Effect of Crackers Made from Psyllim Husk on some Vital Functional Parameters in Obese Rats Suffering from Hypercholesterolemia

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تأثير البسكويت الجاف الهش المعد من قشور القاطونه على بعض قياسات الوظائف الحيوية في الفئران البدينة التي تعاني من فرط كوليسترول الدم

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هدفت الدراسه إلى معرفة التأثير الإيجابي لقشور القاطونه على الصحة وتطبيقاتها الناجحة في الصناعات الغذائية. وقد تم إجراء الدراسة الحالية لمعرفة الخصائص التركيبية لقشور القاطونه واستخدامها في إعداد البسكويت الجاف الهش (الكراكر) المدعم بقشور القاطونه، وذلك عن طريق استخدام قشور القاطونه بالنسب الآتية 10% و15% و 20% ، واستبدال ما يقابلها في الدقيق %) واجريت الدراسة البيولوجية علي أربعون من الذكور فئران التجارب والذي يترواح أوزانها(215 ±10جرام) وتقسيمهم إلى خمس مجموعات (8 فئران في كل مجموعة). المجموعة الأولى (المجموعة الضابطة السالبة: الفئران التي تغذت علي الغذاء الاساسي)، والمجموعة الثانية (المجموعه الضابطة الموجبة: الفئران التي تغذت على الغذاء الغني بالدهون)، والمجموعة الثالثة (الفئران البدينة: تغذت على غذاء غني بالدهون والبسكويت الجاف الهش المعزز(الكراكر) بقشور القاطونه 10% و15% و 20% على الترتيب). وقد أوضحت النتائج أن متوسط القيم المتحصل عليها للخصائص التركيبية لقشور القاطونه لكل من الرماد والألياف الغذائية والبروتين الخام والدهن الخام والرطوبة والمستخلص الخالي من النتروجين وقيمه الطاقه (3,13% &2,94 % &1,84 % &6,19 83,38%& 361,84 على الترتيب). علاوة على ذلك ، كان محتوى كل من الألياف الغذائية والأرابينوكسين (77,66%&47.60 % علي الترتيب). إضافة البسكويت الجاف الهش المعزز (الكراكر) بقشور القاطونه إلى الغذاء الغني بالدهون أدى إلى نقص وزن الجسم، وإنخفاض في متوسط القيم لكل من جلسريدات ثلاثية الدهون ، والكوليسترول الدم ، والكوليسترول الضار وإنزيمات الكبد والجلوكوز في كل المجموعات المعالجة مقارنة بالمجموعات الضابطة الموجبة، بينما ارتفع متوسط قيم الكوليسترول النافع، كما تحسن متوسط القيم لهرمون اللبتين. ويستنتج مما سبق أن البسكويت الجاف الهش المعزز بقشور القاطونه (الكراكر) بنسبة 20% أظهر أفضل تأثير على وزن الجسم، وصورة دهون الدم، ووظائف الكبد، وهرمون الفئران البدنية التي تعاني من زيادة مستوى الكوليسترول فى الدم .

الكلمات الافتتاحيه : قشور القاطونه – الكراكر – الكوليسترول – فئران التجارب – التحاليل الكيميائية الحيوية.

Effect of Crackers Made from Psyllim Husk on some Vital Functional Parameters in Obese and Hypercholesterolemia Rats.

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ABSTRACT

This study aimed at determining the possible effects of psyllim husk on health and its successful applications in food industries. Determination the chemical composition of psyllim husk, and effect of different concentrations 10, 15 and 20% of psyllim husk on chemical composition and sensory evaluation of crackers were also evaluated. Forty adult Albino male rats Sprague Dawley strain and weighting (215 ± 10 g) were classified into five groups, (8 rats each). Group one was fed on basal diet and kept as the control (-ve) group. The other four rat groups were fed high-fat diet to induce obesity and hypercholesterolemia then classified into the control (+ve) and treated groups which were crackers fortified with psyllim husk (10, 15 and 20% respectively). The experimental period was 28days.The results showed that the mean values obtained for the chemical composition of psyllim husk for ash, crude fiber, crude protein, crude fat, moisture, and nitrogen free extract (NFE) and energy were 2.52, 3.13, 2.94, 1.84, 6.19 83.38% and 361.84, respectively. Moreover, total dietary fiber and arabinoxylan content were 77.66 and 47.60%, respectively. Biological results indicated that the addition of crackers fortified with psyllim husk to the high fat diet decreased the body weights, in addition to a significant decrease in the mean values of triglycerides, serum cholesterol, low-density lipoprotein cholesterol (LDL-c), aspartate amino transferase(AST), alanine amino transferase(ALT), and glucose level in all treated groups, as compared to the positive control groups, while high-density lipoprotein (HDL-c) increased. Also, the mean values of leptin hormone were improved. It is concluded that crackers fortified with 20% psyllim husk showed the best effect on body weights, lipid profile, liver functions, glucose level and hormones of obese rats suffering from hypercholesterolemia.

Key words:

Psyllim husk, Crackers, Biochemical analysis and Rat experiments.

INTRODUCTION:

Obesity is the term used to indicate the high range of weight for an individual of given height that is associated with adverse health effects **(Centers for Disease Control and Prevention [CDC].2010).** Obesity has rapidly become a serious concern regarding public health in the United States, and is associated with several adverse health effects in childhood and later in life, including cardiovascular disease risk factors (which include hypertension and altered lipid levels), cancer, psychological stress, asthma and diabetes**(Tirosh *et al.*, 2011).** Obesity is considered as one of the most serious health problems that require special interventional approaches and therapeutic attention. The foremost requirement when managing obesity is to lessen modifiable risk factors, like improper atherogenic diet and physical inactivity throughout changes in lifestyle **(Grundy *et al.*, 2005)**. Obesity, which often includes increased visceral fat, causes unbalanced production of hormones, metabolic products, and adipocytokines such as FFAs, tumor necrosis factor-(TNF-) **(Lebovitz, 2001)**. There is a notion that overweight contributes to diseases and deaths, but this notion needs to be reconsidered. Surely, obesity causes high risk of diseases according to **Lenz *et al.* (2009)**. Obesity can also be a burden whether socially or financially. Dietary fiber (DF) can be defined as "the edible parts of analogous carbohydrates or plants that are resistant to be absorbed or digested in the small intestine of humans, with partial or complete fermentation in the large intestine of humans. It includes lignin, oligosaccharides, polysaccharides, and some associated substances of plant. Dietary fiber displays one or more of blood glucose attenuation and/or blood cholesterol attenuation, and laxation **(Devries *et al.*, 2001)**. It seems that DF has a useful effect on weight control; where there are a considerable number of studies revealed that dietary fiber has an efficient effect on regulating body weight. These studies were conducted on humans and experimental models **(Davy and Melby, 2003; Delzenne and Cani, 2005)**. As an alternative or complementary agent in controlling the symptoms of metabolic syndrome, including obesity, many forms of DF were used **(Papathanasopoulos and Camilleri, 2010)**. There was an inverse relation of DF intake and body weight

