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PRODUCTION OF CRACKERS SUPPLEMENTED WITH PRICKLY PEAR FRUIT COMPONENTS (*OPUNTIA FICUS-INDICA* L.)

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ABSTRACT

This study aimed to explore the possibility to maximize the benefit of the different components of prickly pear fruits (whole fruits, peels, seeds and pulp) in order to minimize the loss in their nutritive value and take advantage of the resulting waste (peels and seeds) in the preparing of healthy cracker. The approximate ratio of the peels and seeds were 47.2 and 4.3%, respectively, of the wholly fresh fruit weight. So that wheat flour 72% extraction was replaced by dried whole fruits or peels or seeds at substitution levels of 4, 8 and 12%, while Pulp of Prickly Pear was separately added as extract (90% moisture) at levels of 20, 40 and 60 ml /100g wheat flour during the preparing of crackers. The produced crackers were chemically, organolyptically, and physically evaluated. The obtained data indicated that increasing of the supplementation levels of the previous materials produced crackers characterized with increasing ash, dietary fiber and mineral contents (*i.e.*, Fe, Zn, Ca, and Mg) with slight increasing in fat, while protein, carbohydrates and energy slightly decreased compared with the control.The decreasing in caloric values were ranged from 448.20 to 435.34 K.cal compared with 450.78 K.cal. for the control. All samples of crackers had acceptance (very good), except the samples which were made from dried seeds of prickly pear at level 8% and peels of prickly pear at level 8 and 12 % which it had less acceptance (good). It is also noticed that in the case of pulp extract of prickly pear all sensory characteristics were improved with increasing the percentage of supplements. The values of height, volume and specific volume in all samples of produced crackers were slightly decreased by increasing substitution level of previous materials, while weight and moisture were increased. The results of storage tests for produced crackers at (18±2 ℃) in sealed poly propylene bags (as economic backing) for up to 6 months cleared that all samples of cracker had the lowest in both of peroxide value and percentage of losses of odor and taste compared with the control. So this leads to prolong the shelf life of crackers. The results showed that 100 gm of crackers containing the previous source

of materials contribute about 13.17-52.08% of the Recommended Dietary Allowances (RDA) of dietary fiber for children, and 6.32-25.0% for adults compared to the control which contribute 7.67 and 3.68% for children and adults, respectively. In addition, all values of minerals (*i.e*., Fe, Zn, Ca and Mg) as RDA% were the higher in all samples of crackers compared with the control. So it could be recommended that incorporation of the dried whole Prickly Pear fruit powder or the different components of Prickly Pear fruit (as a natural economist plant source had chemopreventer effects) with wheat flour 72% extraction to obtain healthy bakery products having high biological value) especially for hypercholesterolemia and diabetic patients) due to its content of high amounts of dietary fiber.

INTRODUCTION

Prickly pear, a member of the family Cactaaceae and a native to arid and semi arid regions, is widely distributed in many parts of the world such as Africa, Australia and Mediterranean basin. It contains high content of some chemical constituents which give added value to its fruit on a nutritional and technological functionality basis **(Piga, 2004).** About 1500 species of Prickly pear cactus are in the genus *Opuntia* and many of them produce edible and highly favored. In Egypt, the total area annually cultivated with Prickly pear fruits was about 6268.5 ha, produced about 28.431.000 Kg fruits of which the calculated peels amounted in about 13.420.000 Kg peels **(Anonymous 2008).**The pulp is the edible part of the fruit and is composed of water (84% to 90%) and reducing sugars (10% to 15%). Sugars range from 10º to 17 º Brix and are mainly of the reducing type, with glucose being the predominant sugar and fructose being the second sugar, thus the fruit pulp is very sweet **(Stintzing *et al*., 2003).** Fruits of Prickly pear are recognized as an important source of vitamins for local people at the natural growth sites of the plant. Peels and seeds are the waste products of the Prickly pear fruits processing industries. Seeds constitute about 10-15% of the edible pulp and are usually discarded as waste after extraction of the pulp. The seeds are rich in minerals and sulphur amino acids. According to literature data of **Stintzing *et al*, 2000 and Helmy-Sh, 2007,** oil processed from the seeds constitutes 7-15% of whole seed weight and it characterized by a high degree of unsaturation wherein linolec acid is the major fatty acid (56.1-77.0%). The sterols in seed oil are composed of ß-sitosterol as the sterol marker, followed by campesterol, then stigmasterol. Likewise, **Hassanien and Morsel, 2003; Ramadan and Morsel (2003b) and Kuti (2004)** pronounced that Prickly pear seed oil contained ɤ - tocopherol and ß-carotene. These compounds exhibit antioxidant activity.

