Current Science International Volume : 05 | Issue : 04 | Oct.- Dec. |2016
ISSN: 2077-4435 Pages: 555-565

Production of Snacks Supplemented with Different Sources of Protein

[1]Fatma A. Nada, [2]Asma A. El-Gindy and [3] M. R. G. Youssif

[1, 3] Bakery and Pasta. Res. Dep. Food Tech. Re. Inst, ARC, Egypt.
[2]Special Foods & Nutrition Res. Dep. Food Tech. Res. Inst, Agri. Res. Center, Egypt

Received: 10 Nov. 2016 / Accepted: 14 December 2016 / Publication date: 25 December 2016

ABSTRACT

This study was aimed to improve nutritional and functional properties of corn snacks by using three different types of protein sources which included chickpea seeds powder as plant source, milk casein powder as animal source and mushroom powder as microbial source to partial replacement of yellow corn grits at levels 5, 10, 15 and 20 %, studies the chemical composition of three different types of protein sources. The results also showed that the effect of these replacement on physical characteristics, organoleptic properties of extruded product .The obtained results revealed that milk casein powder recorded the highest crude protein content being 93.00% followed by mushroom powder and chickpea seeds powder being 36.98% and 24.38%, respectively, while yellow corn grits had lower crude protein content being 8.87%. Milk casein powder recorded the highest total essential amino acid being 65.76 g/100g protein followed by mushroom powder and chickpea seeds powder 49.58 and 43.36 g/100 g protein, respectively. The results also showed that the increasing of replacement level of yellow corn grits with chickpea seeds powder, milk casein powder and mushroom powder resulted in gradually increased of bulk density and decreased expansion ratio and sensory crispness. The results also showed that the increasing levels replacement of yellow corn grits with different levels of chickpea seeds powder and mushroom powder caused gradually increased water absorption index (WAI) and water solubility index (WSI). But, the replacement of yellow corn grits with milk casein powder caused gradually decreased WAI and WSI by increasing levels replacement compared to control sample. The results cleared that the sensory analysis of chickpea seeds powder, milk casein powder and mushroom powder were successfully replaced yellow corn grits in production of snacks up to 10%, without any change in its sensory characteristics and enhanced by protein.

Key words: Snacks - Chickpea - Mushroom - Milk Casein - Physical properties -Organoleptic evaluation -Amino acids.

Introduction

Snack foods have become a significant part of the diet of many individuals, particularly children, and can influence overall nutrition, Meng *et al.*, (2010). The most widely consumed extruded snacks are made primarily with cereals/grains due to their good expansion characteristics; however, they tend to be low in protein and many other nutrients , Gimenez *et al.,* (2013).

Rampersad *et al.,* (2003) reported that the composite extrudates of complementary proteins could increase nutritional value and create better textural or other functional properties. Some efforts have been made to fortify corn or wheat flours with milk, casein, soy, and meat proteins to produce extruded products that could be used in both developed and developing countries.

It is well known that the addition legumes to cereals produces an increase in both the amount and the quality of the protein mix, Perez *et al.,* (2008). Extruded legumes have been reported to have good expansion and are regarded as highly feasible for the development of value-added high nutrition, low calorie snacks, Berrios *et al.,* (2010).

Chickpeas *(Cicer arietinum* L) are one of the oldest and most widely consumed legumes in the world, particularly in tropical and subtropical areas, Singh *et al.*, (1991). The seeds are large in size and contain high levels of carbohydrate (41.l%-47.4%) and protein(21.7%--23.4%). Starch is the major carbohydrate fraction, representing about 83.9% of the total carbohydrates, Rincon *et al.,* (1998). Chickpea protein contains significant amounts of all the essential amino acids except sulphur

Corresponding Author: Fatma A. Nada, Bakery and Pasta. Res. Dep. Food Tech. Re. Inst, ARC, Egypt..
E-mail: Fatmanada3@gmail.com

containing types. Chickpea is also rich in nutritionally important unsaturated fatty acids like linoleic and oleic acid, Jukanti *et al.,* (2012).Chickpea is suggested to improve infant food and nutrition in developed countries, Alarcon-Valdez *et al.,* (2005).