suggested by epidemiological studies and cross-sectional studies (with body mass index) **Kromhout *et al.* (2001)and van de Vijver *et al.* (2009)** or body fat mass **(Liu *et al.*, 2003; Koh-Banerjee *et al.*, 2004)** and large observational studies body weight gain in women and in men **(Theuwissen and Mensink, 2008)**. The studies indicated that the body weight gain has an inversed correlation with the amount of whole-grain ingested **(Verma and Mogra, 2013)**.

The term "Psyllim" is used for the crust, seed and the whole plant. It is considered as a good source for soluble and insoluble fiber, and prebiotic. Its soluble content is almost eight times more than that of oat's bran and also, the psyllim husk contains 6.83%protein, 4.07% ash and 84.98% of total carbohydrates **(Verma and Mogra, 2013)**. Psyllim husk may be able to help with weight loss by increasing fullness **(Giacosa and Rondanelli, 2010)**. Consuming psyllim husk with meals increased fullness and reduced subjective appetite sensation, resulting in weight loss by approximately 10 lbs **(Salas-Salvadó *et al.*, 2008)**. psyllim (*Plantago Psyllim*) husk is a dietry fiber that is rich in soluble components **(Anderson *et al.*, 2000a)**. Using psyllim husk as an adjunct to a low-fat diet has indicated safety and good tolerance. When psyllim husk is used alone, it does not give a significant effect in reducing body weight. However, when combining it with dietary interventions, it gives an encouraging effect recommended by physicians according to the results obtained from meta analyses and clinical trials interventions (**(Marlett and Fischer, 2003; Van Craeyveld *et al.*, 2008)**. These health benefits are attributed to its active fiber fraction consisting of arabinoxylan (AX); polysaccharide containing heteroxylan, with monosaccharaides; arabinose and xylose, collectively referred as arabinoxylan **(Sahu, 2011)**. The arabinoxylan is a highly branch polysaccharide constituting more than 60% of the weight of Psyllim husk. Exclusively, arabinoxylan from psyllim husk is resistant to fermentation as compared to those extracted from wheat, oat or barley. Psyllim husk also have a symbiotic relation with medicine being used to reduce the problems related to obesity, dyslipidemia and CVD **(McKeown *et al.*, 2004)**. psyllim husk is becoming popular as therapeutic agent against various physiological ailments. Therefore, it is desire need to explore

the indigenous food sources for the welfare of the society **(Sahyoun *et al.*, 2006)**. The objective of study was to evaluate the positive effects of psyllim husk on health and its successful applications in cracker processing.

MATERIALS AND METHODS

Materials:

Psyllim husk (*Plantago Ovata*, Forsk) was bought from Imtenan Healthy shop, for the preparation of crackers, and other materials were used, such as sweeteners that contain (sorbitol and sucralose). Wheat flour (%72), and shortening they were purchased from the local market, Alexandria City. Egypt.

- Cellulose, minerals, casein, choline chloride, vitamins and cholesterol 97% extra pure were purchased from El-Gomhoreya Company for chemical, Drugs and Medical Instruments, Cairo, Egypt.
- Forty male Albino rats (Sprague Dawley Strain) were obtained from High Institute of Graduate Studies and Research, Alexandria University, Egypt.

Preparation of crackers:

The ingredients of crackers are tabulated in **Table (1)** according to method described by **Saba (2005)** with some modifications. The crackers were prepared by the replacement of wheat flour mixed with three proportions of psyllim husk powder i.e.(15, 20 and 25%). Wheat crackers samples were prepared without any addition of psyllim husk powder and used as the control. Prepared crackers treatments were baked on an electric oven at 180°C for 15-20 min. The crackers samples were allowed to cool for 40 min and stored in polypropylene bags at room temperature (25°C).

Table (1): Ingredients of crackers made from different levels of psyllim husk powder.

Ingredients (g)	Control sample (g)	Ratio samples %		
		10%	15 %	20%
Wheat flour	**100**	**90**	**85**	**80**
Psyllim husk	**0**	**10**	**15**	**20**
Sweetal (sucralose and sorbitol)	**30**	**30**	**30**	**30**
Eggs	**25**	**25**	**25**	**25**
Shorting	**60.5**	**60.5**	**60.5**	**60.5**
Vanilla essence	**2.5**	**2.5**	**2.5**	**2.5**
Baking powder	**3**	**3**	**3**	**3**
Total	**221**	**221**	**221**	**221**

Estimation for gross chemical composition:

Gross chemical composition of the husk and crackers mixed with different levels of psyllim husk were characterized for various aspects like gross chemical composition including moisture, crude protein (N×6.25), ash, crude fat, crude fiber were estimated according to **A.O.A.C. (2007)**. The N-free extract (NF E) content was obtained by equation **(**100 - percent total of (fat + protein+ fiber +ash**)** contents. Caloric values were calculated from the sum of the percentages of crude protein and total carbohydrates (N-free extract) multiplied by a factor of 4 (Kcal.g^{-}1) plus the crude fat content multiplied by a factor of 9 (Kcal.g^{-1}) according to **Zambrano *et al.* (2004)** .

Estimation of dietary fiber (DF):

Dietary fibers were estimated method described by **Prosky *et al.* (1984).**

Estimation of arabinoxylan (AX):

Arabinoxylan content of husk and different samples of crackers were isolated followed by derivitization of sample for monosaccharides determination and subsequently was calculated the arabinoxylan.

