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STUDIES ON PRODUCTION OF SODA CRACKERS BISCUITS FOR DIABETICS

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ABSTRACT

In this study inulin was isolated from artichoke bracts and supplemented with wheat flour 72% extraction at levels 3,6 and 9% for production of soda crackers biscuits. Sensory evaluation showed that taste, texture and odor of biscuits gradually improved, while color and appearance gradually decreased but not significantly different compared to control. Baking quality of biscuits indicated increasing in weight but volume, diameter and thickness slightly decreased compared to control. Chemical composition of biscuits declared that moisture, ash, fiber and carbohydrate increased, on the contrary protein, ether extract and values of energy (calories) decreased compared to control. Biological evaluation for rats after 4 weeks revealed that blood levels of glucose, LDL, creatinine, urea, uric acid, triglycerides, total cholesterol and total lipids were decreased, while HDL increased in diabetics rats fed on biscuits contain inulin compared to diabetics control rats fed on biscuits without inulin. Histopathological examination were observed severe congestion, hemorrhage and fatty change in liver of diabetics control rats, while were observed very few congestion, hemorrhage and fatty change in liver of diabetic rats fed on biscuits contain 9% inulin. Kidney of diabetics control rats were declared severe hemorrhage and hemolysis, meanwhile kidney in diabetics rats fed on biscuits contain 9% inulin were demonstrated very few hemorrhage without hemolysis.

Key words: Inulin, Biscuits, Sensory evaluation, Biological evaluation and Histopathological examination

INTRODUCTION

Inulin is a white powder that dissolves in hot water without forming gel. It gives no color reaction with iodine. Inulin molecule is made up of about 35 fructose units in which fructofuranose residues are linked by β-D (2 → 1) bonds, so that, hydrolysis of inulin yields small amount of glucose. Inulin is broken down to fructose by the plant enzyme inulinase, hence, it can be used for diabetics **(Heimann 1980). Labell (1992)** reported that the inulin could be regarded as a kind of soluble dietary fiber with a reduced calorie value and used as an additive got dietetic products in the bakery because the fructooligosaccharids help in keeping the bakery products fresh for a longer period. Inulin could be used as a natural sweetener for a healthy diet. It has a good taste, sweetens pleasantly, tastily is quite

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convenient in use, low in energy and does not increase sugar, cholesterol and triglyceride levels of the blood (**Barta 1993**). The classification of inulin and oligofructose as dietary fiber based on their resistance to digestion followed by fermentation in the colon leading to improvement of colonic function especially fecal bulking. And added that the caloric content of inulin is ~4.13 KJ/g (or 1 Kcal/g) (**Roberfroid *et al* 1993**). **Sliva (1996)** reported that over 30.000 plants contain inulin including such commonly known vegetable as artichoke, asparagus, leek, onion, garlic, dahlia and chicory roots. Inulin reduce of the risk of colon carcinogenesis via an inhibition of the development of aberrant crypt foci and other surrogate markers (**Reddy *et al* 1997**).

The main objective of this study is isolation of inulin from artichoke bracts and producing soda crackers biscuits for diabetics and trial sensory evaluation, baking quality, chemical composition of biscuits, biological evaluation for rats fed on biscuits contain 3,6 and 9% inulin and histopathological examination of liver and kidney.

MATERIAL AND METHODS

Material

Artichoke bracts (Cynara scolymus) were obtained from Faculty of Agriculture Moshtohor farm.

American wheat flour (72% extraction) was obtained from South Cairo Mills Company, Egypt.

Methods

Artichoke bracts were cleaned with tap water to remove dusts and other undesirable materials then cut into small pieces and dried in an air oven at 60°C until complete dryness. The dried samples were milled to pass through 125µm sieve.

- Inulin was isolated according to method of ***Margaritis and Bajpai (1982).***
- Soda crackers biscuits were prepared as described by ***Bassiouny et al (1990).***
- Soda crackers biscuits were evaluated by ten panelists were asked to evaluate taste, texture, odor, color, and appearance according to method of ***Wade (1988).***
- Moisture, protein, ether extract, fiber and ash were determined according to methods of ***AOAC (1995).***
- Values of energy were calculated according to ***United States Department of Agriculture (1989)*** as follow:
  (protein x 3.47 + fate x 8.37 + carbohydrate x 4.07).