The high nutritional and attractive medicinal values of the fruiting body of macro fungi (mushrooms) have been variously reported in literature. The reports show that mushrooms are especially rich in dietary protein and contain appreciable amounts of carbohydrate, fats, vitamins, fiber and minerals, *Ahmed et al.,* (2013). It was also noted that mushrooms are not only high in protein content, but the protein contains all the essential amino acids required by adult man, Bernas *et al.,* (2006).Considering that animal protein is not easily affordable to the rural poor in most developing countries, mushrooms are and have been playing the role of good supplements-. In recognition of this fact, the Food and Agricultural Organization (FAO) had earlier recommended mushrooms for reduction of protein malnutrition in underdeveloped countries, Pedneault *et al.,* (2006). Mushroom protein contains considerable amounts of endogenous amino acids,mostly alanine, arginine, glycine, histidine, glutamic acid, aspartic acid, proline and serine, Guo *et al.,* (2007).

Cow milk contains 2 major protein fractions: casein and whey protein. Casein is the principal protein found in cow's milk from which it is extracted commercially. As a result caseinates are widely used as an ingredient in foods to enhance their physical properties, such as whipping, foaming, water binding, thickening, emulsification, texture, flavor, solubility, and to improve their nutritional value, Lahov and Regelson (1996). Caseins and milk soluble proteins greatly differ regarding their amino acid composition, the latter of which contains higher concentrations of total sulfur amino acids (methionine and cysteine), lysine, threonine, and tryptophan, Lacroix *et al.,* (2006).

The aim of this study is to improve the nutrition and functional properties of corn snack by using three different types of protein sources which included chickpea seeds powder as a plant source, casein powder as animal source and mushroom powder as microbial source.

Materials and Methods

Materials:

Yellow corn grits (Zea mays) was obtained from Egyptian-Italian company for maize products (Maiza), 10th of Ramadan City, Cairo, Egypt.Chickpea (*Cicer arietinum L.*) seeds were obtained from local market. Milk casein was obtained as sodium caseinate from Alkan Medical Company for Medical Supplies (Alkan Medical), Giza, Egypt. Freshly-harvested mushroom (*Pleurotus ostreatus*) was obtained from Mushroom Production Unit, Food Technology Research Institute, Agricultural Research Center, Giza, Egypt. Metalized Biaxillary-Oriented Poly Propylene (BOPP) film was used to pack samples.

Methods:

Preparation of chickpea seeds powder:

Chickpea seeds were cleaned from all impurities including broken and diseased seeds, and then milled by perten laboratory mill to- whole chickpea meal. The resultant powder was packed in poly ethylene bags until used.

Preparation of mushroom powder:

The fruits of mushroom were harvested, sorted and sliced before drying them in a hot air drier at a temperature of 35°C for 2 days before being crushed in a fine mill to obtain the mushroom powder.

Preparation of snacks blend:

Different snacks blend were prepared by partially substituting of yellow corn grits by 5, 10, 15 and 20% of chickpea seeds powder, milk casein powder or mushrooms powder, to prepare different blends which used in preparation of experimental samples of snacks.

Analytical methods:

Chemical analysis:

Crude protein, ash, crude fiber and lipid contents were estimated by standard methods A.O.A.C., (2000).Mineral contents were determined by wet acid-digested, using a nitric acid and Perchloric acid mixture (HNO_3: $HClO_4$, 5:1 w/v) according to the method described by Chapman and Pratt (1978). Then the total amounts of K, Na, Ca, Mg, Fe, Zn and Mn in the digested samples were determined by atomic absorption spectrophotometer. Whereas phosphorus was determined by spectrophotometer according to the method of Astm (1975).

Determination of Amino-acids:

Amino acids content were determined according to the method as described by Moore *et al*. (1958).

Snacks making process:

Extrusion experiments were performed using a twin screw extruder (model 65-1 SLG Jinan Saibainuo Technology Co., China) with three heating zones, a 380 mm long and 19 mm diameter extruder barrel, and a compression ratio of 2:1. A rectangular die with internal measurements of 1.5 x 20 x 100 mm long was used. The barrel temperature in the cooking zone (intermediate zone) was varied according to the experimental design, ranging from 140 to 160°C. The temperature in the initial zone (feed zone) and zone die (zone output) was maintained constant at 60 and 90°C, respectively. The feed moisture was 16% and a screw speed of 103 rpm. These variables were fixed based on preliminary experiments. Ten kilograms of samples were used for each run. Thirteen runs were carried out as generated. In each run, extrudates were collected in a steady state (five minutes after the run began). Collected samples were packaged and sealed in 60 microns metalized oriented poly propylene (MOPP) bags.