Isolation*:* In 100g husk sample, arabinoxylan was isolated by using alkali method as outlined by **Cleemput *et al.* (1995)**.

Derivitization of precipitates*:* Arabinoxylan was derivatived for monosaccharide determination according to **Vallance *et al.* (1998).**

Organoleptic evaluations of different samples of crackers:

The organoleptic characteristics were evaluated according to **Hooda and Jood (2005)**,using hedonic score consisting from 10 points.

Biological Experiment:

Forty male Albino rats (215± 10 g B.Wt., were used in this work. Rats were kept in individual stainless steel cages under hygienic conditions and fed one week on basal diet *adlibitum* for adaptation in the animal house of High Institute of Graduate Studies and Research, Alexandria University, Egypt. The basal diet consisted of 14 % protein from casein (≥ 80 %), 3.5% salt mixture, 0. 25 % choline chloride, 5 % cellulose, 1 % vitamin mixture, 4% soya oil, 0.18 % L- cystine and the remainder is corn starch up to 100% **(Reeves *et al.*, 1993).** The vitamin mixture was prepared according to **A.O.A.C. (1975)** and the salt mixture was prepared according to **Hegsted *et al.* (1941).** After a period of adaptation on basal diet (one week), the rats (n=40) have been distributed into two main groups: the first one (n=8 rats) were fed on basal diet and they were kept as a the negative control group (-ve), and the second one (n=32 rats) were given high fat diet for a duration of six weeks to activate obesity in rats. The formation of the high fat diet was 22% fat (1.5%cholesterol plus 19% beef tallow and 1.5% hydrogenated palm oil to provide essential fatty acids). Modification methods were applied according to **Reeves *et al.* (1993) and Liu *et al.* (2004)**.

After six weeks of feeding rats on high fat diet and cholesterol, and before start the experimental diet, the injury was confirmed by analyzing the serum level of lipid profile.

For analyzing the ratio of triglycerides and cholesterol, blood samples have been collected from all the rats. The first main group seemed to be that healthy rats (-ve) recorded 40.811 ± 1.3848mg/dl triglycerides and 80.00 ± 1.475 mg/dl cholesterol, while the second main group recorded (70.131 ± 0.75135 mg/dl triglycerides and

137.787 ± 0.39042mg/dl cholesterol, then the high fat diet group was distributed into four subgroups (n=8 rats for each) group (1) :provided that high fat diet as the positive control group (+ ve),others groups (2,3and 4) provided that high fat diet containing 150g crackers enriched with (10% psyllim husk powder and15% psyllim husk powder) and (20% psyllim husk powder), respectively. It was noted that the diets were consumed and the body weights were recorded every week all along the period of the experiment (28 days). The feed efficiency ratio (FER) and the body weight gain (BWG) and were estimated according to **Chapman *et al.* (1959)** by using the following equations.

$$\text{BWG\%} = \frac{\text{Final weight - Initial weight}}{\text{Initial weight}} \times 100$$

Relative organ weight was calculated by the following formula:

$$\text{Relative organ weight (ROW)} = \frac{\text{organ weight}}{\text{total body weight}} \times 100$$

Blood samples collection and estimation of the biochemical parameters:

By reaching the end of the experiment, some procedures were done. First, the animals were fasted overnight, and then the rats were weighed, anaesthetized, and sacrificed. Then after, blood samples were collected from the aorta and then centrifuged. The serum was separated to evaluate some biochemical parameters, i.e. serum cholesterol **(Allain *et al.*, 1974)**, triglycerides **(Foster and Dumns, 1973)**, HDL-c **(Lopes-Virella *et al.*, 1977**; **Richmond, 1973).**

Low-density lipoprotein (LDL) was determined by the calculation (cholesterol-(TG/5+HDL) **(Friedewald *et al.*, 1972)**.

By dividing the values of TG by factor of 5, very low-density lipoprotein (VLDL) was calculated **(Crook, 2006).** Atherogenic Index (AI) was estimated by =(LDL+VLDL) /HDL **(Nwagha *et al.*, 2010)**.

Glucose **(Trinder, 1969)**, alanine amino transferase(ALT) and aspartate amino transferase (AST) **(Reitman and Frankel., 1957).** Alkaline phosphatase (ALP) activity was determined according to the method of **Principato *et al.* (1985)**, gamma-glutamal-

transferase (GGT) was determined by kits from Barcelona, Spain,(Costa Brava 30), Biosystems S.A. **(Lorentz, 1997).** leptin hormone was determind according to the method of **Guilloume and Björntorp (1996).**

Statistical analysis:

Values were presented as means ± SD analyzed statistically by using one way ANOVA test, then Post Hoc test (LSD) was followed($P \leq 0.05$) was also used for indicating significance **(Kotz *et al.*, 1998)**.

RESULTS AND DISCUSSION

Sensorial quality of crackers fortified with psyllim husk:

Crackers fortified with psyllim husk and the control was evaluated for sensory, like color, odor, texture and overall acceptability is shown **Table (2)**. There were non-significant ($P \leq 0.05$) differences between the control and crackers fortified with psyllim husk of sensory specifications i.e. color, and texture. These findings are not in agreement with **Fradinho *et al.* (2015)** who reported that there were significant differences mean color and texture (6.6, 7.4 and 5.8 and 6.9, respectively). These values indicated that, cracker fortified with 10 % psyllim husk had the lowest mean of taste F_1 (6.53) compared with the other proportions for all crackers formulations and the control, while the highest was F_3 (7.55) in cracker fortified with 20 % psyllim husk. The results of odor showed that the highest value was in F_3 (7.74),but the lowest value was in F_0 at (7.30).It can be noted that, there was a significant variation in overall acceptability between F_1 and the other formulations (F_0,F_2,F_3) being 6.80 vs. 7.55, 7.35 and 7.45, respectively. These data are not in link with the results of **Fradinho *et al.* (2015)** who stated that there was a non-significant difference at flavor score.

