Ana, et. al. (2014) found that bread made from (75%) of wheat flour and (25%) of J. artichoke tubers powder retained slight specific smell and taste of J. artichoke. Nevertheless, due to good organoleptic properties of wheat bread it could be accepted better for consumption than fresh tubers of J. artichoke. Besides, Jerusalem artichoke tubers are rich in inulin. Inulin content ranges from (8 to 21%) in fresh Jerusalem artichoke 'tubers, (Kays & Nottingham, 2007). Wang, et. al. (2002) stated that inulin and oligofructose are interesting for food industry to improve organoleptic properties of food. Their incorporation upgraded taste and mouth feel in a wide range of applications. Biljana, et. al. (2009) found that regarding sensory quality, the only significant differences ($p<0.05$) were the higher taste and lower volume in the white supplemented breads and lower crumb elasticity in the white bread made with barley flour. Hussein, et. al. (2006) revealed that adding barley extractions and different types of barley flour to wheat flour improved the color and weight of produced bread

Table 6: Sensory evaluation of balady bread producing from wheat flour substitute with different levels of Jerusalem artichoke tubers powder and Barley flour 82%

Bread groups	Sensory properties					
	Crust color	Crumb properties	Texture	Taste	Flavor	Overall acceptance
1	9.30±.20	9.0±.20	9.00±.30	9.10±.20	9.20±.20	9.10±.20
2	9.50±.15	9.20±.20	9.20±.20	9.40±.30	9.40±.30	9.50±.30
3	9.40±.10	8.95±.30	9.10±.10	9.35±.30	9.30±.20	9.30±.40
4	9.40±.20	8.50±.40	8.90±.20	8.70±.20	8.80±.40	8. 90±.30
5	9.40±.30	9.10±.30	9.00±.50	9.30±.40	9.25±.20	9.40±.20
6	9.40±.10	9.00±.40	9.10±.40	9.20±.50	9.00±.30	9.20±.20
7	9.10±.20	8.10±.30	8.20±.30	8.80±.20	8.60±.10	8.50±.40
8	9.30±.30	9.10±.20	9.20±.30	9.20±.30	9.10±.30	9.10±.30
9	9.20±.20	8.8±.10	8.70±.40	8.90±.40	8.8±.50	8.90±.30
10	9.10±.10	8.30±.30	8.50±.20	8. 55±.20	8.40±.20	8.60±.20
11	9.00±.15	8.20±.30	8.30±.20	8.40±.10	8.25±.30	8.50±.30
LSD	**N.S**	**0.49**	**0.40**	**0.49**	**0.36**	**0.43**

*1:Control bread,2: 10% (JATP) bread,3: 20% (JATP) bread ,4: 30% (JATP) bread,5: 10% (BF) bread ,6: 20% (BF) bread,7: 30% (BF) bread ,8: 10% JATP +10% BF bread,9: 20% JATP+ and10% B bread F,10: 15% JATP+ and 15% BF bread,11: 10 JATP+ and20% BF bread

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Table 7: Effect of experimental diets on body weight gain (B.W.G)

Rat	Initial weight (g)	After 28days of fed on high cholesterol diet			After 28days of fed on experimental diet		
		Final weight (g)	B.W.G (g)	B.W.G (%)	Final weight (g)	B.W. G (g)	B.W.G (%)
1	176±1.9	198.25±3	22.25	12.64	192.5±2.5	16.5	9.37±2.1
2	176±2	187.75±2.3	11.75	6.67	193.5±3.5	17.5	9.94±1.43
3	173.5±4.5	193.75±4	20.25	11.67	187.5±2.75	14.00	8.1±1.5
4	175.75±2.6	197.5±1.5	21.75	12.37	190.5±1.5	15.00	8.55±.87
5	177±1	198.75±3.5	21.75	12.29	185±1	8.00	4.52±.34

*Group1: Control (+),group (2): Control (-),group (3):rats fed on bread contain 20% BF, group (4): rats fed on bread contain 20% JAT, group (5): rats fed on bread contain % 10 BF + 10% JAT, Groups (3,4 and 5) only fed on high cholesterol diet and experimental diets but group (1) fed on high cholesterol diet only, group (2) fed on basal diet only)

Effect of experimental diets body weight gain (B.W.G) of Diabetic Rats: Data in Table 7 showed decreases in body weight gain (BWG) for all groups (diabetic and hyperglycemic rats) fed on of experimental diets comparing with the (positive and negative) control. The highest value of percentage body weight gain % was (9.94±1.43) for group (2), while the lowest value was (4.52±.34) recorded for group (5).