Chiefly, the biological studies on rats purported that prickly pear seed oil exhibited a significant decrease in serum glucose, total cholesterol and LDL-cholesterol in the treated rats **(Ennouri *et al*., 2005b and Ennouri *et al*., 2007).**

Prickly pear peels are a new desert source of dietary fiber and its content in galacturonic acid was superior to that of commercial cladode cactus racquet. Furthermore, Prickly pear fibers show a pleasant aroma and flavours **(Terrazas *et al*, 2002).** Their no toxicity effect was detected either on liver or kidney function in treated rats. Furthermore, a significant decrease was observed in blood urea and serum creatinine, liver Enzymes (ALT and AST) as well as serum LDL-cholestrol level following oral administration of prickly pear peels daily for 21 days to rats (**El-Said Nesreen *et al*.,2011)**. In humans, **Shapiro and Gong (2002)** demonstrated the benefit of *Opuntia* for improvement of hyperlipidemic profiles.

The antioxidative action is one of many mechanisms by which fruit and vegetable substances might exert their beneficial health effects. The presence of several antioxidants (ascorbic acid, carotenoids, reduced glutathione, cysteine, taurine and flavonoids such as quercetin, kaempferol and isorhamnetin) has been detected in the fruits and vegetables of different varieties of cactus prickly pear (**Tesoriere *et al*., 2005 a and Tesoriere *et al*., 2005b)**. More recently, the antioxidant properties of the most frequent cactus pear betalains (betanin and indicaxanthin) have been revealed (**Tesoriere *et al*., 2004 and Gentile *et al*., 2004).**

Prickly pear has a long history of traditional Mexican folk medicine use, particularly as a treatment for diabetes. The fruit has been used for treating diarrhea, asthma, and gonorrhea. Cactus pear plant components display a remarkable array of biochemical, immunological and pharmacological action, including anti-cancer (**Supino *et al*., 1996 and De Palo *et al*., 2002**), anti-viral (**Ahmad *et al*., 1996**), anti-inflammatory (**Lee *et al*., 2001 and Allegra *et al*., 2005**), anti-diabetic-type II (**Trejo-Gonzalez, *et al*., 1996 and Cicero *et al*., 2004**) and anti-hyperlipidemic and hypercholesterolemic **(Jones *et al*., 2000; Stintzing *et al*., 2001 and Stintzing and Carle, 2005)** effects. **Linares *et al*. (2007)** indicated an advantage of using *Opuntia* in dietary supplements and functional foods because of improvement of blood lipid parameters associated with cardiovascular risks. Furthermore, the health-promoting capacity of cactus pear fruit is highly attractive for the development of nutraceutical and functional food. Functional components such as dietary fiber, natural colorants, and antioxidant vitamins are some of the nutrients people want to

include in their daily diet certain vegetable are promising sources of such components **(Saenz, 2002 and Feugang *et al* 2006).**

Because of crackers is considered confectionary favorite product for all people and are used in their breakfast or tea time, this study was designed to produce healthy cracker. Natural plant source which have chemopreventers effects such as different components of prickly pear fruits (whole fruits, peels, seeds and pulp) were used as supplemented materials. The produced crackers were evaluated chemically, organolyptically and physically.

MATERIALS AND METHODS

2.1. Materials:-

- Mature prickly pear fruits (*Opuntia - ficus-indica*) were purchased from El- Oboor Market, Cairo.
- Soft wheat flour (*Triticum aestivum,* L.) 72 % extraction rate was obtained from the North Cairo Flour Mills Company, Egypt.
- Other materials: Salt, corn oil, dry yeast, dry milk and improver were purchased from local market.