Dietary fiber of husk can be applied in a variety of functional foods, like meat products, bakery products, and beverages. Influence of different processing treatments (like extrusion-cooking, canning, boiling, frying) alters the physicochemical properties of dietary fiber and improves their functionality **Papathanasopoulos and Camilleri**

(2010); Michael *et al.*, 2012 and Beikzadeh *et al.* (2016) observed a high level of total fiber and ash found in samples with 15% of husk, and overall acceptability of samples with husk were closer to the properties of the control.

Table (2): Effect of treatments on sensory properties (%) of crackers fortified with psyllim husk.

Formulations	Sensory parameters				
	Taste	Color	Odor	Texture	Overall acceptability
F_0Control	$7.38^{a} \pm 0.41$	$7.40^{a} \pm 0.15$	$7.30^{b} \pm 0.23$	$7.53^{a} \pm 0.01$	$7.55^{a} \pm 0.17$
F_1(10 %Ph)	$6.53^{b} \pm 0.41$	$6.60^{a} \pm 0.02$	$7.31^{b} \pm 0.02$	$7.43^{a} \pm 0.60$	$6.80^{b} \pm 0.26$
F_2(15 %Ph)	$7.50^{a} \pm 0.41$	$7.04^{a} \pm 0.89$	$7.39^{ab} \pm 0.26$	$7.39^{a} \pm 0.81$	$7.35^{a} \pm 0.32$
F_3(20%Ph)	$7.55^{a} \pm 0.42$	$7.18^{a} \pm 0.10$	$7.74^{a} \pm 0.22$	$7.40^{a} \pm 0.11$	$7.45^{a} \pm 0.37$

Values are expressed in mean ± SD.Mean value with different letters in the same column are significantly different ($P \leq 0.05$). **Ph** Psyllim husk.

F_0: Control. **F1**: Crackers fortified with10% of psyllim husk.
F2: Crackers fortified with15% of psyllim husk
F3 : Crackers fortified with 20 % of psyllim husk.

Characterization of psyllim husk:

Compositional estimation of the fortified (husk) is important because addition of husk in crackers may play a mandatory role in the adjustment of physical and chemical characteristics. Chemical analysis is also important to assess the efficacy of the supplement. Thus, husk was examined for its constituents including moisture, ash, protein, crude fat, crude fiber and Nitrogen free extract (NFE) along with dietary fiber especially the arabinoxylan content.

Chemical composition:

Table 2 shows chemical composition of psyllim husk. Mean values for moisture, ash, crude protein, crude fat, crude fiber ash, and NFE, and energy value in husk were (6.19, 2.52, 2.94.1.84.3.13, 83.38, and 361.84, respectively. Total dietary fiber and arabinoxylan contents were 77.66 and 47.60%, respectively. The results are agree with to **Guo *et al.* (2008)**. Earlier studies supported the current results that arabinoxylan content in husk is ranging from 45 to 60% further indicated that the major fractions are arabinose and xylose ,whilst minor fractions include some other sugars and uronic acid. Considering psyllim husk as a source of dietary fiber, some researchers stated that arabinoxylan is the active fraction helpful to manage various physiological ailments **(Saghir *et al.*, 2008)**.

Table 3: Chemical composition of psyllim husk.

Constituents	Quantity (%)
Moisture	6.19±0.05
Ash	2.52±0.04
Crude protein	2.94±0.06
Crude fat	1.84±0.01
Crude fiber	3.13±0.02
Nitrogen free extract (NFE)*	83.38±0.08
Energy Value (kcal/100g)	361.84±0.01
Dietary fibers(DF)	77.66±1.32
Arabinoxylan)(AX)	47.60±2.14

*** N-free Extract (%) calculated by difference. Values are expressed in mean ± SD.**
(AX): Arabinoxylan . (DF): Dietary fiber. (NFE): Nitrogen free extracts

Chemical composition of crackers:

Moisture:

Means for moisture of the control and other treatments were 3.01, 3.32, 3.38.3.45and 3.62, respectively. **Table 4** are presented the data reveal an increase of moisture as a result of adding psyllim husk in crackers. Such an increase may be increasing psyllim husk level that tends to absorb water for its hydrophilic nature. The present results are in confirmatory with the outcomes of **Uysal *et al.* (2007)** who reported significant effect on moisture as a result of addition of fiber in oven-baked crackers. They concluded that in the crackers fiber improves the water holding capacity as compared to

wheat flour resultantly increasing moisture level. Similarly, **Pasha *et al.* (2002)** also reported increase in moisture level in the crackers during storage.

Ash:

Total ash increased gradually in the treatments from the control (F_0) to crackers containing 10%, 15% and 20 % psyllim husk as shown in **(Table 4)**. Means for ash in the control (F_0) was 1.19% compared to crackers containing 10%, 15% and 20 % psyllim husk were found 1.42, 1.56,1.96and 1.78, respectively. The increase of ash in various treatments is attributed to increased psyllim husk level as fiber provides sufficient amount of ash to the recipe, being a compositional constituent **(Table 4). Pasha *et al.* (2011)**, showed increased mineral profile in the baked products attributed to high ash content of the composite flour.

Crude protein:

After adding psyllim husk in different treatments of crackers **(Table 4)**, a decrease in the content of protein was observed. The highest mean value (8.24) was reported for F_0 the control while it declined to 5.37in F_3 (crackers containing 20% psyllim husk). The main source of protein in crackers is white flour, and by replacing flour with psyllim husk, a decrease in protein content is resulted. The decrease in protein content may be also owing to the increasing content of moisture of the crackers that caused a change in the overall chemistry of the end product. This opinion is supported by earlier work of **Bilgiçli *et al.* (2007),** they reported decreased protein digestibility due to fiber content. Moreover, exploration of **Uysal *et al.* (2007)** found that adding up of fiber from fruit sources lowered protein content in crackers.

Crude fat*:*

Treatments showed a slight decrease in fat percentage of crackers. The maximum mean value was recorded as 17.39% in the control while it declined up to 17.09% in crackers containing 20% psyllim husk **(Table 4)**. Treatments exerted slight decline in fat percentage that may be as a result of increased moisture contents and fiber. Accordingly, **Uysal *et al.* (2007)** described the decrease in fat

percentage of crackers as a result of the addition of wheat fiber. Also, present results are in harmony with the results of **Pasha *et al.* (2002)** that in bakery products, increased moisture content may be one of the factors for declining trend in fat during storage.