Table 8: Effect of experimental diets on organs / body weight (BW) (%)

Rat groups	Liver/B.W (%)	Kidney/B.W. (%)	Heart/B.W.(%	Spleen/B.W. (%)
1	2.54±.1	.24±.03	.63±.04	.24±.01
2	2.58±.03	.24±.02	.71±.05	.25±.01
3	2.9±.05	.26±.02	.62±.05	.29±.02
4	2.4±.1	.24±.02	.68±.03	.22±.01
5	2.4±.2	.23±.02	.62±.06	.22±.01

*Group (1): Control (+),group (2): Control (-),group3:rats fed on bread contain20% BF, group (4): rats fed on bread contain 20% JAT ,group (5): rats fed on bread contain%10 BF + 10% JAT, (Group3,4 and 5) only fed on high cholesterol diet and experimental diets but group (1) fed on high cholesterol diet only, group (2) fed on basal diet only)

Effect of experimental diets on organs/body weight (BW)(%)of Diabetic and hyperglycemic rats shown in table 8 . The weights of liver, kidney, heart and spleen of experimental rats fed on diet contain balady bread producing from wheat flour substitute with different levels of Jerusalem artichoke tubers powder and Barley flour 82% groups (3, 4 and 5) are presented in Table 8. From the obtained results, it could be observed that, The highest value of percentage of the liver, Kidney and Spleen are (2.9±.05, .26±.02 and.29±.02 %) respectively in group 3. while The highest value of percentage of the Heart was (.71±.05 and .68±.03) for (group 2 & group 4) respectively. Eid (2009) observed that the liver and spleen of hyperglycemic rats had high mean values than that of rats fed basal diet (control). Moreover, the rats fed JAT at the concentration (5, 10 & 15%) had the similar level.

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Table 9: Effect of experimental diets on glucose content (mg/dl) in diabetic and hyperglycemic rats

Rat groups	Initial	After 28days of fed on high cholesterol diet	After 28days of fed on experimental diet	percent decrease in serum glucose
1	113.0±9	168.75±5.5	162.5±1.5	3.70
2	117.75±7	125.0±5	124.25±4	0.06
3	117.0±5	165.75±6	146.25±1.75	11.76
4	103.0±11	165.5±4.5	143.0±2	13.59
5	120.5±4.5	161.0±5	136.5±2.5	15.22

*Group1: Control (+),group2: Control (-),group3:rats fed on bread contain20% BF, group4: rats fed on bread contain20% JAT ,group 5: rats fed on bread contain%10 BF + 10% JAT,(Group3,4 and 5 only fed on high cholesterol diet and experimental diets but group 1fed on high cholesterol diet only ,group2 fed on basal diet only)

Table (9) shows the decreases of serum glucose for all groups (diabetic rats Effect of experimental diets. The mean values of serum glucose content after (28) days of fed of experimental diet were 162.5±1.5, 124.25±4, 146.25±1.75, 143.0±2and 136.5±2.5 mg/dl serum for groups (1, 2, 3, 4 and 5) respectively. From the above results, it could be observe that the percent decrease in serum glucose levels were 11.76%, 13.59%and 15.22% for group 3,4 and5 respectively ,when compared with control (+) group (1). These observations may be due to the dietary fibers both β -glucan and soluble (Fructo-oligosaccharides, FOS) suggested by Kopec & Cieslik, (2005).These results are in agreement with those reported by Alegria, & Vivanco (2004). Cereal β -glucans are known for their ability to lower postprandial serum glucose levels and insulin response and to lower serum cholesterol levels, Brennan & Cleary (2005). Consumption of beta-glucans from oats or barley contributes to the reduction of the glucose rise after a meal" and may reduce risk of coronary heart disease, EFSA (2011).