2.2. Methods:-

2.2.1. Determination of prickly pear fruit components:-

Whole fruits, pulp, peel and seed weights were determined and the percentage of each parameter was calculated according to the method of **Duru and Turker (2005).**

2.2.2. Preparation of dried prickly pear fruits and its fractions:-

Dried prickly pear fruits and its fractions were prepared according to the methods described in **Siham *et al*. (2004)** with some modification as presented in Fig. (1). All dried products were milled to a fine powder, and then sieved on a 100 µm. then, packaged in polyethylene bags and stored in deep freezer (-18°C) until using.

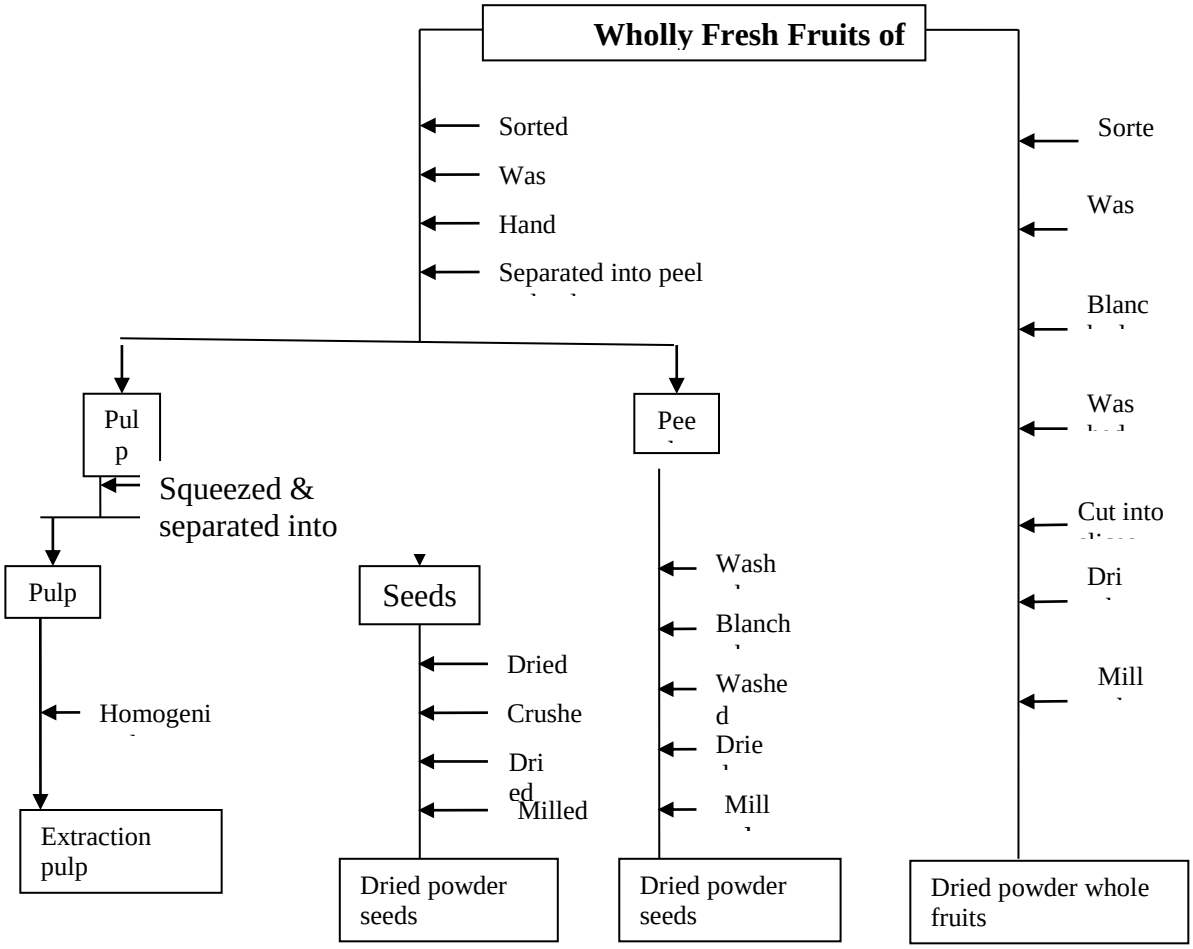

Fig. (1):- Preparation of whole fruit parts dried of Prickly Pear and its fraction.
a) Blanched in boiled water containing 1%NaoH /2MIN., at 90C, then step b)Dried it at 50C / over