Crude fiber*:*

Means for crude fiber in different treatments are presented in **Table 4.** Minimum crude fiber was detected in F_0 the control being 0.30. Nevertheless by the addition of psyllim husk it increased to 1.12% in crackers containing 20% psyllim husk). Regarding crude fiber in crackers, data exposed an increasing trend possibly due to adding up of psyllim husk as dietary fiber contributes in its inclination. The similar pattern was observed by **Pasha *et al.* (2011)** elucidated that addition of fiber enriched mung bean flour resulted in increased crude fiber content in bakery products.

Nitrogen free extracts (NFE):

psyllim husk addition to crackers explicated insignificant differences in NFE **(Table 4)**. The data indicated that means for NFE ranged from 72.34%, 72.40 %, 72.81%,73.11% and 73.64 %,respectively in F_0 the control and treatments groups.

Energy values:

psyllim husk addition to crackers summarized significant differences calories in **(Table 4).** The highest calories was detected in the control (F_0) being 483.69, and the lowest calories crackers fortified with 20% psyllim husk (F_3) being 469.73 compared with the control and other crackers fortified with psyllim husk. Concerning calories in crackers, values showed a decreased this is scientifically explained to add up of psyllim husk as dietary fiber contributes in its diminishing. High-fiber foods are habitually reduced in fat and energy density, both of which are useful for preserving a healthy body weight **(Joanne, 2013).**

Dietary fiber (DF):

It appears from **Table (4) t**hat means for total dietary fiber in F_0 the control was 0.96%, while in treatment groups with psyllim husk were (1.80%, 3.59%, and 5.12% and 6.45%), respectively depicting a defined increasing trend with progressive increment of psyllim husk. Enhanced dietary fiber in different treatments owes to fortification of crackers with psyllim husk containing high fiber contents. Similar results are assessed by other researchers that incorporation of fiber enriched sources boost the dietary fiber in resultant bakery products. The current results are supported by the work of **Vega-López *et al.* (2001)** indicating significant increase for this trait in crackers fortified with fiber.

Arabinoxylan (AX):

It has been assessed that AX percentage increased with the gradual increase of psyllim husk in various samples of crackers **(Table 4).** The value for this parameter in the control was 0.07 that significantly increased to 3.23in F 3 (crackers containing 20% psyllim husk). Formulations containing psyllim husk possessed high arabinoxylan content as compared to the control certainly due to sample amount of this fraction in husk. Earlier studies by **Van Craeyveld *et al.*, 2009 ; Saghir *et al.*(2008**) supported the current results inferring that psyllim husk comprised of 45-60% of arabinoxylan. Analysis of crackers containing psyllim huskas therapeutic food for vulnerable segment showed that psyllim husk has pronounced effect on rheology and composition of product. pysllium husk based crackers due to high dietary fiber and arabinoxylan contents are confirmed as suitable dietary intervention against life style-related disorders.

Table 4: Effect of treatments on proximate composition (%) of crackers fortified with psyllim husk.

Parameters / Formulations	Moisture	Ash	Cured protein (%)	Cured Fat	Crude Fiber	N FE	DF %	AX %	Energy values (kcal /100g)
F_0 Control	3.01^{a} ± 0.45	1.19^{a} ± 0.01	8.24^{a} ± 0.66	17.93^{a} ± 0.77	0.30^{d} ± 0.15	72.34^{b} ± 0.89	0.96^{a} ±0.02	0.07^{a} ±0.01	483.69^{a} ±0.07
F_1 (10 %Ph)	3.38^{a} ± 0.66	1.56^{a} ± 0.31	7.20^{ab} ± 0.90	17.65^{a} ± 0.39	0.78^{bc} ± 0.25	72.81^{ab} ± 0.21	3.59^{c} ±0.06	1.63^{c} ±0.04	478.89^{b} ±0.07
F_2 (15 %Ph)	3.45^{a} ± 0.21	1.69^{a} ± 0.77	6.92^{b} ± 0.54	17.32^{a} ± 0.13	0.96^{ab} ± 0.04	73.11^{ab} ± 0.66	5.12^{d} ±0.03	2.87^{d} ±0.05	476.0^{c} ± 0.08
F_3 (20%Ph)	3.62^{a} ± 0.38	1.78^{a} ± 0.33	5.37^{c} ± 0.42	17.09^{a} ± 0.20	1.12^{a} ± 0.08	73.64^{a} ± 0.89	6.45^{e} ±0.10	3.23^{e} ±0.08	469.73^{d} ±0.02

Values are expressed in mean ± SD. Mean value with different letters in the same column are significantly different ($P \leq 0.05$). **Ph:** Psyllim husk.
F_0: Control.
F_1: Crackers Fortified with10 % of Psyllim husk.
F_2: Crackers Fortified with15 % of Psyllim husk.
F_3: Crackers Fortified with20 % of Psyllim husk.
(AX): Arabinoxylan. **(DF): Dietary fiber.** **(NFE): Nitrogen free extracts.**

Effect crackers fortified with psyllim husk on feed intake, body weight gain % and changes of weight of obese rats:

The effect crackers fortified with psyllim husk on feed intake, body weight gain% and changes of weight of obese rats are presented in **Table (5)**.Feed intake (g/day for each rat).

The mean value of feed intake in healthy group fed on basal diet (the control group –ve) showed non-significant differences compared with the obese group fed on a diet of high fat that contains 22% fat (the control +ve group). Feed intake in all the obese groups which were treated with different levels of psyllim husk crackers fortified with psyllim husk had insignificant ($P \leq 0.05$) differences of mean values as compared with the normal group (the control group –ve) and obese group fed on a diet of high fat that contains 22% fat(the control +ve group).

Weight changes of obese rats during the experimental period (g).

Table (5) showed the follow-up development in weight of normal, and obese rats which were treated with crackers fortified with psyllim husk during the experiment. Data in show a significant ($P \leq 0.05$) decrease in the weight of normal group (the control –ve group) in both initial and final of the experimental period, as compared to obese group (the control +ve group) and all obese rats groups were treated with crackers fortified with psyllim husk.

