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PRODUCTION AND EVALUATION OF HEALTHY CRACKERS BY USING FLOUR MIXES OF DIFFERENT TYPES OF CEREAL AND AROMATIC HERBS

BY

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ABSTRACT

The Purpose of this study is to produce healthy crackers by using natural sources which have chemoprevents. So that types of suggested crackers were prepared by using formula from cereal and aromatic herbs. The formula consisted of 60% whole meal grains naked barley or sorghum with 30% wheat flour 72% ex. and 10% corn germ . Also with adding any of the following aromatic herbs Anise or Cumin or Black cumin, or Thyme to formula at level 3 or 3 or 2 or 1 gm/100gm of formula, respectively. The produced crackers were evaluated chemically, organolyptically, microbiologically and economically. The results cleared that all samples of crackers containing different sources of cereals and aromatic herbs had the highest value of protein, fat, ash, crude fiber. Also they were highest of minerals contents as iron, manganese, calcium, zinc and magnesium compared with control crackers .While all samples of crackers had lowest values of total carbohydrate and total energy compared with control crackers. And all produced crackers had acceptance (v. good or good). And by doing storage tests for produced crackers at room temperature in sealed poly propylene bags as economic backing for up to 4 month, the results cleared that all types of cracker especially that contain aromatic herbs had the Lowest of P.V and total microbial counts. So this leads to prolong the shelf life of crackers. Most of samples of crackers have lowest economic cost. And the results showed that 100 gm of crackers containing different sources of cereals flour and aromatic herbs contribute (44.29-45.36%) of the RDA of protein for children, and (21.38-22.03%) for adults. And all values of %RDA for studied nutrient were high in samples of crackers compared with control crackers. So it could be recommended that incorporation of the mentioned cereals and aromatic herbs with wheat flour to obtain healthy bakery products having high biological value especially for diabetic and hypercholesterolemia patients.

INTRODUCTION

There is a great need for natural and safe products that can reduce the risk of chronic diseases such as diabetes and cardio vascular diseases in at risk subjects. Whole grains which are rich sources of fiber are important part of healthy and their products provide about 30% of total energy intake. It is recommended that we consume 6-11 servings of grains food daily, three of them coming from whole grains (Marlett *et al.*, 2002).

The therapeutic value of barley whole flour in the management of diabetes was linked to its content of soluble fiber B-glucan (Li *et al.*, 2003 and Yang, *et al.*, 2003) and its high content of Cr (Mahdi and Naismith, 1991; Mahdi *et al.*, 1994 and Hanan Ahmed *et al.*, 2005). Barley is an excellent source of B-glucan soluble fiber as compared to wheat bran, which contains mostly insoluble fiber. Clinical studies have confirmed that the consumption of barley improved blood glucose insulin respons and lowered blood cholesterol in diabetics (Baurdon *et al.*, 1999; Kalra and jood, 2000; Hallfrish and Behall, 2000; Li *et al.*, 2003, Yang, *et al.*, 2003). Food sorghum flour is an ideal substitute for wheat in baked good formulas especially that are targeted at consumers who gluten sensitive or diabetic (Lovis, 2003). Sorghum has a level of

phenolic acid which have good antioxidant activity in vitro and may contribute significantly to the health benefits associated with whole grain consumption also contain phytosterol and policosanols that reduce blood cholesterol levels, and most of the fiber in sorghum is present in the pricarp, sorghum contain 6.5-7.9% insoluble fiber and 1.1% soluble fiber, composed primarily of B- glucan and pentosans (Rooney and Awika, 2005). Cereal germs are ideally suited to be used as nutrient fortifiers for cereal foods, corn germ is an almost complete food, Its oil is particularly rich in fat essential acids (50-60%) and in natural vitamins (E in particular), it is an excellent source of protein, a good balance of amino acids and essential nutrients (Barbieri and Cariraghi, 1983; Tsen, 1984; Fatma Shahine, 1995 and Goffman and Boehme, 2001).

On the other hand medicinal plants (especially aromatic herbs) are very useful so, they are used in many purposes. They have therapeutic properties. At present, they become very important because they are considered as natural food additives. They possess flavoring properties as well as they have antioxidant, anticancer, antimicrobial effects. Herbs are being incorporated into a variety of different food products such as biscuits and pastries. There are few herbs available that provide some help for person with either hyperlipidemia, an abnormal tendency to form blood clots, impaired blood flow or other cardiovascular problems (Burke *et al.*, 1997; Winston, 1999 and Tahraoui *et al.*, 2007).

The black cumin seed (*Nigella sativa L.*) and its oilseed have to possess cardiovascular and hypoglycemic activities (El -Tahir and Ashour, 1993 and El-Dakhakhny *et al.*, 2002). Also its had been shown to be anticancer, antidiabetic, antiradical and immunomodulator, analgesic, antimicrobial, anti-inflammatory, spasmolytic, bronchodilator, hepatoprotective, antihypertensive and renal protective Al-Naggar *et al.*, 2003; Fararh *et al.*, 2004 and Fawzy,2007).