2.2.3. Blends:-

The flour blends were formulated on a replacement basis as follows wheat flour was separately substituted with 4, 8 and 12% whole meal fruit , Seeds and Peels of Prickly Pear while Pulp of Prickly Pear was added as extract (90% Moisture) at level 20, 40 and 60 ml for each 100g wheat flour from the formula. Wheat flour without any supplementation was considered as control.

2.2.4. Preparation of Crackers:

The crackers were prepared according to the method described by **Sathe *et al.* (1981)** with some modification in the formula. The blends and ingredients used for production of crackers were tabulated in Table (1).

For making cracker the following procedure was followed: - All ingredients were blended in warm water using a laboratory mixer for 4 min. and the resulted dough was let to rest for 15 min., then the dough was removed from the bowel and shaped to the final form and given 40 min as a fermentation time at 37°C and 85% relative humidity. The fermented cracker was drilled and painted by egg (40 gm whole egg batten with 10 ml water and 0.5 anise) for cracker face, then baked at 200°C for 6 min. After baking, crackers were allowed to cool at room temperature for 1 hr. before organoleptic evaluation.

2.2.5. Storage of cracker:

After cooling, cracker samples were preserved in poly propylene bags, then piled in a cardboard box, and stored at 18±2℃ for 2, 4, and 6 months to study the changes occurred in sensory evaluation (Taste and odor), and peroxide value of cracker samples during storage periods.

2.2.6. Chemical analysis:

Moisture, protein, ash, crude fiber content, ether extract and Peroxide value were determined according to the methods described by **A.O.A.C. (2005)**. Digestible carbohydrates (D.C) were calculated by difference according to the following equation:

D.C =100 - (%protein + % total lipid+ % ash+ % fiber).

Caloric value was calculated according to the following equation **(FAO/WHO, 1974):**

Caloric value = 4 (protein% + Carbohydrate %) + 9 (fat %).

Minerals content, *i.e.*, Fe, Zn, Ca and Mg were determined in the diluted solution of ash samples by using the atomic absorption spectrophotometer (3300 Perkin-Elmer) as described by **A.O.A.C. (2005)**. Dietary fiber was determined according to the method described by **Prosky *et al.* (1984).**

2.2.7. Physical properties of produced cracker:-

The volume of the cracker was determined according to the methods described by **A.A.C.C. (2002).** The cracker was weighed and the specific volume was calculated as the ratio between the volume of the cracker, and their weight.

2.2.8. Sensory evaluation of produced cracker:-

Produced crackers using suggested blends were evaluated for their sensory characteristics by ten panelists from the staff of the Bread and Pastries, Research Dep., Agric. Res. Center, Giza. The scoring scheme was

established as mentioned by **Bates *et al.* (1991)** as follows; odor (20), taste (20), general appearance (20), Crispy (20) and color of crust (20). The overall score was 100 degrees. The obtained data for sensory evaluation was statistically analyzed by the least significant difference value (L.S.D) at 0.05 levels probability by procedure of **Snedecor and Cochran (1980).**

3. RESULTS AND DISCUSSION

3.1. Component of Prickly Pear fruits:

Prickly Pear fruits divided into three fractions that may exploited by commercial processing, seeds, peel and pulp. The thick pericarp is covered with small barbed spines hosting a juicy pulp with 150-300 non-edible seeds. The latter account for 3-7% on weight basis, followed by the pericarp and mesocarp (36-48%) and edible pulp (39-64%) **(Fleker *et al*, 2005 and Mobhammer *et al*, 2006).**

In this study, the proximate percentage of peels, pulp and seeds of Prickly Pear fruits was investigated and is reported in Table (2), the results manifested that the fruits of prickly pear fruits contained 47.2 % peels, 48.4% pulp and 3.4 % seeds based on a fresh weight. These results are in agreement with those obtained by **Piga (2004) and Duru and Turker (2005) and El-Samahy *et al*. (2006).**

Table (2): Proximate percentage of peels, pulp and seeds of Prickly Pear fruits.

