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EVALUATION OF CORN SNACKS FORTIFIED WITH CHICK-PEA

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ABSTRACT

Sweet chick-pea flour was used at different levels (10, 20,30%) to fortify corn grits to produce extrusion snakes using laboratory single – screw extruder. The produced snacks were subjected to chemical composition, minerals contents, β-carotene and physical properties, water absorption, hunter color, sheer force and sensory characteristics. The results showed that all fortified snacks had higher contents of protein, fat, ash and minerals. Hunter color showed that L. value (Lightness) of snacks fortified at high levels of sweet chick-pea flour was higher than that of control and other treatments. β-carotene content increased with increasing the levels of sweet chick-pea. The addition of sweet chick-pea at 10% increased the acceptability of the snack than other treatments.

INTRODUCTION

Legumes are important source of proteins and other nutrients and are commonly used as food particularly in developing countries. Legumes represent the major component of dietary food stuffs along as bread (Shalaby, 2000). In Egypt, legumes represent the major Egyptian diets what ever the standard of living (Abd-Allah *et al*., 1988).

The use of legumes assumes significance as cheap and concentrated source of proteins, compared with the high cost of proteins of animal origin and their in accessibility as a source of protein which is the cheapest compared with animal protein, (Tharanathan and Mahadevamma, 2003).

Snacks baised on cereals are the most widely consumed snacks food items, and many of these are in low in nutrient density and high in calories and fat content, (Park *et al*., 1993). Corn is an excellent source of carbohydrates with low crude fiber levels. The protein content is low and of poor quality because of low levels of essential amino acids lysine and tryptophan, which represent the most limiting amino acids (James *et al*., 2004).

β-carotene is still an important biological compound because it theoretically possesses 100% vitamin A activity. In addition, both α and β-carotene are present as positional isomers in foods (Heinonen, 1990).

Vitamin A also acts as antimalarial agent (Hamzah *et al*., 2003), plays a role in embryo genes (Mizuno *et al*., 2003). The high dietary intake of vitamin A reduces the risk of cancer, cardiovascular disease and other diseases (Ghoshal *et al*., 2003).

Santiago *et al*., (2001) prepared highly acceptable snack products by extrusion cooking of defatted chick-pea. They showed that snacks with chick-pea had high quality protein content and provided 30-40% iron of the recommended daily allowance (RDA) for children.

Gujska and Khan, (1991) noticed that it is possible to produce a highly acceptable snacks of high nutritional quality that can be useful in nutritional programs against anemia and malnutrition.

Iron is a key element in metabolism for all organisms with respect to many basic functions. It may be said that iron in diet must be in available form to be absorbed in blood circulation from intestine (Andrade *et al*., 2004).

The present work aimed to evaluate the extruded snacks produced from corn grits fortified with sweet chick-peas, for its technological and sensory characteristics.

MATERIALS AND METHODS

Yellow corn:

Corn grits were purchased from the local market at Giza Governorate, Egypt.

Chick-pea:

Sweet chick-pea was purchased from the local market at Giza Governorate, Egypt.

Extrusion process:

The whole milled yellow corn was partially substituted by the ground chick-pea at 10, 20 and 30%. The extrusion process was carried out using a Barabender Laboratory twin=screw extruder, 2150510, sereal 94011 equipped with a feeding screw, type HAAKE RHEODRIVE a speed control of feeding deice, temperature regulators for thereextruder zones and a die head. The extrution process condations for zones temperatures were 90, 130 and 200°C for the screw speed was 249 min-1 and for the feeding screw speed was 160 min^{-1}. The tested materials were conditioned in the first step of processing by adding appreciated amount of water and oil (1:2 ratio v/v) to be adjusted to 18%. The water and oil amount were slowly added during stirring using a laboratory mechanical stirrer. The conditioned product was extruded in the second step under the conditions previously mentioned. The specie were dissolved in oils then sprayed on the extrudate product in the third step of processing. The resultant extrudates were directly dried in an air forced dryer oven at 110°C for 5 min and left to equilibrate at the room temperature (extruder unite in Food Engreering and Packagiug dep. Food Technology Research Institute. Agricultural Research Center).