Thyme (*Thymus vulgaris, L.*) in its crude herb form is carminative, antibiotic, anathematic and antitussive. It is indicated for Low immunity, anemia, it improved growth traits, blood picture, enzymatic activity, metabolic process (Ibrahim *et al.*, 2000). It had lower values of blood total lipids, total cholesterol content and liver function enzymes (El-Mallah, 2003 and Tollba, 2003).

Cumin (*Cuminum cyminum, L.*) exhibited anticarcinogenic properties against carcinomats in the stomach (Aruna and Sivaramakrishan, 1992; Nalini *et al.*, 1998 and Gagandeep *et al.*, 2003). And it has a protecting effect to colon by decreasing the activity of bacterial B-glucuronidase and mucinase (Nalini *et al*, 1998). Also it was useful in reducing blood glucose and plasma and tissue cholesterol, Phospholipids, free fatty acid and triglycerides on diabetic rats (Dhandapani *et al.*, 2002).

Anise (*Anethum graveolens L.*) was used in the orient as condiments or flavoring and also in traditional medicine applications. Anise had the highest amount of selenium (0.687 ppm) which had a cytotoxic activity against brain tumor, human hepato cellular and lung carcinoma (Badaweya Hamza and Fahmy, 2004).It acts as a strong antimycotic agent (Elgayyar *et al.*, 2001). The activity of raw material used, qualifies them as chemo protective food.

The aim of this study is to formulate novel crackers by using flour mixes of different types of cereal and aromatic herbs to enriched products, besides having good nutriative value, show new dimensions of health benefits.

MATERIALS AND METHODS

Materials:-

Wheat flour 72 % extraction rate (*Triticum aestivum, L.*) was obtained from the North Cairo Flour Mills Company, Egypt.

Corn germ (*Zea mays, L.*) was obtained from the Egyptian Starch and Glucose Manufacturing Company. It was milled using Hummer mill to obtain Corn germ flour.

Hull-less (naked) barley grains (*Hordeum vulgare, L*) and Sorghum grains (*Sorghum biocolor L.*) were obtained from crops research Institute, Agric. Research, Center, Giza, Egypt. They were milled using Hummer mill to obtain whole meal flour.

Cumin (*Cuminum cyminum, L.*), Anise (*Anethum graveolens L.*), Black cumin (*Nigell sativa, L.*) and Thyme (*Thymus vulgaris, L.*) were obtained from Medicine plant and Agricultural Seeds Haraz Company. They were milled using Hummer mill to obtain whole meal flour.

Other materials: Salt, corn oil, dry yeast, dry milk and improver were purchased from local market.

Methods:-

Preparation of Crackers:

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

Table (1): The formula used to preparing crackers.

Suggested name		Wheat crackers	Wheat crackers with corn germ	Barley crackers	Barley crackers with Cumin	Barley crackers with Anise	Barley crackers with Black cumin	Barley crackers with Thyme	Sorghum crackers	Sorghum crackers with Cumin	Sorghum crackers with Anise	Sorghum crackers with Black Cumin	Sorghum crackers with Thyme
#Ingredient (g)		Con	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Mixer of flour	Wheat flour 72 % ex.	100	90	30	30	30	30	30	30	30	30	30	30
	Corn germ	-	10	10	10	10	10	10	10	10	10	10	10
	Barley flour	-	-	60	60	60	60	60	-	-	-	-	-
	Sorghum flour	-	-	-	-	-	-	-	60	60	60	60	60
Corn oil		10	*6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5
Herbs added	Cumin	-	-	-	3	-	-	-	-	3	-	-	-
	Anise	-	-	-	-	3	-	-	-	-	3	-	-
	Black cumin	-	-	-	-	-	1		-	-	-	1	-
	Thyme	-	-	-	-	-	-	2	-	-	-	-	2
Water		As required											

Note: - Pretest experiment has been carried out to determine the best mixes ratio of suggested materials for this study.

To every prepared cracker:- 1g. dry yeast, 1g. dry milk, 2g. salt and 1g. improver, were added.

* Corn oil was reduced in the formula according to content of fat in corn germ (35%).

For making cracker the following procedure was followed: - All ingredients were mixed with 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 fermentation time at 37°C and 85% relative humidity. The fermented cracker was drilled and painted by reconstituted milk (20 gm dry milk for 100 ml water) for cracker face, then baked at 200°C for 6 min. After baking, crac-ker was allowed to cool at room temperature for 1 hr. before organoleptic evaluation.

Storage of cracker:

The crackers were cooled at room temperature and then stored at room temperature in sealed poly propylene bags for 1, 2, 3, and 4 months to study the sensory evaluation, antimicrobial and antioxidant activities of formula used.