*Component	peels	pulp	seeds
%	47.2	48.4	3.4

*****Based on fresh weight.

Recent studies have shown the potential supply of the Prickly Pear fruit by-products may be enormous. Peel, which is a by-product, gives oil with appreciable amounts of polyunsaturated fatty acids, mainly linoleic acid, α-tocopherol, sterols, β-carotene and vitamin K1 **(Ramadan and Morsel 2003a and El-Said Nesreen *et al*., 2011).** Carotenoids represented the major insoluble water pigments in the peels (2.97 mg/100g on FW). β-carotene is pro-vitamin A, which play an important role in the integrity of the cells. High content of vitamin E amounting to 21.8g/Kg oil, dominated by α-tocopherol with 17.6g/Kg were found in the lipids extracted from cactus pear peel **(Hassanien and Morsel, 2003 and Ramadan and Morsel, 2003b).** Significant amount of ascorbic acid are generally found in fruits of different *Opuntia* spp. ranging from 180 to 300 mg/Kg in the most common prickly pear (**Piga, 2004)**. So, the peel is considered as a very good source of

such vitamin. Prickly Pear fruit and its fractions having good nutritive value, show new dimensions of health benefits.

3.2. Chemical composition of raw materials:-

The data presented in Table (3), demonstrate that soft wheat flour (72% extraction) contained the highest values of total carbohydrate (88.09%) and protein (9.94%), whereas it was showed the lowest values of fat, crude fiber and ash (0.96, 0.48 and 0.53 %, respectively). Dried prickly pear seeds were contained the highest values of fat and crude fiber (14.18 and 48.81%, respectively), while dried prickly pear peels were contained the highest values of ash (9.82%). These results are nearly similar with that found by **Farvili *et al.* (1997), Piga, (2004) and Ennouri *et al*. (2005a).**

Table (3): Chemical composition of raw materials used for the preparation of crackers (% on dry weight basis).

Component	Soft Wheat flour (72%extraction)	Prickly Pear			
		Whole fruit	Seeds	Peels	Pulp
Protein	9.94	5.17	7.40	5.52	4.86
Fat	0. 96	5.59	14.18	8.58	2.0
Crude fiber	0.48	14.23	48.81	5.99	19.21
Ash	0.53	6.42	2.40	9.82	3.33
*carbohydrate	88.09	68.59	27.21	70.09	70.60
Minerals content mg/100gm					
Fe	1.14	65.10	9.45	129.0	5.33
Zn	0.48	43.82	1.48	90.0	0.80
Ca	19.34	594.08	16.34	951.0	280
Mg	18.65	772.71	475.39	987.20	580

* Calculated by difference.

Concerning mineral content, it could be observed that dried prickly pear peels had the highest value of Fe, Zn ,Ca and Mg (129.0, 90.0, 951.0 and 987.20 mg/100 gm, respectively) followed by dried whole fruit of prickly pear (65.10, 43.82, 594.08 and 772.71 mg/100 gm, respectively.) while soft wheat flour (72% extraction) had the lowest value in these previous minerals (1.14, 0.48, 19.34 and 18.65 mg/100 gm for Fe, Zn, Ca and Mg, respectively). These results are confirmed by those of **El-Kossori *et al.* (1998) and Feugang *et al.* (2006).**

Also, from the present data, It could be expected that combination of soft wheat flour (72% extraction) with dried whole fruit of prickly pear or its

fractions (peels or pulp or seeds) as a flour supplemented caused an increase in crude fiber, ash and minerals and reduced the total carbohydrate in mixed flour.