Feeding obese rats groups on high fat diet containing 22% fat and treated with 10%, 15% and 20% of crackers fortified with psyllim husk led to a significant ($P \leq 0.05$) decrease in the weight at the final of the experiment, as compared to the positive control group.

Groups of rats which were treated with (crackers fortified with20% of psyllim husk) recorded the lowest a significantly ($P \leq 0.05$) decrease in the mean value of weights when comparing to all other treated groups.

Body Weight Gain % (BWG %)

Body weight gain % of obese rats fed on diet containing22% fat (the control +ve) increased significantly ($P \leq 0.05$), as compared to the negative control group fed on basal diet. On the other hand, comparing all treated groups with the control +ve group demonstrated significant decrease. Treated groups with 10%, 15% and 20% of crackers fortified with psyllim husk resulted in the highest decrease in BWG%, as compared to (the control +ve). In this study, psyllim husk appeared to affect reduction of weight gain in rats that were fed on a diet of high fat. psyllim husk is believed to instigate loss of body weight when it acts as a bulking agent, causing a reduction in caloric intake and an increasing satiety. It is also believed that psyllim husk is associated with reduced plasma lipid concentrations **(Kang *et al.*, 2007).** The use of psyllim had an enhanced anti-obesity effect regarding reducing accumulated body fat weight and body weight gain. When conducting studies on animals and humans, psyllim husk displayed hypolipidemic effects **(Romero *et al.*, 2002).** When taking psyllim husk for three days before breakfast and lunch, a feeling of increased fullness and less

hunger between meals is resulted, comparing to a placebo. Upon testing the doses (3.4, 6.8, and 10.2g), it was found that the 6.8g dose has more consistent satiety benefits than the placebo **(Brum *et al.*, 2016)**.Meanwhile, **Abutair *et al.* (2016)** found that people with type 2 diabetes who took 10.5 grams of psyllim husk daily for eight weeks had a lower body mass index (BMI) compared to those who ate their regular diet for eight weeks. Additionally, fasting blood sugar, insulin, and other blood markers improved after psyllim supplementation. Psyllim husk contains soluble dietary fiber, which forms a gel-like layer after coming in contact with water. This layer helps slow down the transit of food through the stomach, resulting in increased satiety **(McRorie, 2015).**

Table (5): Effect of crackers fortified with psyllim husk on feed intake, body weight gain % and changes of weight of obese rats at the end of study.

Parameters / Groups	Feed intake (g/day)	Initial weight G	Final weight	BWG%
Control (-)	20.000 ^{ab}± 0.87	182.500 ^{b}± 2.455	197.000 ^{f}± 8.165	15.035 ^{d}± 1.520
Control (+)	18.350 ^{b}± 0.78	244.750 ^{a}± 2.994	317.500 ^{a}± 10.408	35.983 ^{a}± 1.440
F_1(10 %Ph.)	19.600 ^{ab}± 0.47	246.500 ^{a}± 2.557	267.250 ^{e}± 7.365	11.773 ^{e}± 0.666
F_2(15 %Ph)	18.000 ^{ab}± 1.13	246.500 ^{a}± 3.415	280.000 ^{d}± 4.082	17.173 ^{d}± 1.731
F_3(20%Ph)	19.700 ^{ab}± 0.57	249.250 ^{a}± 1.258	259.500 ^{e}± 2.645	7.281 ^{f}± 0.607

Values are expressed in mean ± SD.Mean value with different letters in the same column are significantly different ($P \leq 0.05$). **Ph:** Psyllim husk.

F_0: Control.

F_1: Crackers Fortified with10 % of Psyllim husk.

F_2: Crackers Fortified with15 % of Psyllim husk.

F_3: Crackers Fortified with20 % of Psyllim husk.

Effect of crackers fortified with psyllim husk on lipid fractions of obese rats.

A summary of data of glucose and lipid profile (mg/dl) is shown in **Table 6**. A reveal significant increase ($P \leq 0.05$) in serum glucose was shown when treatment with high fat diet alone was applied, as compared to the negative control group. While the presence of crackers fortified with verity ratios of psyllim husk (10%,15% and 20%, respectively) decreased the concentration of serum glucose, but these did not reach the values of the negative control group. **Abutair *et al.* (2016)** found that combining soluble fiber to the normal diet reduced glycemic response. Moreover, when foods containing moderate amounts of these fibers are consumed, this may cause an improvement in lipid profile, type 2 diabetes patients and glucose metabolism. Fiber supplementation has been

shown to control glycemic response to a meal and reduce insulin and blood sugar levels. This is particularly the case with water-soluble fibers like psyllim **(Dow *et al.*, 2012)**.

The findings of lipid fractions had significantly ($P \leq 0.05$) increased for the positive control group, in comparison with the negative control group (275.90, 265.50, 41.05, 182.74, 55. and 5.60, Vs 130.07, 125.34, 70.97, 36.28, 25.15 and 0.86, respectively).

The percentage of increase in cholesterol content was about 74.79 % while HDL-c content (mg/dl) for the positive control group decreased than that of the negative control group by about 48.26 %. Addition of crackers fortified with psyllim husk to the high fat diet of obese rats resulted in a significant reduction in cholesterol, triglycerides, LDL-c and VLDL-c compared to the positive control group. It is noticeable that the obese rats which fed on crackers fortified with psyllim husk had higher mean values of HDL-c than that of the positive control group. Our results are in agreement with many studies which showed that, the addition of psyllim husk significantly($P \leq 0.05$) reduced total lipids. Treatment with 5.1 g psyllim husk two times a day causes a significant reduction in serum total cholesterol and LDL-c concentrations in men and women with primary hypercholesterolemia. psyllim husk therapy is an effective adjunct to diet therapy and may provide an alternative to drug therapy for some patients **(Anderson *et al.*, 2000b)**.