Chemical analysis:

Moisture, protein, ash, crude fiber content, ether extract, Peroxide value was determined according to the method described in A.O.A.C. (2000). Total carbohydrates were calculated by difference. The approximate

energy of crackers was calculated according to the (FAO/WHO, 1974) as follows:-

Total energy (K.cal) = 4 (Carbohydrate + Protein) + (9×fat)

Minerals content i.e., Fe, Mn, Ca, Zn and Mg were determined in the diluted solution of ash samples by using the atomic absorption spectrophotometer (3300 Perkin-Elmer) as described in A.O.A.C. (2000).

Sensory evaluation of cracker:

Crackers produced using suggested blends were evaluated for their sensory characteristics by ten panelists from the staff of bread and pastry, research Dep., Agr. Res. Center, Giza. The scoring scheme was established as mentioned by Bates *et al.*, (1991)) as follows; color of crust (20), taste (20), Crispy (20), general appearance (20) and odor (20). The overall score 100 degrees.

Microbial analysis:

Microbial analysis was determined for each sample of cracker four times (after 1, 2, 3 and 4 month after baking). Total bacterial, Yeast, and molds count were determined according to the procedure described by (A. O.A.C., 2000).

Statistical analysis:

The data obtained from Sensory evaluations were statistically analyzed by the least significant differences value (L.S.D) at 0.05 levels probability procedure to Snedecor and Cochran (1967).

RESULTS AND DISCUSSION

Chemical composition of raw materials:

Data presented in Table (2), show the Chemical composition of raw materials used for the preparation of crackers .It could be demonstrated that corn germ contained the highest values in protein, fat, ash and fiber (23.20, 35.0, 5.34 and 3.94%, respectively.) whereas it was the lowest values in total carbohydrate (32.52%) than the other cereals flour samples under this study (i.e. Wheat flour 72% ex., Hull-less barley and Sorghum flour). On the other hand wheat flour 72% ex. contained the highest value in total carbohydrate (86.29%) followed by sorghum (80.86%) then hull-less barley (80.30%). These results are confirmed by those obtained by Delgado and Serna- Saldivar (2000); Goffman and Bboehme (2001); Lovis, (2003) and Hatcher *et al.*, (2005). From the same table, it could be noticed that the crude fiber content of all the studied herbs powders were relatively high and it ranged between 10.35 to 19.30%. The Anise had the highest crude fiber content (19.30%) followed by Thyme (17.97%).While the Black cumin contained the highest value in fat (36.50%). Also from Table (2), it could be noticed that the minerals contents of aromatic herbs (i.e. Cumin, Anise, Black cumin and Thyme) had the highest content in Fe, Mn, Ca, Zn and Mg (ranged from 15.29-123.97, 1.65-7.11, 276-1850, 4.88-9.80 and 230-377 mg/100g for these respectively) compared with cereals flour (ranged from 2.13-5.41, 0.53-1.14, 21.40-208, 0.86-4.97 and 45.85-224.11 mg/100g for the same previous parameters respectively). These results are in agreement with those reported by Al-Bataina *et al.* (2003) and Mekhael, (2004).

Chemical composition of produced crackers:

The results presented in Table (3), showed that all samples of cracker containing different sources of cereals (Corn germ and whole meal barley or sorghum flour) and aromatic herbs (i.e., cumin or anise or black cumin or thyme) had the highest value of protein, fat, ash and crude fiber and lowest value of total carbohydrate compared with wheat crackers (control). In all crackers except control had protein content ranged from 12.26-12.78%, fat 9.78-11.09%, ash 3.67-4.79%, crude fiber 0.66-2.32%, total carbohydrate 69.28-73.49 % and total energy 425.33- 431.58 K.cal, while control crackers had protein 11.01%, fat 9.57%, ash 3.14%, crude fiber 0.32%, total carbohydrate 75.96% and total energy 434.01 K.cal.

Also the results presented in Table (3), showed that all samples of crackers contenting different sources of cereals flour

and aromatic herbs had the highest values in minerals content (i.e., Iron, manganese, calcium, zinc and magnesium) compared with control crackers. Hence, crackers containing different sources of cereals flour and aromatic herbs are favorable than control crackers because of their high content of important minerals.

Sensory evaluation of produced crackers:

The data in Table (4) indicated that odor was increased in samples containing herbs (i.e. cumin, anise, black cumin and thyme) compared to control and samples without herb. This increase in odor may be attributed to the volatile oil in herb used. Generally aromatic plants and spices may improve enhance or attribute a certain flavor to bakery products. The roasted aroma is one of the attractive flavors. It is the characteristics of all high temperature processed foods including bakery products. Pyrazine compounds are responsible for this roasted aroma (Bassiouny *et al.*, 1990). On the other hand general appearance and color showed decrease compared to control sample, this might be due to the high content of fiber and ash in herbal used, also due to the color of used raw material. In general, it could be observed that all samples of crackers were highly accepted (very good), except samples which made from barley or sorghum with black cumin or thyme had less acceptance (good).