3.3. Chemical composition and caloric value of produced cracker:

The results presented in Table (4), showed that, all samples of cracker (containing different levels of dried whole fruit of Prickly Pear powder or its fractions) had the highest value of ash and dietary fiber compared with the control. Also, fat contents were the highest in all samples of cracker except cracker samples containing pulp extract of Prickly Pear which were the lowest compared with the control. The values of protein, digestible carbohydrate and total energy were slightly decrease compared with the control. In all crackers (except the control) protein content ranged from 8.57-8.97%, ash 3.07-3.94%, dietary fiber 1.58-6.25%, digestible carbohydrate 67.15-73.07 % and total energy 448.20-435.34 K.cal, while the control crackers contained protein of 9.04%, ash 3.01%, dietary fiber 0.92%, digestible carbohydrate 73.73% and total energy 450.78 K.cal. The rate of decrease in total caloric for samples was ranged from 0.82 to 3.43 %.

Also, the results presented in Table (4), showed that all samples of crackers containing different level of dried whole fruit of Prickly Pear powder or its fractions had the highest values in minerals content (*i.e*., iron, zinc, calcium and magnesium) compared with the control crackers, especially samples which contained dried peels of prickly pear . Hence, crackers containing dried whole fruit of Prickly Pear or its fractions are favorable than the control crackers because of their high content of important minerals, dietary fiber as well as other interesting physico-chemical characteristics (**Feugang *et al* 2006).**

It could be mentioned that the substitution with dried whole fruit resulted in increasing Fe by about 3.22, 5.44 and 7.67 times in parallel with its levels as that of control, Meanwhile Zn increased by about 4.27, 7.57 and 10.89 fold as that of control. Ca increased by about 1.71, 2.43 and 3.14 times as that of control. Mg increased by about 2.49, 3.99 and 5.48 times as that of control. While the substitution with dried seeds of prickly pear resulted in increasing Fe by about 1.28, 1.57 and 1.89 times in parallel with its levels as that of control, Meanwhile Zn increased by about 1.07, 1.16 and 1.23 fold as that of control. Mg increased by about 1.90, 2.81 and 3.71 times as that of control. In the case of substitution with dried peels of prickly pear resulted in increasing Fe by about 5.44, 9.86 and 14.32 times in parallel with its levels as that of control, Meanwhile Zn increased by about 7.77, 14.56 and 21.34

fold as that of control. Ca increased by about 2.15, 3.31 and 4.46 times as that of control. Mg increased by about 2.92, 4.84 and 6.76 times as that of control. While in the case of supplemented with pulp extract of prickly pear resulted in increasing Fe by about 1.07, 1.15 and 1.21 times in parallel with its levels as that of control, Meanwhile Zn increased by about 1.02, 1.05 and 1.07 fold as that of control. Ca increased by about 1.16, 1.32 and 1.47 times as that of control. Mg increased by about 1.55, 2.08 and 2.60 times as that of control.

For the above mentioned data, it could be concluded that the substitution of wheat flour with dried prickly peels produced crackers characterized with highest amount of minerals followed by whole fruits, dried seeds and pulp extract. This means that the supplementation with prickly either peels or whole fruits produced crackers rich in the important which treated a prevented some diseases such as anemia

3.4. Sensory evaluation of produced cracker:

Organoleptic tests are generally the final guide to the quality from the consumer's point of view.

From data presented in Table (5), it could be observed that taste, general appearance, color and over all score were decreased with increasing the percentage of supplements for dried seeds and peels of prickly pear .This may be due to the oxidation of some pigments found in the seeds or peels **(Kuti, 2004 and Helmy-Sh, 2007)**. While in the case of pulp extract of prickly pear all sensory characteristics were improved with increasing the percentage of supplements. In general, it could be observed that all samples of crackers were highly accepted (very good), except samples which made from dried seeds of prickly pear at level 8% and peels of prickly pear at level 12 % had less acceptance (good).

3.5. Physical properties of produced cracker:

Table (6), shows that moisture content of cracker samples (as indicated by crispy) ranged from 5.63 to 5.96% which about 1.10 and 1.12 times as that of the control, and this may be due to the Prickly Pear or its fractions which contain high level of dietary fiber which affect of water holding capacity. Slight decrement was observed in height, volume and specific volume by increasing the supplementation levels of Prickly Pear fruits or its fractions in all samples of crackers compared with the control.