Moreyra *et al.* (2005) observed that dietary psyllim supplementation in patients who take a dose of drug10 mg of a dose simvastatin has proven dose efficiency in lowering cholesterol as 20 mg. For that, psyllim soluble fiber is recommended as a well-tolerated dietary supplement choice and safe in enhancing LDL-C and lowering apolipoprotein B. **Wei *et al.* (2009)** found that psyllim is capable of producing dose- and time-dependent serum cholesterol-lowering effect in patients of moderate and mild hypercholesterolemia. It can also be of good use as an adjunct to dietary therapy in treating hypercholesterolemia. Significant modifications in bulk, volume, and viscosity in the intestinal lumen can be caused as a result of the physicochemical properties of soluble fiber. This can change the metabolic pathways of lipoprotein metabolism and hepatic cholesterol which contribute to lowering

plasma LDL-cholesterol **(Fernandez, 2001). Giacosa and Rondanelli (2010)** noted that the acceptable effect of various fibers, especially of psyllim, on satiety and reducing body weight, on blood pressure, on triglycerides and cholesterol levels, and on fasting glycaemia suggests a likely role of these fibers in metabolic syndrome treatment. **Ganji and Kuo (2008)** reported that post- and pre-menopausal, hypercholesterolemia women have different responses to psyllim fiber supplementation, where post-menopausal women can be benefited when adding psyllim to their diets to reduce heart diseases risk.

Table (6): Effect of crackers fortified with psyllim husk on glucose and lipid fractions of obese rats at the end of study.

Parameters / Groups	Glucose	Cholesterol	Triglycerides	HDL-c	LDL-c	VLDL-c	AI
	mg/dl						
Control (-)	120.94^{a} ±2.25	130.07^{e} ± 2.56	125.34^{d} ± 1.89	70.97^{a} ± 2.02	36.29^{e} ± 1.99	25.16^{bc} ±2.52	0.86^{d} ± 0.04
Control (+)	158.62^{b} ±2.24	275.91^{a} ± 2.53	265.51^{a} ± 2.06	41.05^{d} ± 1.31	182.74^{a} ± 3.73	55.34^{a} ± 2.81	5.60^{a} ± 0.40
F_1(10 %Ph)	142.89^{c} ±2.25	170.96^{b} ± 2.45	137.97^{b} ± 1.53	53.78^{c} ± 1.80	86.78^{b} ± 2.30	26.56^{b} ± 1.83	2.17^{b} ± 0.64
F_2(15 %Ph)	137.65^{c} ±2.61	161.06^{c} ± 2.55	130.16^{c} ± 1.67	63.57^{b} ± 2.10	72.74^{c} ± 1.90	23.96^{cd} ±2.48	1.54^{c} ± 0.02
F_3(20%Ph)	128.99^{e} ±13.4	152.04^{d} ± 3.05	126.25^{d} ± 3.66	69.63^{a} ± 2.86	61.66^{d} ± 5.27	22.06^{d} ± 2.18	1.16^{d} ± 0.21

Values are expressed in mean ± SD. Mean value with different letters in the same column are significantly different ($P \leq 0.05$). **Ph:** Psyllim husk.

F_0: Control.

F_1: Crackers Fortified with10 % of Psyllim husk.

F_2: Crackers Fortified with15 % of Psyllim husk.

F_3: Crackers Fortified with20 % of Psyllim husk.

Effect of crackers fortified with psyllim husk on some liver enzymes of obese rats:

Concerning Alanine transaminase (ALT), Aspartate transaminase (AST) Alkaline phosphates (ALP) and Gamma-glutamic trans peptidase (GGT), it can be noted that the rats in the negative control group had a significant ($P \leq 0.05$) lower mean values than the values of the positive control group (obese rats), as the values in healthy group were found (32.52, 35.86, 66.17 and 37.99, respectively). Clear long-term high-fat diet could cause different degrees of degeneration of the livers **(Table 7)**.When crackers fortified with psyllim husk were added to the high fat diet of obese rats a significant ($P \leq 0.05$) decrease of AST, ALT, ALP and GGT values were noted in comparison with the positive control group (50.26, 52.03,139.57 and 44.81, respectively).

Notwithstanding, crackers fortified with 20 % of psyllim husk induced a significant decrease than other groups that received the crackers fortified with10 % of psyllim husk. So, the best results were for group of rats fed on crackers fortified with20 % of psyllim husk. A few number of studies examined the effects of processing on certain soluble fibers and their hepatic lowering enzymes. **Cantero *et al.* (2017)** conducted that the dietary patterns which depended on consuming insoluble fiber and fiber from fruits regarding energy restriction to manage obese patients that suffer from fatty liver disease. **Han *et al.* (2015)** reported that cereal dietary fiber fortification causes an abrogation to obesity-related liver lipotoxicity and dyslipidemia in rats that were fed on high fat diet.

Table (7): Effect of crackers fortified with psyllim husk on some liver enzymes of obese rats at the end of study.

Parameters / Groups	ALT	AST	ALP	GGT
	u/l			
Control (-)	$32.52^{c} \pm 1.61$	$35.86^{bc} \pm 2.61$	$66.17^{c} \pm 1.21$	$38.00^{b} \pm 2.33$
Control (+)	$50.26^{a} \pm 2.09$	$52.04^{a} \pm 2.49$	$139.58^{a} \pm 2.11$	$44.82^{a} \pm 2.77$
F_1(10 %Ph)	$35.05^{b} \pm 2.51$	$36.65^{b} \pm 2.75$	$72.85^{b} \pm 5.09$	$39.56^{b} \pm 2.03$
F_2(15 %Ph)	$32.02^{cd} \pm 1.75$	$34.20^{cd} \pm 1.40$	$67.97^{c} \pm 2.19$	$37.59^{bc} \pm 2.98$
F_3(20%Ph)	$30.29^{d} \pm 1.82$	$31.95^{d} \pm 1.64$	$59.61^{d} \pm 1.96$	$35.13^{c} \pm 2.40$

Values are expressed in mean ± SD. Mean value with different letters in the same column are significantly different ($P \leq 0.05$). **Ph:** Psyllim husk.

F_0: Control. **F_1**: Crackers Fortified with10 % of Psyllim husk.

F_2: Crackers Fortified with15 % of Psyllim husk.

F_3: Crackers Fortified with20 % of Psyllim husk.