Physical properties of different types of crackers:

Table (5), Shows that moisture content of crackers samples (as indicated by crispy) ranged from 5.11 to 5.81% which about 0.86 and 0.98 times as that of control, and this may be due to the difference in water holding capacity and also to the composition of different formulas of these samples. There was slight decrement observed for weight, height, volume and specific volume in most samples of crackers compared with control.

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

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 (6) showed that the characteristics of odor and taste decreased with the increase of storage period up to 4 months for all types of produced crackers. Wheat crackers then wheat crackers with corn germ gave the highest percentage of losses on odor (28.57and 26.78%, respectively) and taste (26.77 and 25.13 %, respectively) after the 4 months of storage time. All types of produced crackers were acceptant for odor and taste except wheat crackers and wheat crackers with corn germ for odor after the 4 months of storage time.

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's 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 (7), show the changes in P.V of crackers lipids during storage period of crackers at room temperature. It could be seen that the P.V of all samples of produced crackers increased with the increase of storage period up to 4 months. Wheat crackers and wheat crackers with corn germ gave the higher values of P.V (10.92 and 10.88 milliequivalent peroxides/Kgfats, respectively), after storage for 4 months and there were non-acceptance, while P.V of all other treatments of produced crackers (ranged from 5.49 to 9.0 mill equivalent peroxides/Kg fats) conceded accepted (Allen and Hamilton, 1983). The Lowest P.V of some treatments of produced crackers especially that contain aromatic herbs due to its content of volatile oil. Herbs and spices possessing high antioxidant activity, (Lee and Shibamoto, 2002). *Nigella* seeds contain five antioxidative components as follows; - Thymol, thymoquinone, hydroquinone, tert-butyl, carvcol and menthol (Owon, 1998). Thymol and carvcol are major aroma components of essential oil of thyme, and both show high antioxidant and antimicrobial activity (Nakatani, 1997and Damien Dorman, 2000).

Table (2): Chemical composition of raw materials used for the preparation of crackers (%on dry weight basis).

Constituent	Cereals				Aromatic herbs			
	Wheat flour 72%	Hull- less barley flour	Sorghum flour	Corn germ	Cumin	Anise	Black cumin	Thyme
Moisture	11.66	8.53	9.25	8.55	7.68	6.90	5.76	7.3
Protein	11.80	12.05	11.65	23.20	18.96	22.06	21.11	9.34
Fat	1.01	2.65	2.88	35.0	21.99	20.54	36.50	7.34
Ash	0.53	2.39	2.16	5.34	7.90	5.33	4.91	11.69
Crude fiber	0.37	2.61	2.45	3.94	10.35	19.30	12.70	17.96
Total carbohydrate	86.29	80.30	80.86	32.52	40.80	32.77	24.78	53.67
Minerals content mg/100g								
Fe	2.13	3.31	2.90	5.40	21.13	15.29	22.43	123.97
Mn	0.53	1.09	0.67	1.14	1.65	1.96	6.53	7.11
Ca	21.40	275	208	23.78	372.0	276.0	883.91	1850
Zn	0.86	2.34	3.43	4.97	5.10	4.88	9.8	7.91
Mg	45.85	67.0	66.5	224.11	295.0	251.0	377.0	230.0

Table (3): Chemical composition of produced crackers (% on dry weight basis).

Constituent	Types of cracker											
	Wheat crackers		Barley crackers with					Sorghum crackers with				
	Control	with corn germ	-	Cumin	Anise	Black cumin	Thyme	-	Cumin	Anise	Black cumin	Thyme
Protein	11.01	12.40	12.53	12.70	12.78	12.60	12.47	12.32	12.49	12.57	12.39	12.26
Fat	9.57	9.78	10.67	10.97	10.93	10.90	10.61	10.79	11.09	11.05	11.03	10.73
Ash	3.14	3.67	4.67	4.75	4.69	4.67	4.79	4.54	4.63	4.57	4.55	4.67
Fiber	0.32	0.66	1.86	2.08	2.32	1.95	2.14	1.77	1.99	2.23	1.87	2.06
Total Carbohydrate	75.96	73.49	70.27	69.50	69.28	69.88	69.99	70.58	69.81	69.58	70.16	70.28
Total energy (K.cal)	434.01	431.58	427.23	427.53	426.61	428.02	425.33	428.71	429.01	428.05	429.47	426.73
Minerals content mg/100g												
Fe	1.9	2.22	2.85	3.33	3.17	3.03	4.99	2.63	3.12	2.97	2.81	4.77
Mn	0.47	0.54	0.85	0.87	0.87	0.90	0.96	0.62	0.65	0.67	0.68	0.75
Ca	30.3	31.10	167.56	173.23	170.48	174.02	197.43	131.51	138.13	135.38	138.28	162.0
Zn	0.79	1.18	1.98	2.05	2.06	2.05	2.11	2.97	2.65	2.64	2.63	2.66
Mg	41.27	58.5	69.9	75.83	74.68	72.63	72.79	69.62	75.57	74.42	72.36	72.52