Chemical analysis:

Raw materials (corn grits, sweet chick-pea) and extruded samples were analyzed for moisture, protein, fat, ash according to the methods described in A.O.A.C. (2000). Meanwhile carbohydrates were calculated by differences.

Minerals determination:

Eight minerals Mg, Na, K, Ca, Mn, Fe, Zn and Cu were determined according to the methods outlined in A.O.A.C. (2000) using the perkin Elmer 3300 (USA) atomic absorption.

Determination of β- carotene

Beta carotene was extracted from the samples according to the method outlined in A.O.A.C. (1965) the extracted pigment was measured at 450 nm using DU-40 spectrophotometer according to the method described by Umiel and Gabvelman (1971).

Vitamin A was calculated according to FAO (1997) International units (I.U.) retinol = 0.3 µg retinol = 0.3 RE

Retinol equivalents 1(RE) = 3.331 U. retinol

1RE= 6 µg β- carotene

Physical analysis:

Expansion ration (ER) of extrudates was determined as described by Skierkowski *et al*. (1990) as follows:

ER was calculated by dividing the replicated reading of dienozzle on its number. Each value was an average of 10 readings.

Bulk density (BD) was determined as described by Park *et al*. (1993).

Water absorption (WA):

Water absorption (WA) was determined as described by Park *et al*. (1993).Water absorption was calculated as WA (%) = (weight gain upon hydration / dry weight) x 100. Each product was determined in triplicate.

Hunter colour:

Hunter colour (L, a and b) were determined in triplicates using procedures described by Kramer and Twigg (1970). The L, a, and b values were reported as L: Lightness, a: Redness, b: yellowness.

Shear Force (SF):

The warner – Bratzler shear force apparatus was used to measure the SF of extruded samples. The samples were sheared three times at different positions, and the average SF was calculated. Low shear force values indicated high tenderness (crispiness) as reported by Herring (1976).

Sensory evaluation:

Sensory evaluation (appearance, colour, aroma, taste and texture) was conducted according to Abu- Foul (1990).

Statistical analysis:

Sensory evaluation data were analyzed using the analysis of variance (ANOVA), and duncan's multiple range test was used to assess significance among treatments means as described by Steel and Torrie (1980).

RESULTS AND DISCUSSION

Chemical composition of raw materials and extrudate:

From the results in Table (1), it could be seen that raw sweet chick-pea had a higher content of protein, fat, ash and fiber and lower content of carbohydrates, compared with the corn flour. On the other hand all the snacks had high content of protein (10.41, 11.86 and 13.46) in compare with snack of control (8.10%). All fortified snacks had high ash, fiber and fat content when compared with control snack (without chick-pea). Finally, all fortified snacks were higher in protein and ash content than control samples. These results are in agreement with Gujska and Khan (1991)

With respect to energy values (EV), all levels of fortification with chick-pea, showed very slight traition. Mean while, increasing protein content was parallel to the decreasing in carbohydrate content, which affected the child body growth.

Table (1): Chemical composition of raw materials (%) and extrudates (on dry weight basis).

	Raw materials		Extrudate			
	Corn grits	Chick-pea	Snacks with chick-pea 10%	Snacks with chick-pea 20%	Snacks with chick-pea 30%	Control snacks
Protein	8.40	25.04	10.41	11.86	13.46	8.10
Fat	1.07	6.49	1.41	1.96	2.47	0.98
Ash	0.70	2.96	0.81	1.13	1.26	0.74
Fibers	0.98	2.73	1.17	1.26	1.41	0.87
[a]Carbohydrates	88.85	62.78	86.2	83.79	81.40	89.31
[b]Energy value (kcal/100g)			399.13	400.23	401.64	398.46

a: Carbohydrate were calculated by difference
b: Energy value was calculated (protein % x 4 +fat % x 9 +carbohydrate %x 4)

Physical and rheological attributes of extrudates:

Table (2) show that all snack samples had slight difference in physical properties. Control samples had lowest bulk density (BD) and shear force (SF) values. Among fortified snacks, the lowest expansion ratio resulted in 30% level of chick-pea (1.23) and water absorption (394%) values. This is may be due to high content of fat and protein which resulted a lower expansion ratio and increase the bulk density values (Breen *et al*., 1977). On the other hand, increasing protein content of sweet chick-pea samples decreased values of expansion ratio Mohamed (1990).