Data in Table (10) reveals the decrease in serum urea for all groups (diabetic and hyperglycemic rats) fed on diet contain balady bread producing from wheat flour substitute with different levels of Jerusalem artichoke tubers powder and Barley flour 82% compared with control positive. The mean values of serum urea contents were, 20±3, 19.25±2, 17.75±1, 16.5±.5 and 15.5±.5mg/dl for groups (1, 2, 3, 4 and 5) respectively. In addition, a decrease in serum creatinine for groups (3, 4 and 5) respectively (.725±.17, .700±.01, and.710±.05 mg/dl) respectively compared with the control positive (group1) was recorded the highest value.787±.04 mg/, while the lowest value was.525±.03 mg/dl in-group (2) (control negative) The obtained data are in agreement with those reported by El-Hofi (2005). Kaur & Gupta (2002) reported that inulin is effective in lowering the blood urea and uric acid levels, thereby maintaining the nitrogen balance. Gibson & Roberfriod (1995) indicated that inulin and non-absorbable sugars such as lactulose have been known for a long time to reduce blood NH3 and serum urea levels. These effects have been associated with the growth of the colonic biomass and nitrogen fixation by colonic bacteria, coupled with colonic a cidification and conversion of diffusible NH3 into the less diffusible NH+4 ion. Increased fecal nitrogen elimination has been reported with inulin, Bouhnik, et. al. (1996). Moreover, fecal ammonia concentration decreased on feeding inulin, indicating that ammonia was more utilized in bacterial mass production, Vanhoof, et. al. (1998). In other respect, the increased excretion of fecal microbial N may have resulted mainly from desquamation of the enlarged intestinal mucosa. Castiglia-Delavaud et al. (1998).

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Table 10: Effect of experimental diets on Kidney function in diabetic and hyperglycemic rats

	Initial		After 28days of fed on high cholesterol diet		After 28days of fed on experimental diet	
Rat groups	Creatinine (mg/dl	Urea (mg/dl	Creatinine (mg/dl	Urea (mg/dl	Creatinine (mg/dl	Urea (mg/dl
1	.263±.02	9.5±1.5	.83±3	22.25±1.75	.787±.04	20±3
2	.235±.03	10.75±2.5	.51±2	18±1	.525±.03	19.25±2
3	.274±.02	11.0±1.2	.84±2	22.75±1	.725±.17	17.75±1
4	.260±.03	10.25±1	.84±2	22.25±1.75	.700±.01	16.5±.5
5	.258±.03	10.5±.9	.85±2	22.25±2	.710±.05	15.5±.5

*Group1: Control (+),group2: Control (-), group3:rats fed on bread contain20% BF, group4: rats fed on bread contain20% JAT ,group 5: rats fed on bread contain%10 BF + 10% JAT ,(Group3,4 and 5 only fed on high cholesterol diet and experimental diets but group 1fed on high cholesterol diet only ,group2 fed on basal diet only)

Table 11: Effect of experimental diets on the liver function, albumin and total protein in diabetic hyperglycemic rats

Rat groups	Initial				After 28days of fed on high cholesterol diet				After 28days of fed on experimental diet			
	AST (U/L)	ALT. (U/L	Albumin	Total protein (g/dl	AST (U/L)	ALT (U/L	Albumin	Total protein (g/dl	AST (U/L)	ALT (U/L	albumin	Total protein (g/dl
1	49±2	19.25±.5	3.93±.3	5.8±.1	87±2.5	36.5±1.5	5.03±.3	10.75±.4	76.25±1	32.75±2.5	3.5±.5	10±.5
2	47.5±1.5	18.75±2	3.9±.2	5.6±.1	55.25±1.75	24±2	4.5±.2	7.76±.1	57.25±2.5	26±1	3.25±25	8.63±.6
3	53.5±1.5	19.25±1.75	4.1±.3	5.73±.08	87.25±1	35.75±1.5	4.95±.4	11.2±.5	71.25±2.5	30±2	3.5±.1	9.5±.1
4	46.75±1	19.5±.5	4.05±.2	5.63±.17	87.5±1.5	37.5±2	5.1±.2	10.98±.2	65.75±1.5	27±2	3.25±.5	9.25±.5
5	49.75±3	20±2	4.05±.2	5.75±.15	87.5±1.5	36.5±.5	5±.3	10.7±.4	58.75±3	24.75±1.5	3±.5	8.53±.5

*Rats fed on bread contain20% BF, group4: rats fed on bread contain20% JAT ,group 5: rats fed on bread contain%10 BF + 10% JAT,(Group3,4 and 5 only fed on high cholesterol diet and experimental diets but group 1fed on high cholesterol diet only,group2 fed on basal diet only)