Microbiological evaluation for different types of crackers:

The total microbial counts of different types of cracker were investigated to assess the most important factors in evaluation of cracker safety and quality. Data in Table (8), indicated that no detectable of any microbial count for all crackers samples taken after 1 month from storage. This may be due to the packaging plays a vital role in the maintenance of the shelf life of foods. The Basic function for packaging is to keep the product free from contamination (Orville, 1981). By increase the storage period from 1 to 4 months the total bacterial count increased. Lower bacterial count values were obtained with samples which contain aromatic herbs especially that contain thyme and black cumin,

also these samples remained without any mould and yeast detected at each period of storage period. These results are confirmed by those obtained by Elgyyar *et al.*, 2001, and Guynot *et al.*, 2003 they shown that volatile oil of black cumin and thyme have strong antimicrobial activity. Sagdic and Ozcan, 2003 found that the hydrosols of (distilled Spice water) anise, cumin and thyme had antibacterial activity. From data in Table (8), indicated that using the aromatic herbs clearly reduced the microbial growth and prolongs the shelf life of crackers.

Economic evaluation:

Cost production of the tested crackers was found in Table (9), it could be noticed that the lowest cost of sorghum crackers, followed by sorghum crackers with black cumin followed by wheat crackers with corn germ followed by barley crackers followed by barley crackers with black cumin followed by sorghum crackers with thyme compared with wheat crackers (control). The highest cost was found in barley crackers with cumin. The cost increased in some products could be justified to consumer by the increase of their potential health benefits.

Percentages of the recommended dietary allowances (% RDA) are provided from produced cracker:

From the data in Table (10), it could be observed that 100gm of crackers containing different sources of cereals flour and aromatic herbs cover (44.29-45.36%) of daily protein requirement for children, and (21.38-22.03%) for adults. And all values of %RDA for studied nutrient were high in all samples of crackers compared with control crackers as shown in Table (10).

Table (4): Sensory evaluation of produced crackers.

Type of cracker		Odor (20)	Taste (20)	General appearance (20)	Crispy (20)	Color (20)	Over all score (100)	Acceptance
Wheat crackers	Control	18.9^{b}	19.8^{a}	20.0^{a}	18.6^{d}	20.0^{a}	97.3^{a}	VG
	with corn germ	18.3^{d}	19.5^{b}	19.8^{a}	19.0^{c}	20.0^{a}	96.6^{a}	VG
Barley crackers with	-	18.0^{d}	$19.o^{c}$	19.6^{a}	19.2^{bc}	19.5^{b}	95.3^{b}	VG
	Cumin	19.7^{a}	20.0^{a}	19.2^{b}	19.5^{b}	19.1^{b}	97.5^{a}	VG
	Anise	19.8^{a}	20.0^{a}	19.1^{b}	20.0^{a}	19.0^{c}	97.9^{a}	VG
	Black cumin	19.2^{b}	16.0^{e}	17.0^{c}	19.5^{b}	18.0^{e}	89.7^{c}	G
	Thyme	19.0^{b}	15.0^{g}	16.0^{d}	19.5^{b}	18.5^{d}	88.0^{d}	G
Sorghum crackers with	-	18.2^{c}	19.0^{c}	19.3^{b}	19.2^{bc}	19.3^{bc}	95.0^{b}	VG
	Cumin	19.5^{a}	19.2^{bc}	19.0^{b}	20.0^{a}	18.9^{c}	96.0^{a}	VG
	Anise	19.4^{ab}	19.5^{b}	19.0^{b}	20.0^{a}	19.0^{cd}	96.9^{a}	VG
	Black cumin	19.0^{b}	16.5^{d}	17.2^{c}	19.2^{bc}	17.5^{c}	89.4^{cd}	G
	Thyme	18.7^{b}	15.5^{f}	16.5^{d}	19.1^{c}	$17.o^{g}$	86.8^{e}	G
LSD		0.4341	0.4311	0.5211	0.3988	0.4112	1.5744	

Each value in the same column followed by the same letters is not significantly different at level of 0.05.
90-100 Very Good (VG). 80-89 Good (G). 70-79 Satisfactory (S). Less Than 70 Questionable (Q).

Table (5): Physical properties of different types of crackers.