Table (2): Physical and rheological attributes of extrudates.

	Extrudates			
	Control snack	Snacks with chick-pea 10%	Snacks with chick-pea 20%	Snacks with chick-pea 30%
Water absorption index (WAI) g/100g	402	397	399	394
Bulk density (g/cm^3)	0.11	0.131	0.155	0.333
Expansion ration	1.41	1.39	1.27	1.23
Shear force (kg/cm^3)	15.40	15.41	15.42	16.20

Values mean of three replicate

Color measurements (L, a and b) of extrudates:

From the results in Table (3), color (L, a and b), of snack samples had different values in which control snack was the lowest in L value (lightness) in compare to those containing sweet chick pea (Lee *et al*., 2003). Snacks fortified with 30% chickpea had higher L, a and b values (73.82), and highest a and b values (-2.28 and 27.25). Finally, a trend was observed with Hunter color values which generally reflected difference in quantity of added sweet chick-pea as well as difference in myoglobin concentration. It could be mentioned that the presence of some free sugars and amino acids may be affected color of the produced snacks due to millard reaction.

Table (3): Values of Hunter color measurements (L, a and b) of extrudates .

	L	a	b
Control snacks	57.71	-1.83	21.20
Snacks with chickpea 10%	62.34	-1.30	26.65
Snacks with chickpea 20%	67.42	-0.78	20.19
Snacks with chickpea 30%	73.82	-2.28	27.25

L: Lightness, a: redness, b: yellowness

Minerals content of extruded samples:

Data of Table (4) revealed that inorganic nutrient levels were different as a result of addition of chick-pea at different ratios. The difference was great among fortified snacks, control snack and raw materials for some minerals. Potassium content of fortified snacks as higher than control, this might be due to the highest content of potassium in chick-pea compared with corn grain. In general, the estimated safe and adequate daily dietary intake of potassium is 1875-5625mg for adults (NAS- NCR, 1980) and the produced snacks provided about 10% -17% of RDA for K.

Table (4): Minerals content of raw materials and extradates (mg/100g).

	Raw materials		Extrudate			
Minerals	**Corn grits**	**Chick-pea**	**Control snacks**	**Snacks with chick-pea 10%**	**Snacks with chick-pea 20%**	**Snacks with chick-pea 30%**
Mg	34.25	161.5	37.38	85.25	93.25	108.63
Na	108.0	159.75	99.13	116.63	129.63	141.5
K	243.25	1197.5	202.13	317.25	588.82	570.0
Ca	48.75	96.25	56.0	53.75	65.73	76.25
Mn	0.188	1.91	0.43	0.45	0.7	0.855
Fe	4.93	10.83	4.6	5.4	6.35	7.41
Zn	0.775	3.3	0.703	1.5	1.8	2.13
Cu	0.004	0.395	0.03	0.033	0.057	0.095

Magnesium levels had different trend, in which the lowest level was 37.38 mg/100 g for control sample, but the highest was 108.63 mg/100g which about 3 fold as that of control for 30% level of chick-pea snakes.

From Table (4) it may be concluded that, increasing fortification from 10, 20 to 30 % (sweet chick-pea), iron increased in extruded snacks (5.4, 6.35 and 7.41, respectively) compared with corn snack control (4.6 mg/100g). Therefore these minerals will be playing an important role in bones, blood in human metaboilm. (Rude *et al*., 2001).

Finally, it appeared that fortification of snack samples produce food with different, levels of some inorganic nutrients (minerals), in compare with yellow corn snacks (El-Naggar *et al*., 2008).