Effect of crackers fortified with psyllim husk on kidney functions of obese rats:

The mean values of serum urea nitrogen, uric acid, and creatinine of obese rats that were fed on high fat diet that is full of crackers fortified with psyllim husk 10%, 15% and 20% are given in **Table (8)**. It can be observed that the rats in the negative control group had a significant lower mean values than that of the positive control group (obese rats). When crackers fortified with psyllim husk were added to the high fat diet of obese rats, a significant decrease of uric acid, urea nitrogen and creatinine values were noted in comparison with the positive control group. A recent study showed that a high dietary total fiber intake is accompanied by a lower rate of risk to mortality and inflammation in diseases related to kidney. Dietary fiber also has the ability to reduce inflammation and all-cause mortality in chronic kidney diseases **(Krishnamurthy *et al.*, 2012)**. In addition, higher dietary fiber intake was a reason for lowering levels of serum of interleukin-6 and tumor necrosis factor-alpha receptor-2 in postmenopausal women according to the Women's Health Initiative Study **(Ma *et al.*, 2008).** Moreover, dietary fiber intake was a reason for lowering serum CRP in cross-sectional studies **(King *et al.*, 2003; Ajani *et al.*, 2004)**.Dietary fiber supplementation also has a significant reduction of serum urea and reduced creatinine levels in the primary pooled analyses (MD, -1.76 mmol/l (95% CI, -3.00, -0.51), $P \leq 0.05$ and MD, -22.83 m mol/l (95% CI, -42.63, -3.02), $P=0.02$, respectively)**(Chiavaroli *et al.*, 2015)**. High dietary total fiber intake is accompanied by a lower level of risk of mortality and inflammation in diseases related to kidney, where the effect is stronger. Interventional trials are required for establishing the effects of fiber intake on mortality and inflammation in diseases related to kidney **(Krishnamurthy *et al.*, 2012)**.

Table (8): Effect of crackers fortified with psyllim husk on kidney functions of obese rats at the end of study.

Parameters / Groups	Uric acid	Urea nitrogen	Creatinine
		mg/dl	
Control (-)	$4.56^{c} \pm 0.28$	$35.93^{b} \pm 2.45$	$0.85^{b} \pm 0.12$
Control (+)	$7.48^{a} \pm 0.86$	$51.55^{a} \pm 1.94$	$1.76^{a} \pm 0.35$
F_1(10 %Ph)	$5.10^{b} \pm 0.48$	$35.87^{b} \pm 1.75$	$0.77^{b} \pm 0.15$
F_2(15 %Ph)	$4.36^{c} \pm 0.42$	$33.52^{c} \pm 2.35$	$0.65^{bc} \pm 0.21$
F_3(20%Ph)	$3.51^{d} \pm 0.39$	$29.74^{d} \pm 1.29$	$0.46^{c} \pm 0.08$

Values are expressed in mean ± SD, Mean value with different letters in the same column are significantly different ($P \leq 0.05$). **Ph:** Psyllim husk.

F_0: Control.

F_1: Crackers Fortified with10 % of Psyllim husk.

F_2: Crackers Fortified with15 % of Psyllim husk.

F_3: Crackers Fortified with20 % of Psyllim husk.

Effect of crackers fortified with psyllim husk on some serum hormones of obese rats:

Data at **Table (9)** show that the mean values of leptin hormone had a significantly ($P \leq 0.05$) increased for the positive control group, in comparison with the negative control group. Rats which received high fat diets with addition of crackers fortified with psyllim husk at any tested levels 10%, 15% and 20% had lower mean values of serum leptin hormone compared with the positive control group. The best result of serum leptin hormone among all treated groups was observed in the group of rats fed on high fat diet containing crackers fortified with20 % of psyllim husk, followed by group that fed on crackers fortified with15 % of psyllim husk and finally group of rats fed on crackers fortified with10 % of psyllim husk. In this respect, there are agreements with our results. When the high-fat diet is consumed for a long term, it causes an increase in plasma leptin concentration and fat cell size. Besides, a high-fat sucrose (HFS) diet caused hyperinsulinemia and hyperleptinemia before observing that adipocyte size increases**Roberts *et al.* (2002).** Interestingly, this study found that high fat diets that contain primarily sugar cane and psyllim caused lower plasma leptin concentrations when comparing to high fat diet containing 10% cellulose or the high-fat diet alone**Wang *et al.* (2007)**. As for the mechanism, there is an important question that imposes itself: Did the processing of the

dietary fiber, i.e. degree of fermentation and production of short-chain fatty acids, directly affected leptin production as suggested by other reports **(Tune and Considine, 2007)** or there was an unrelated mechanism responsible for that **Zhang *et al.* (2016)** indicated that mice that were fed oat or wheat bran fiber displayed a lower level in body weight, serum lipids, insulin and leptin. The two cereal fibers potently increased the protein expressions of LepR in the adipose tissue. In addition, protein expressions of Janus kinase 2 (JAK2) and transcription 3 (STAT3) (induced by LepR), which enhances leptin signaling, were significantly higher and the expression of cytokine signaling-3 (SOCS3), which inhibits leptin signaling, was a significantly lower in the two cereal fiber groups than in the HFD group.

Table (9): Effect of crackers fortified with psyllim husk on some serum hormones of obese rats at the end of study.

Parameters / Groups	Leptin mg/dl
Control (-)	$1.76^{d} \pm 0.31$
Control (+)	$12.96^{a} \pm 1.71$
F_1(10 %Ph)	$5.98^{b} \pm 1.82$
F_2(15 %Ph)	$4.48^{c} \pm 1.02$
F_3(20%Ph)	$3.53^{c} \pm 0.88$

Values are expressed in mean ± SD. Mean value with different letters in the same column are significantly different ($P \leq 0.05$). **Ph:** Psyllim husk.
F_0: Control.
F_1: Crackers Fortified with10 % of Psyllim husk.
F_2: Crackers Fortified with15 % of Psyllim husk.
F_3: Crackers Fortified with20 % of Psyllim husk.

CONCLUSION

In conclusion, the crackers fortified with psyllim husk have a good effect in diminishing obesity, as they cause a lowering level in body weight, lipid profile, liver functions, and glucose level. In addition, some obesity hormones induced rats fed on high fat diet decreased. As a recommendation, further studies need to be conducted in order to determine the medicinal effect of other different fractions of psyllim husk.

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