Type of cracker	Moisture (%)	Weight (gm)	Height (mm)	Volume (Cm^3)	Specific volume (Cm^3/gm)
Wheat crackers (Control)	5.95	4.10	13.0	6.0	1.46
Wheat crackers with corn germ	5.81	3.90	12.0	5.7	1.46
Barley crackers	5.75	3.47	10.0	4.9	1.41
Barley crackers with Cumin	5.29	3.70	9.8	4.9	1.32
Barley crackers with Anise	5.16	3.89	9.0	4.8	1.23
Barley crackers with Black cumin	5.45	3.52	9.8	4.9	1.39
Barley crackers with Thyme	5.72	3.59	10.1	4.9	1.36
Sorghum crackers	5.29	3.92	10.0	4.9	1.25
Sorghum crackers with Cumin	5.11	3.89	9.5	4.9	1.26
Sorghum crackers with Anise	5.13	3.64	9.6	4.9	1.35
Sorghum crackers with Black cumin	5.30	3.35	9.3	4.9	1.46
Sorghum crackers with Thyme	5.65	3.40	10.0	4.9	1.44

Table (6): Mean values of odor and taste for produced crackers during storage at room temperature.

Type of crackers		Odor (20) Storage period (month)					LSD	% Losses on odor*	Taste (20) Storage period (month)					LSD	% Losses on taste*
		0	1	2	3	4			0	1	2	3	4		
Wheat crackers	Control	18.9^{a}	18.5^{a}	16.9^{b}	15.4^{c}	13.5^{d}	1.20	28.57	19.8^{a}	19.0^{a}	18^{b}	17.0^{b}	14.5^{c}	1.12	26.77
	with corn germ	18.3^{a}	18.2^{a}	17.0^{b}	15.5^{c}	13.4^{d}	1.11	26.78	19.5^{a}	18.3^{a}	17.9^{b}	16.5^{c}	14.6^{d}	1.05	25.13
Barley crackers with	-	18.0^{a}	17.8^{a}	17.5^{a}	16.7^{b}	15.6^{c}	1.01	13.33	19.0^{a}	18.9^{ab}	18.5^{b}	17.9^{b}	16.5^{c}	1.14	13.16
	Cumin	19.7^{a}	19.6^{a}	19.2^{a}	18.9^{a}	17.4^{b}	1.32	11.68	20.0^{a}	19.8^{a}	19.6^{ab}	18.5^{b}	17.8^{b}	1.32	11.0
	Anise	19.8^{a}	19.7^{a}	18.3^{b}	17.9^{b}	17.3^{b}	1.35	12.63	20.0^{a}	20.0^{a}	19.6^{a}	19.0^{ab}	18.5^{b}	1.28	7.5
	Black cumin	19.2^{a}	19.0^{a}	18.5^{ab}	18.0^{b}	17.3^{b}	0.69	9.90	16.0^{a}	16.0^{a}	15.8^{b}	15.2^{ab}	14.9^{b}	0.88	6.88
	Thyme	19.0^{a}	18.8^{a}	18.5^{ab}	18.0^{b}	17.5^{b}	0.88	7.89	15.0^{a}	14.8^{a}	15.5^{a}	14.4^{ab}	14.0^{b}	0.93	6.67
Sorghum cr ackers with	-	18.2^{a}	18.1^{a}	17.9^{ab}	17.3^{b}	16.0^{c}	0.78	12.09	19.0^{a}	18.7^{a}	18.2^{a}	17.5^{b}	16.0^{b}	0.98	15.79
	Cumin	19.5^{a}	19.3^{a}	19.0^{ab}	18.5^{b}	18.0^{b}	0.93	10.99	19.2^{a}	19.0^{a}	18.5^{a}	18.0^{ab}	17.6^{b}	1.04	8.33
	Anise	19.4^{a}	19.2^{a}	19.0^{ab}	18.5^{b}	18.0^{b}	0.88	7.22	19.5^{a}	19.2^{a}	18.9^{a}	18.5^{ab}	18.0^{b}	1.01	7.69
	Black cumin	19.0^{a}	18.8^{a}	18.4^{a}	18.0^{ab}	17.5^{b}	1.05	7.89	16.5^{a}	16.2^{a}	16.0^{a}	15.7^{ab}	15.5^{b}	0.81	6.06
	Thyme	18.7^{a}	18.6^{a}	18.5^{a}	18.0^{a}	17.7^{b}	0.78	5.65	15.5^{a}	15.3^{a}	15.0^{a}	15.9^{ab}	14.6^{b}	0.85	5.81

Values with the same row followed by the same letters is not significant different at level of 0.05.
Score ≤14 non acceptant. . * After 4 months.

Table (7): Changes in peroxide value of produced crackers during storage at room temperature.