Biological evaluation

Forty albino male rats weight 140-145gm were housed individually in stainless steel cages with wire mesh floor under condition (25°C, 60%rh, 12hr light and dark cycle). Distilled water and diets were offered *ad libitum*. One group (8 rats) was fed on basal diet and considered as normal control, other rats (32 rats) was injected intraperitoneally alloxan monohydrate dissolved in saline to induce hyperglycemia after fasting overnight at a dose of 150mg/kg of body weight. One group from diabetics rats was fed on the basal diet and kept as diabetics control. The basal diet consisted of 12.5% casein (10% protein), corn oil (10%), cellulose (5%), salt mixture (4%), vitamin mixture (1%), choline chloride (0.2%) and corn

starch (67.3%) according to **Lane-Peter and Pearson (1971)**. The other diabetics groups were divided into six groups (8 rats each) and fed on biscuits containing inulin at levels 3,6 and 9% for 4 weeks.

- Total lipids were determined according to method of **Knight *et al* (1972)**.
- Total cholesterol was determined according to method of **Allain *et al* (1974)**.
- Creatinine and uric acid were determined according to methods of **Caraway (1963)**.
- Blood glucose was determined according to method of **Tietz (1986)**.
- Triglycerides were determined according to method of **Lowell (1973)**.
- High density lipoprotein was determined according to method of **Warnick *et al* (1982)**.
- Low density lipoprotein was calculated according to equation of **Friedewald *et al* (1972)**. LDL = total cholesterol – [(triglycerides/5) + HDL]
- Histopathological examination of organs rats (liver and kidney) were subjected according to method of **Drury and Wallington (1980)**.

The obtained data were statistically analyzed using the **Statical Analysis System SAS (1996)**.

RESULTS AND DISCUSSION

Artichoke bracts were chemically analyzed as shown in Table (1) from these results it could be observed that artichoke bracts contain 6.10% moisture, 10.17% protein, 2.13% ether extract, 26.11% fiber, 15.26% ash and 46.33% total carbohydrates. From the same table it can be seen that inulin isolate was 60.75%. At the same time **Labell (1992)** reported that wheat flour can be substitute for up to 10% in baked goods, at these levels it does not compromise the functionality of the wheat gluten or flour.

Soda crackers biscuits are important bakery items and used all day and are not restricted to any particular of the day. It has very long shelf life, as they are not prone to destruction by fingers, etc.

With respect to sensory evaluation of biscuits the data in Table (2) showed that taste, texture and odor gradually improved by increasing inulin replacement. On the contrary color and appearance gradually decreased compared to control but not significantly different among all samples.

Concerning baking quality of biscuits the given data in Table (3) demonstrated that as a result of decreasing of diameter and thickness the volume also gradually decreased by increasing inulin percent replacement compared to control. These findings may be related to increment of bulking agent in biscuits as a results of adding inulin as explained by **Labell (1992)** meanwhile expansion factor, weight and density were gradually increased by increasing inulin percent replacement compared to control. These results coincide with the data mentioned by **Kathy (1999)** who reported that inulin is used to improve the mouthfeel, acceptability, flavor and texture of foods and added that it can be used to fortify foods without contributing any deleterious organoleptic effects.

Concerning chemical composition of soda crackers biscuits the foregiving results in Table (4) showed that moisture, ash, fiber and total carbohydrates slightly

Table 1. Chemical composition (%) of artichoke bracts (on dry weight basis)

Moisture	Protein	Ether extract	Fiber	Ash	Total* carbohydrates	Inulin isolate
6.10	10.17	2.13	26.11	15.26	46.33	60.75

* Calculated by difference

Table 2. Sensory evaluation of biscuits

Samples	Color 10	Taste 10	Texture 10	Odor 10	Appearance 10
Biscuits (control)	9.5 a	8.8a	9.2 a	8.9a	9.0 a
Biscuits (3% inulin)	9.3 a	9.0a	9.2 a	9.2a	8.9 a
Biscuits (6% inulin)	9.0 a	9.1a	9.3 a	9.3a	8.7 a
Biscuits (9% inulin)	8.9 a	9.4a	9.4 a	9.5a	8.6 a