3.6. Changes occurred in sensory evaluation (Taste and odor) of crackers during storage time:

Both of odor and taste are considered the most important characters that affect the quality of cracker during storage, it was evident from the data in Table (7) that the characteristics of odor and taste decreased with the increase of storage period up to 6 months for all samples of produced crackers. Control crackers gave the highest percentage of loss on odor and taste (32.43 and 28.21%, respectively) after the 6 months of storage time, while percentage of loss on odor and taste of all other treatments of produced crackers ranged from 10.0 to 23.08 % for odor and 9.0 to 16.22 for taste. All types of produced crackers were accepted for odor and taste except the control crackers for odor after the 6 months of storage time. This may be due to the presence of some natural antioxidants such as phenolic compounds.

3.7. Changes occurred in peroxide value (P.V) of crackers lipids during storage:

Peroxide value (P.V) is an indicator for measuring oxidative deterioration of lipids and it is a good index for the quality of fat. Refined fats should have P.V of less than 1 milliequivalent/Kg fats and fat that has been stored for some period of time after refining may have P.V of up to 10 milli equivalent/Kg fats **(Allen and Hamilton, 1983).** The results in Table (8) show the changes in P.V of cracker lipids during storage period of crackers at (18±2°C). It could be seen that the P.V of all samples of produced crackers increased with the increase of storage period up to 6 months. Control crackers gave the higher values of P.V (10.85 milliequivalent peroxides/Kg fats), after storage for 6 months which reflect the non-acceptability, while P.V of all other treatments of produced crackers (ranged from 7.47 to 9.40 mill equivalent peroxides /Kg fats) which considered acceptable **(Allen and Hamilton, 1983).** The lowest P.V for all treatments of produced crackers (except the control) was due to its content of antioxidant which found in Prickly Pear or its fractions. **Kuti (2004) and Tesoriere *et al*. (2005a)** reported an antioxidative effect due to the major flavonoids encountered in cactus fruits (quercetin, kaempferol and isorhamnetin) since phenolic compounds are able to delay prooxidative effects on lipids by the generation of stable radicals. And **Helmy-Sh (2007)** reported the activity of unsaponifiable matter (sterols) of prickly pear seed oil against oxidation as a natural antioxidant, which could prolong the shelf life of edible fats and oils.

3.8. Percentages of the recommended dietary allowances (% RDA) are provided by cracker produced:

From the data in Table (9), it could be observed that 100 gm of cracker containing different levels of dried whole fruit of Prickly Pear or its fractions contribute 13.17 - 52.08 % of the RDA of dietary fiber for children, and 6.32-25.0% for adults that compared to the control which contribute 7.67 and 3.68% for children and adults, respectively. All values of minerals (*i.e*., Fe, Zn, Ca and Mg) as RDA% were high for all samples of cracker compared with the control as shown in Table (9).

The nutritional and pharmacological properties of cactus pears are quality attributes that may contribute to their increased consumption in the future **(Hegwood, 1990)**. However, the fruits' of short shelf-life requires adequate processing techniques to provide products of high nutritional quality and entered industrial production.

Conclusion and recommendation it can be enriched bakery products, besides having good nutritive value, show new dimensions of health benefits by using flour mixed with prickly pear fruits or its components (whole fruits, peels, seeds and pulp) especially for patients of hypercholesterolemia and diabetic or anemic which confirmed by the data obtained by **El-Said Nesreen *et al*., (2011)**.

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إنتاج مقرمشات مدعمة بمكونات ثمرة التين الشوكي

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ملخص

تتميز ثمار التين الشوكي وأجزئها المختلفة بإحتوائها علي نسبة عالية من مضادات الأكسدة علاوة علي قيمتها الغذائية المرتفعة و فوائدها البيولوجية العديدة للوقاية من الأمراض الفسيولوجية الشائعة وأهمها (إرتفاع الكولستيرول والسكر وتصلب الشرايين).