Type of cracker	Peroxide value (milliequivalent peroxides/Kg lipids)				
	Storage period after				
	Baking	1 month	2 months	3 months	4 months
Wheat crackers (Control)	0.95	1.65	4.85	7.95	10.92
Wheat crackers with corn germ	0.93	1.59	4.77	7.85	10.88
Barley crackers	0.89	1.98	4.66	6.87	9.00
Barley crackers with Cumin	0.86	1.13	3.61	4.60	7.93
Barley crackers with Anise	0.83	1.20	3.53	4.58	7.85
Barley crackers with Black cumin	0.85	1.16	3.75	4.30	6.32
Barley crackers with Thyme	0.82	1.15	2.25	3.95	5.79
Sorghum crackers	0.84	1.44	4.51	6.80	8.89
Sorghum crackers with Cumin	0.83	1.11	3.50	4.55	7.80
Sorghum crackers with Anise	0.82	1.18	3.45	4.42	7.74
Sorghum crackers with Black cumin	0.81	1.14	3.70	4.15	6.11
Sorghum crackers with Thyme	o.80	1.13	2.02	3.79	5.49

Table (8): The total microbial count cell/gm in different types of crackers treatments during storage period at room temperature.

Type of crackers		Storage period (month)							
		After 1 month		After 2 months		After 3 months		After 4 months	
		Total bacteria	M & Y	Total bacteria	M & Y	Total bacteria	M &Y	Total bacteria	M & Y
Wheat crackers	Control	N.D	N.D	20	1	45	10	90	15
	with corn germ	N.D	N.D	10	N.D	30	5	70	10
Barley crackers with	-	N.D	N.D	5	N.D	26	3	40	5
	Cumin	N.D	N.D	1	N.D	5	N.D	10	N.D
	Anise	N.D	N.D	4	N.D	9	N.D	15	N.D
	Black cumin	N.D	N.D	N.D	N.D	3	N.D	12	N.D
	Thyme	N.D	N.D	ND	N.D	2	N.D	11	N.D
Sorghum crackers with	-	N.D	N.D	8	N.D	25	2	50	4
	Cumin	N.D	N.D	2	N.D	4	N.D	20	N.D
	Anise	N.D	N.D	3	N.D	6	N.D	25	N.D
	Black cumin	N.D	N.D	N.D	N.D	3	N.D	15	N.D
	Thyme	N.D	N.D	ND	N.D	1	N.D	12	N.D

M &Y = Mould and yeast. ND = Not detected.

Table (9): Production cost of different types of crackers for (1 K gm flour).

Raw materials		Suggested name		Wheat cracker	Wheat crackers with corn germ	Barley crackers	Barley crackers with Cumin	Barley crackers with Anise	Barley crackers with Black cumin	Barley crackers with Thyme	Sorghum crackers	Sorghum crackers with Cumin	Sorghum crackers with Anise	Sorghum crackers with Black Cumin	Sorghum crackers with Thyme
		Amount (g)	Cost P.T	Con.	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Wheat flour (72 % ex.)		1000 900 300	350 315 105	350	315	105	105	105	105	105	105	105	105	105	105
Corn germ		100	30		30	30	30	30	30	30	30	30	30	30	30
Barley flour		600	210			210	210	210	210	210					
Sorghum flour		600	180								180	180	180	180	180
Harps	Cumin	30	96				96					96			
	Anise	30	78					78					78		
	Black cumin	10	8						8					8	
	Thyme	20	64							64					64
*(A+B)				#285	246	246	246	246	246	246	246	246	246	246	246
Net cost for 1 Kgm flour				635	590	591	688	670	599	655	561	657	639	569	625
**Net cost for 1 K gm crackers				508	472	473	551	536	479	524	449	526	511	455	500

Other ingredients: - Yeast (10 g) +dry milk (10g)+ Corn oil (65g)+Salt (20g)+Improvers (10g)
Cost of other ingredients (A) = 16 + 50 + 71.5 + 2 + 6.5= 146. P.T Cost of production (B) =100 P.T * (A+B) = 246 P.T
The amount of ingredients gave (1250 g) crackers. # 246+39 (price of 35 g. corn oil extra in control)
Net cost (P.T) for 1 K gm crackers = 1000× Net cost for 1 Kgm flour/1250

Table (10): Percentage of the RDA (1989)* for some nutrient provided from 100g crackers for children and adults.