- Values followed by the same letter in column are not significantly different

Table 3. Baking quality of biscuits*

Samples	Diameter mm	Thickness mm	Expansion factor Di/Th	Volume Cm^3	Weight G	Density g/cm^3
Biscuits (control)	66.50	4.30	15.46	8.75	10.15	1.16
Biscuits (3% inulin)	66.46	4.27	15.56	8.72	10.83	1.24
Biscuits (6% inulin)	66.12	4.00	16.53	8.69	11.20	1.28
Biscuits (9% inulin)	65.79	3.91	16.82	8.67	11.90	1.37

* Mean of five measurement

increased by increasing inulin percent replacement compared to control. On the contrary protein, ether extract and values of energy decreased. These results can be supported by **Kathy (1999)** who reported that inulin has been used in many countries to replace fat or sugar and reduce the calories of foods such as ice cream, dairy products, confections and baked goods. Inulin has lower caloric values than typical carbohydrates due to the β (2-1) bonds linking the fructose molecules. These bonds render them non-digestible by human intestinal enzyme. Thus, inulin pass through the mouth, stomach and small intestine without being metabolized. This has been proven by many scientific. **Rumessen *et al* (1990) and Knudsen & Hessov (1995)**. These studies indicate that almost all of the inulin ingested enters the colon where it is totally fermented by the colonic microflora. The energy derived from fermentation is largely a result of the production of short-chain fatty acids and lactate, which are metabolized and contribute 1.5 kcal/g of useful energy for inulin. Other by-products of fermentation include bacterial biomass and gases that are eventually excreted. Due to the non-digestibility of inulin was found to be suitable for consumption by diabetics.

The obtained results in Table (5) revealed that after 4 weeks blood levels of glucose, LDL, creatinine, urea, uric acid,s triglycerides, total lipids and total cholesterol were decreased while HDL increased in diabetics rats fed on biscuits contain inulin compared to diabetics control rats fed on biscuits without inulin. These results are in agreement with those mentioned by **Canzi *et al* (1995)** who observed significantly, lower triglycerides, LDL and total cholesterol concentration in young male volunteers who consumed 9g inulin added to a rice breakfast cereal for a period of 4 weeks. And so, recent studies have shown the effects on serum triglycerides to be due to reduced secretion of VLDL particles from the liver and to be associated with reduced activity and gene expression of the key regulatory enzyme, fatty acid synthetase (**Kok *et al* 1996**). At the same time **David *et al* (1999)** reported that inulin reduce serum urea level in renal disease.

On the other hand the Table (6) showed that after 4 weeks total lipids, total cholesterol and triglycerides in liver of rats fed on biscuits contain inulin decreased compared to diabetics control rats feed on biscuits without inulin.

Regarding to histopathological examination Fig. 1, 2, 3 and 4 illustrated organs liver and kidney for diabetics control rats fed on biscuits without inulin and diabetics rats fed on biscuits supplemented with 9% inulin. Histopathological examination were observed severe congestion, hemorrhage and fatty change in liver of diabetics control rats, while were observed very few congestion, hemorrhage and fatty change in liver of diabetic rats fed on biscuits contain 9% inulin. Kidney of diabetics control rats were declared severe hemorrhage and hemolysis, meanwhile kidney in diabetics rats fed on biscuits contain 9% inulin were demonstrated very few hemorrhage without hemolysis.

From the above mentioned results it could be concluded that inulin possess several nutritional properties which may be used to formulate innovative healthy foods for diabetics.