Effect of experimental diets on the liver function, albumin and total protein in diabetic rats Data in table(11) revealed, there decreases in serum AST for all groups (Diabetic rats) fed on diet contain balady bread producing from wheat flour substitute with different levels of Jerusalem artichoke tubers powder and Barley flour 82% compared with control positive(group 1). The highest value was 76.25±1u/l in the positive control (group1), while the lowest value were 57.25±2.5 and 58.75±3 u/l in groups (2 & 5) respectively. Moreover, decreases in serum ALT (U/L) for groups (2, 3, 4 & 5) compared with control positive (group 1). The highest value was 32.75±2.5u/l in the positive control (group1), while the lowest value was 24.75±1.5 u/l in (group 5). In addition, the data shows that decrease in total protein for all in groups (2, 3, 4 & 5). The highest value was 10±.5g/dl in the positive control (group1), while the lowest value was 8.53±.5g/dl in (group 5) but no change clear in albumin (g/dl). From the obtained results, it could be observed that activities of (ALT) and (AST) had the highest values for rats of control (+) (group1) comparing that the other one. These results are in agreement with those reported with Kaur & Gupta (2002) and Daubioul, et. al. (2005).

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Mokhtar, et. al. (2006) found that treatment of diabetic rats with barley and some of its components (chromium and amino acids) caused that, The activities of aspartate aminotransferase (AST), alanine aminotransferase (ALT), acid phosphatase (ACP) and alkaline phosphatase (AlP) were significantly decreased in both plasma and liver of alloxan-diabetic rats.

Table 12: Effect of experimental diets on cholesterol, triglycide, HDL and LDL in diabetic rats

Rat groups	Initial				After 28days of fed on high cholesterol diet				After 28days of fed on experimental diet			
	CH. mg/dl	T.G mg/dl	HDL mg/dl	LDL mg/dl	CH. mg/dl	T.G mg/dl	HDL mg/dl	LDL mg/dl	CH. mg/dl	T.G mg/dl	HDL mg/dl	LDL mg/dl
1	91.0±4	85.0±2	40.75±1.25	32.0±1	248.0±2	159.75±5	37.25±2	194.0±3	236.5±1	152.0±4	44.75±2	176.25±1.5
2	93.5±5	88.75±2.5	42.25±1.75	30.0±3	98.75±3.5	93.75±1.75	51.0±3	42.0±1	112.0±3	121.75±3	55.0±2	45.75±3
3	92.0±3	92.0±4	41.5±2.5	31.25±1.75	253.25±2	164.5±2	36.75±1.5	198.0±1	233.25±1.5	150.25±1.5	53.75±2.5	165.25±1.5
4	90.5±2	91.75±3	44.25±1.75	30.5±1.5	251.5±4	164.25±4	39.0±2	195.5±2.5	225.75±1	145.25±2	64.5±3.5	147.25±3
5	91.0±4	87.0±4	40.5±1.5	31.0±3	254.75±4.2	160.0±6	37.25±3	193.75±1.5	217.75±5	137.0±2	66.75±4	137.75±2

*Group1: Control (+),group2: Control (-),group3:rats fed on bread contain20% BF, group4: rats fed on bread contain20% JAT ,group 5: rats fed on bread contain%10 BF + 10% JAT ,(Group3,4 and 5 only fed on high cholesterol diet and experimental diets but group 1fed on high cholesterol diet only ,group2 fed on basal diet only)

Data in Table (12) show that decrease in serum total cholesterol, triglycerides and LDL for all groups (diabetic rats) fed on diet contain balady bread producing from wheat flour substitute with different levels of Jerusalem artichoke tubers powder and Barley flour 82% compared with control positive (group1). The highest values were in positive control group (1), while the lowest values were in groups (2 & 5). In addition the data showed that increase of serum HDL for all groups (diabetic rats) fed on diet contain balady bread producing from wheat flour substitute with different levels of Jerusalem artichoke tubers powder and Barley flour 82% (groups, 3, 4 & 5) compared with control positive group (1). The obtained results indicated that JAT reduced the levels of total cholesterol, triglycerides and LDL L-cholesterol in the serum of diabetic and hyperglycemic rats. Effected JAT on the hypolipidaemic may be due to increasing fecal lipid excretion and decreasing lipid absorption, as reported by Cieslik & Filipiak-Florkiewiez (2002.).These results are in agreement with those reported by Anderson & Hanna (1999). β -Glucans are also recognized as having important positive health impacts, centered on their benefits in coronary heart disease, cholesterol lowering and reduc-ing the glycaemic response. Inclusion of barley flour in plain wheat bread formulation enhances the β -glucan content of bread, which may have a beneficial effect on human health Biljana, et. al. (2009). From previous results it is clear that rats fed on bread contains JAT 10%+ BF10% group (5), give the highest positive healthy effect. This might be due to β -glucan and inulin found in the same diet, and can be also due to a synergistic action which protect the human body against diabetes

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