	C	Type of crackers											
		Wheat crackers		Barley crackers with					Sorghum crackers with				
	RDA**	Control	with corn germ	-	Cumin	Anise	Black cumin	Thyme	-	Cumin	Anise	Black cumin	Thyme
Children (7-10) years	Protein (28 gm)	39.32	44.29	44.75	45.36	45.64	45.0	44.54	44.0	44.61	44.89	44.24	43.79
	Energy (2000 K.cal)	21.70	21.58	21.36	21.38	31.33	21.40	21.27	21.44	21.45	21.40	21.47	21.34
	Fe (10 mg)	19.0	22.20	28.50	33.3	31.70	30.30	49.9	26.3	31.2	29.7	28.1	47.7
	Zn (10 mg)	7.92	11.80	19.80	20.5	20.60	20.50	21.1	29.7	26.5	26.4	26.3	26.6
	Ca (800 mg)	3.79	3.89	20.95	21.65	21.31	71.75	24.68	16.44	17.27	16.92	17.29	20.25
	Mg (170 mg)	24.28	34.41	41.21	44.61	43.93	42.72	42.82	40.95	44.45	43.78	42.56	42.66
Adults (19-24) years	Protein (58 gm)	18.98	21.38	21.60	21.70	22.03	21.72	21.5	21.24	21.53	21.67	21.36	21.14
	Energy (2900 K.cal)	14.97	14.88	14.73	14.74	14.7	14.76	14.67	14.78	14.79	14.76	14.81	14.71
	Fe (10 mg)	19.0	22.20	28.50	33.3	31.7	30.30	49.9	26.3	31.2	29.7	28.1	47.7
	Zn (15 mg)	5.28	7.87	13.20	13.67	13.73	13.67	14.07	19.8	17.67	17.6	17.53	17.73
	Ca (1200 mg)	2.53	2.59	13.96	14.44	14.21	14.5	16.45	10.96	11.51	11.28	11.52	13.5
	Mg (350 mg)	11.79	16.71	19.97	21.67	21.34	20.75	20.80	19.89	21.59	21.26	20.67	20.72

* According to Food and Nutrition Board (1989).
** % RDA=Value of nutrient in sample of cracker × 100/RDA for the same nutrient.

CONCLUSION

From this study it could be concluded that incorporated of wheat flour with different sources of cereals (Corn germ and whole meal naked barley or sorghum flour) and aromatic herbs (i.e., cumin or anise or black cumin or thyme) caused rising in nutrition value, minerals content and shelf life of produced crackers. And it is recommended to incurporation the mentioned cereals and aromatic herbs in bakery products.

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إنتاج وتقييم مقرمشات صحية بإستخدام خلطات دقيق أنواع مختلفة من الحبوب وبعض الأعشاب العطرية

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تهدف هذه الدراسة إلى إنتاج مقرمشات صحية باستخدام مصادر طبيعية لها خصائص وقائية وتحقيقا لذلك تم اقتراح عدة نماذج للمقرمشات باستخدام توليفة من الحبوب وبعض الأعشاب العطرية تكونت من ٦٠% من المطحون الكامل لحبوب الشعير أو السورجم مع ٣٠% من دقيق القمح استخلاص ٧٢% مع ١٠% دقيق جنين الذرة مع إضافة إحدى الأعشاب العطرية الآتية للخليط كمون أو ينسون أو حبة البركة أو زعتر كلا على حده بما يعادل ٣،٣ ، ٢، ١جم/١٠٠جم من المخلوط على التوالى. وقيمت عينات المقرمشات الناتجه كيميائيا وحسيا و ميكروبيولوجيا و اقتصاديا- وأظهرت نتائج الدراسة الأتى:- أظهرت نتيجة التحليل الكيميائى أن كل عينات المقرمشات المحتوية علي دقيق الحبوب المختلفة و الأعشاب العطرية أعلى في محتواها من البروتين و الدهن و الرماد والألياف الخام وأيضا ارتفعت فى محتواها من العناصر الغذائية لكل من الحديد و المنجنيز و الكالسيوم و الزنك والماغنسيوم مقارنة بعينة الكنترول – بينما لوحظ انخفاض بسيط لعينات المقرمشات فى قيم كل من الكربوهيدرات الكلية و السعرات الحرارية مقارنة بعينة الكنترول وكانت كل العينات الناتجة مقبولة حسيا (بدرجة جيد جدا أو جيد). وبإجراء إختبارات التخزين للمقرمشات الناتجة بعد تعبئتها في عبوة من البولى بروبلين كعبوة إقتصادية لفترة إمتدت الي ٤ شهور عند درجة حرارة الغرفة وجد أن كل أنواع المقرمشات المحتوية علي مصادر الحبوب المختلفة وخاصة المحتوية على الأعشاب العطرية أقل في قيم رقم البيروكسيد ومحتواها الميكروبى والتي كانت أقل من الحدود المسموح بها مقارنة بعينة الكنترول مما يعطي مؤشر لإمكانية زيادة مدة الحفظ وأظهرت معظم العينات إنخفاض في تكلفتها الإقتصادية وأوضحت النتائج أن كل ١٠٠جم من المقرمشات المدعمة تساهم بحوالي ٢٩,٤٤- ٤٥,٤٦% من الإحتياجات اليومية من البروتين للأطفال و ٢١,٣٨- ٢٢,٠٣% بالنسبة للبالغين وكذلك كانت هي الأعلي في قيم المغذيات الأخري المدروسة. وتوصي نتيجة هذه الدراسة بدمج خلطات الحبوب الموضحة مع الأعشاب العطرية مع دقيق القمح لعمل مخبوزات صحية عالية القيمة الحيوية وخاصة لمرض ارتفاع السكر وكوليستيرول الدم.