Table 4. Chemical composition of biscuits

Samples	Moisture	Protein	Ether extract	Ash	Fiber	Total carbohydrates*	Energy (cal/100g)
Biscuits (control)	6.10	10.25	1.96	0.88	1.55	85.26	398.96
Biscuits (3% inulin)	6.81	9.98	1.52	1.38	1.83	85.29	394.48
Biscuits (6% inulin)	7.16	9.66	1.21	1.70	2.12	85.31	390.85
Biscuits (9% inulin)	7.93	9.13	1.05	2.05	2.27	85.50	388.44

* Calculated by difference

Table 5. Values of glucose, creatinine, uric acid, urea, triglycerides, total lipids, total cholesterol, high density lipoprotein (HDL) and low density lipoprotein (LDL) of blood for groups of rats after 4 weeks

Groups of rats*	Glucose	Creatinine	Urea	Uric acid	Triglycerides
Normal control	89e	0.92c	12e	4.40b	75d
Diabetics control	253a	1.03a	56a	7.45a	106a
Group No.1	187b	0.99a	38b	6.25a	100b
Group No.2	140c	0.96b	23c	5.16ab	93c
Group No.3	101d	0.93c	15d	4.19b	88c

Table 5. Cont.

Groups of rats*	Lipids	Cholesterol	HDL	LDL
Normal control	260e	85d	57.11a	12.89d
Diabetics control	319a	113a	41.26d	50.54a
Group No.1	312b	109a	46.31c	42.69a
Group No.2	303c	106b	49.67b	37.73bc
Group No.3	295d	97c	55.27a	24.13c

* Groups No. 1, 2 and 3 fed on biscuits contain 3,6 and 9% inulin respectively
- Values within a column followed by different superscript letter are significantly different

Table 6. Values of total lipids, total cholesterol and total triglycerides of liver (mg/100g) for groups of rats after 4 weeks

Groups of rats*	Total lipids	Total cholesterol	Triglycerides
Normal control	4.86d	0.50e	2.43c
Diabetics control	7.11a	0.81a	3.17a
Group No. 1	6.55ab	0.73b	2.85a
Group No. 2	6.20b	0.64c	2.61b
Group No. 3	5.41c	0.55d	2.49c

* Groups No. 1,2 and 3 fed on biscuits contain 3,6 and 9% inulin respectively
- Values within a column followed by different superscript letter are significantly different

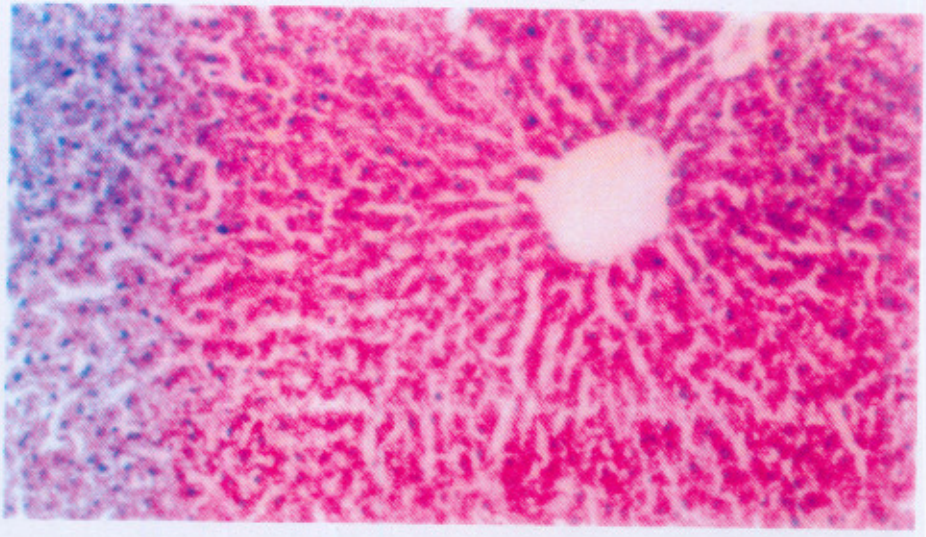

Figure 1. Photomicrograph of liver for diabetics control rats fed on biscuits without inulin. It obvious severe congestion, hemorrhage and fatty change.