Sensory attributes of snacks:

One of the limiting factors for consumer acceptability is the sensory evaluation of different quality attributes, therefore, the organolyptic test of the samples was estimated to measure the acceptability of such products in relation to the control sample, Table (5). With respect to the color preference, no significant differences could be detected among all the different snack products. The most preferable sample with respect to taste was the snack fortified with 10% of sweet chick-pea. The odor possessed no pattern in significance differences, but most of the snacks seemed to be more preferable than the corn sample (control). Crispness and after taste characteristics of the products were enhanced in chickpea 10% more preferable than control sample, followed by chickpea 20% and 30% levels. However, the general appearance of chickpea at 30% level was the lowest for snacks and control sample. Finally, control snacks as well as fortified samples were liked by the panelists for all sensory quality attributes. These results are in agreement with Mobarak *et al*., (2005).

Table (5): Sensory evaluation of extrudates.

Parameter	extrudates			
	Control snacks	Snacks with chick-pea 10%	Snacks with chick-pea 20%	Snacks with chic-kpea 30%
Colour	8.38^{a}	8.5^{a}	8.1^{b}	7.37^{c}
Taste	7.66^{b}	8.16^{a}	8.07^{ab}	7.59^{b}
Odor	8.05^{ab}	8.21^{a}	7.92^{a}	7.65^{b}
Crispness	8.21^{ab}	8.38^{a}	8.01^{ab}	7.26^{b}
After taste	7.15^{c}	8.23^{a}	7.8^{b}	7.28^{c}
General appearance	8.11^{a}	8.43^{a}	8.01^{b}	7.3^{c}

β-carotene and vit. A of extrudate products:

β-carotene content in the tested products was estimated in relative to the control sample and the results are illustrated in Table (6). It shows that raw yellow corn and sweet chick-pea possessed the highest β-carotene content. β-carotene rapidly decreased in the products and this decrement may also be the result of extrusion process in all the tested samples. On the other hand the severe effect may be regarded to the extrusion process including high severe temperature and pressure (Lee *et al*., 2000 and Mathew *et al*., 1999). Concerning Vit. A, the calculated values were in parallel with those of β-carotene.

Table (6): β.carotene and Vit. A of extrudate products (ppm)

Treatment samples / evaluation	β-carotene	* RE
Control snacks	0.159	0.026
Snacks with chickpea 10%	0.163	0.027
Snacks with chickpea 20%	0.166	0.028
Snacks with chick-pea 30%	0.259	0.043
Raw materials		
Corn	17.00	2.833
Chick-pea	25.33	4.221

Values mean of three replicates ***RE mean Retinol equivalents**

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تقييم وجبات الذرة الخفيفة المدعمة بالحمص

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من خلال هذه الدراسة تم خلط مجروش الذرة مع دقيق الحمص بنسب (١٠، ٢٠، ٣٠%) واستخدمت هذه المخاليط فى إنتاج أغذية بالبثق الحرارى عالية فى القيمة الغذائية نتيجة إضافة دقيق الحمص٠

وقد أجريت اختبارات كيماوية وتكنولوجية وحسية على الأغذية الناتجة من البثق الحرارى للمعاملات السابقة لتحديد أفضل معاملة مقارنة بالكنترول (جريش الذرة فقط)٠

التركيب الكيماوي والعناصر والبيتا كاروتين ومعدل الامتصاص للماء، والخواص الفيزيائية ودرجة اللون، ومعدل القطع والصفات الحسية تم تقديرها حيث أوضحت النتائج أن منتجات الاكسترودر أعلى فى محتواها من البروتين والدهن والرماد وعنصرى البوتاسيوم والحديد ٠ كما لوحظ تغير فى دلائل قياس اللون (b, a, L) حيث كانت أعلى فى منتجات البثق الحرارى كذلك زيادة محتوى البيتا كاروتين كلما زادت نسبة إضافة دقيق الحمص سجلت نسبه١٠% إضافة من دقيق الحمص أعلى نتائج فى التقييم الحسى مقارنه بالمعاملات الأخرى.

قام بتحكيم البحث

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