إستهدفت هذه الدراسة بحث إمكانية الإستفادة التطبيقية لثمار التين الشوكي من حيث إستخدام الثمار الكاملة أو أجزائها المختلفة (القشور- البذور- مستخلص اللب) بهدف تقليل الفاقد في محتواها الغذائي والإستفادة من المخلفات الناتجة عنها (القشور- البذور) في إنتاج مخبوزات صحية (المقرمشات)، حيث تبلغ نسبة كل من القشور والبذور تقريبا (47,2 ، 3,4%) علي التوالي من الوزن الطازج للثمرة الكاملة . وبناءا علي ماسبق تم إستبدال دقيق القمح (إستخراج 72%) والمستخدم في صناعة المقرمشات بالمطحون الجاف لكل من ثمار التين الشوكي الكاملة أو البذور أو القشور عند مستويات إستبدال 4، 8، 12% أو أستخدام مستخلص اللب (90% رطوبة) بمستويات إضافة (20، 40، 80 مل/100 جم دقيق) كلا علي حدة لإنتاج المقرمشات الصحية . وقيمت المقرمشات المنتجة كيميائيا وحسيا و طبيعيا.

أظهرت نتائج التقييم الكيميائي أنه عند زيادة مستويات الإستبدال بأي من المكونات السابق ذكرها يزداد المحتوي من الرماد و الألياف الغذائية و العناصر المعدنية لكل من الحديد و الزنك و الكالسيوم والماغنسيوم . وعلي الجانب الأخر حدث نقص طفيف في كلا من المحتوي من البروتين و

الكربوهيدرات والسعرات الحرارية مقارنة مع العينة المرجعية (بدون إضافة). حيث أن القيمة السعرية للمقرمشات المنتجة ترواحت مابين (448,20– 435,34 كيلوكالوري / 100 جرام) مقارنة بالقيمة (78, 450 كيلوكالوري/100 جرام) للعينة المرجعية – وعند أجراء التقييم الحسى للمقرمشات الناتجة كانت درجة القبول العام لمعظم العينات (جيد جدا) بينما قلت درجة القبول الي جيد عند مستوي إستبدال 12،8% من مطحون البذور و عند مستوي إستبدال12% من مطحون القشور. كما لوحظ تحسن لكل خصائص التحكيم بزيادة مستويات الإضافة من مستخلص اللب للثمار في المقرمشات. و سجل حدوث نقص طفيف في الإرتفاع و الحجم والحجم النوعي بزيادة نسب الاستبدال من المكونات السابقة مع زيادة طفيفة في قيم كلا من الرطوبة و الوزن. وبإجراء إختبارات صلاحية التخزين للمقرمشات الناتجة بعد حفظها في عبوات أكياس من البولى بروبلين (كعبوة إقتصادية) لفترة إمتدت الي 6 شهور علي درجة (18±2 م) وجد أن كل أنواع المقرمشات الناتجة كانت أقل في قيم رقم البيروكسيد التي كانت في الحدود المسموح بها مقارنة بالعينة المرجعية وكذلك كانت العينات الناتجة هي الإقل لمعدل الفقد في كل من النكهة والطعم، مما يعطي مؤشراً لإمكانية إطالة فترة الصلاحية للتخزين. كذلك أوضحت النتائج أن كل 100جم من المقرمشات المدعمة بالمطحون الجاف لثمار التين الشوكي الكامله أوأحد أجزائها المختلفه ساهم بحوالي (**13,17- 52,08%**) من الإحتياجات اليومية من الألياف الغذائية للأطفال مقارنة ب (**7,67%**) في العينة المرجعية و ساهم بحوالي (**6,32 - 25,0%**) بالنسبة للبالغين مقارنة ب (**3,68 %**) في العينة المرجعية وكذلك كانت تلك العينات هي الأعلي في تغطية الإحتياجات اليومية من العناصر المعدنية لكل من الكالسيوم والحديد و الزنك و الماغنسيوم.وتوصي نتائج هذه الدراسة بدمج المطحون الجاف لثمار التين الشوكي الكامله أوأحد أجزائها المختلفه (كمصدر نباتي طبيعي إقتصادي مرتفع القيمة الحيوية) مع دقيق القمح 72% لعمل مخبوزات صحية عالية القيمة الحيوية (وخاصة لمرضي إرتفاع الكولستيرول والسكر) والذى يرجع لمحتواها المرتفع من الألياف الغذائية.