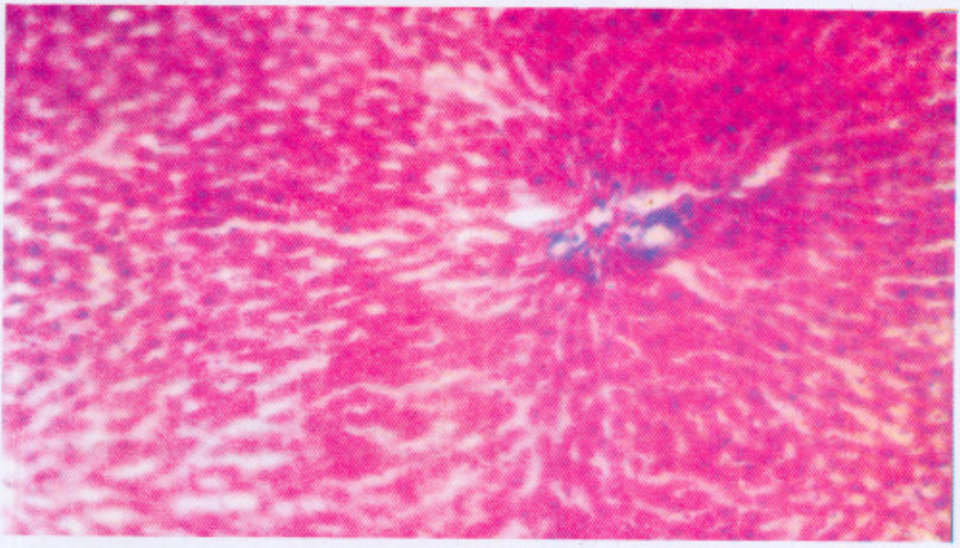

Figure 2. Photomicrograph of liver for diabetics rats fed on biscuits contain 9% inulin. It shows very few congestion, hemorrhage and fatty change.

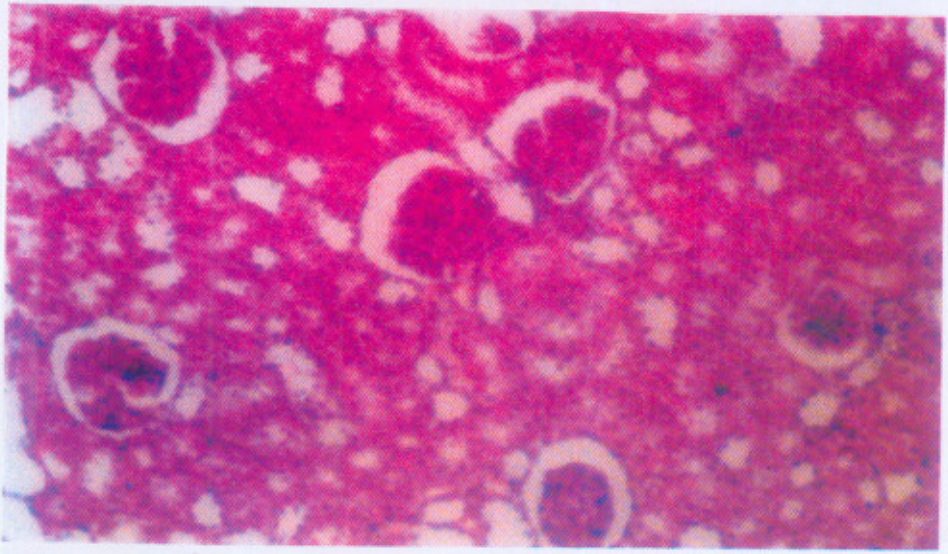

Figure 3. Photomicrograph of kidney for diabetics control rats fed on biscuits without inulin. It observes severe hemorrhage and hemolysis.

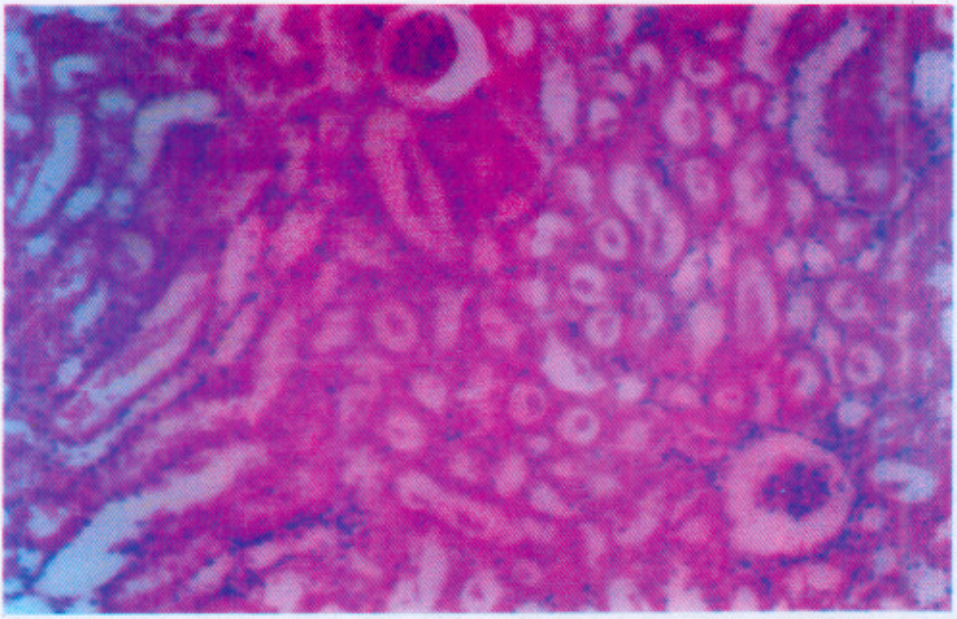

Figure 4. Photomicrograph of kidney for diabetics rats fed on biscuits contain 9% inulin. It notice very few hemorrhage without hemolysis.

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مجلة حوليات العلوم الزراعية ، كلية الزراعة ، جامعة عين شمس ، القاهرة ، م٤٩ ، ع(٢)، ٥٨٥ - ٥٩٥ ، ٢٠٠٤

دراسات على انتاج بسكويت مالح لمرضى السكر

[٤٠]

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الانيولين مادة كربوهيدراتية (أوليجوفركتوز) عبارة عن سلسلة مستقيمة وحدة تكوينها الفركتوز والجرام الواحد ينتج عنه واحد كالورى (سعر حرارى). وفى هذه الدراسة تم استخلاص الانيولين من قنابات الخرشوف واستخدم بنسب ٣، ٦، ٩% محل الدقيق استخلاص ٧٢% لعمل بسكويت مالح. أظهر التقييم الحسى تحسن تدريجى فى طعم وقوام ونكهة البسكويت فى حين انخفض لون ومظهر البسكويت تدريجياً بزيادة نسبة إحلال الانيولين ولكن لم تختلف النتائج معنوياً بالمقارنة بالكنترول. أظهر اختبار جودة البسكويت زيادة فى الوزن بينما قل حجم وقطر وسمك البسكويت قليلا بالمقارنة بالكنترول. أظهر التحليل الكيميائى للبسكويت الناتج زيادة فى الرطوبة والرماد والألياف والكربوهيدرات فى حين انخفضت نسبة البروتين والمستخلص الاثيرى والسعرات الحرارية وذلك بزيادة نسبة استبدال الانيولين بالمقارنة بالكنترول. التقييم البيولوجي لفئران التجارب أوضح أن الفئران المصابة بالسكر (المحقونة بالالوكسان) والتى تغذت على بسكويت يحتوى على ٣، ٦، ٩% انيولين لمدة ٤ أسابيع انخفض بها جلوكوز الدم والكريناتينين واليوريا وحمض اليورك والجلسريدات الثلاثية والليبيدات الكلية والكوليسترول واللايبوبروتين منخفض الكثافة بينما زاد الليبوبروتين عالى الكثافة بالدم. الفحص التشريحى لكبد الفئران المصابة بالسكر المغذاه على بسكويت لا يحتوى على الانيولين أوضح وجود احتقان ونزيف وتغيرات دهنية بدرجات كبيرة بالكبد فى حين أن كبد الفئران المغذاه على بسكويت به ٩% انيولين أوضح وجود احتقان ونزيف وتغيرات دهنية بدرجة قليلة جداً. شوهد فى كلى الفئران المصابة بالسكر والمغذاه على بسكويت لا يحتوى على الانيولين نزيف وتكسير فى كرات الدم بدرجة كبيرة فى حين أن كلى الفئران المغذاه على بسكويت به ٩% انيولين شوهد بها نزيف بدون حدوث تكسير فى كرات الدم.

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