Evaluation of snacks qualities:

Physical properties:

Bulk density:

Bulk density was measured as (g/cm^3) by weighing the quantity of extrudates required to fill a marked volume of glass cylinder (1000 cm^3) according to the following equation as described method of Stojeeska *et al.,*(2009).

$$\text{Bulk density (g/cm}^3\text{)} = \frac{\text{Weight of sample (g) product}}{\text{Volume (cm}^3\text{)}}$$

Expansion ratio:

Expansion index of the extrudates was determined by the method described by Dileep *et al.,* (2010) by dividing the extrudates diameter by the extruder die orifice diameter. Each value was an average of five determinations.

$$\text{Expansion ratio} = \frac{\text{Diameter of extruded product product}}{\text{Diameter of die extruder}}$$

Water absorption index (WA1) and water solubility index (WS1):

WAI and WSI of extrudates were determined by method suggested by Anderson (1982).

$$\text{WAI} = \frac{\text{Weight of sediment(g) product}}{\text{Weight of dry solids (g)}}$$

$$\text{WSI} = \frac{\text{Weight of dissolved solids in supernatant (g) (g)sediment(g) extruded product}}{\text{Weight of dry solids (g)}}$$

Organoleptic evaluation:

Fresh samples of snacks were organoleptically evaluated. Taste panels from the staff in Food Tech. Res., Institute Agric. Res. Center, Giza, Egypt. They were asked to score the internal characteristics of snacks for taste (20), odor (10), color(10), hardness(10), crispness(10), bitterness(10), porous texture (15), porous distribution (15) and Over all Acceptability (100) according to the method described by Bhattacharya and Parkash (1994).

Statistical analysis:

Data were analyzed by Analysis of Variance using General Linear Model (GLM) procedure according to the procedure reported by Sendecor and Cochran (1997). Means were separated using Duncan's test at a degree of significance ($P < 0.05$). Statistical analyses were made using the producer of the SAS software system program SAS, (1997).

Results and Discussion

Chemical composition:

The proximate compositions of yellow corn grits, chickpea seeds powder, milk casein powder and mushroom powder are presented in Table (1).

Table 1: Proximate composition of yellow corn grits, chickpea seeds powder, milk casein powder and mushroom powder (% on dry weight basis).

Samples	Crude protein	Lipids	Ash	Crude fiber	Nitrogen free extract * (NFE)
Yellow corn grits	8.87±0.02	3.12±0.01	1.58±0.03	1.64±0.01	84.79
Chickpea seeds powder	24.38±0.04	5.23±0.14	2.86±0.02	1.92±0.01	65.61
Milk casein powder	93.00±0.01	0.90±0.11	4.80±0.08	0.00±0.00	1.30
Mushroom powder	36.98±0.01	1.76±0.10	6.25±0.01	3.62±0.15	51.39

*Means of triplicate ±SD. *NFE: Calculated by difference.*

The obtained results revealed that, milk casein powder recorded the highest crude protein content being 93.00% followed by mushroom powder and chickpea seeds powder being 36.98% and 24.38%, respectively, while yellow corn grits had lower crude protein content being 8.87%. On the other hand, the highest value of lipid content was recorded for chickpea seeds powder 5.23%, followed by yellow corn grits and mushroom powder being 3.12 and 1.76%, respectively. Meanwhile, milk casein powder had the lowest lipid content being 0.90%. Mushroom powder contained the highest ash content 6.25% followed by milk casein powder 4.80% and chickpea seeds powder 2.86%, while yellow corn grits had the lowest ash content being 1.58%. Mushroom powder contained the highest crude fiber content 3.62% followed by chickpea seeds powder 1.92% and yellow corn grits 1.64%.

Meanwhile, milk casein powder did not contain fiber. Yellow corn grits recorded the highest value of nitrogen free extract (NFE) (84.79 %) followed by chickpea seeds powder and mushroom powder being, 65.61 and 51.39%, respectively. While, milk casein powder had the lowest NFE being 1.30%.The obtained data are in line with (EL-Adawy, 2002; Bernas and Jaworska, 2010).

Minerals content:

From the results presented in Table (2) it could be noticed that, both of chickpea seeds powder, milk casein powder and mushroom powder contained significant high amount of important minerals in comparison with yellow corn grits. The higher minerals content of chickpea seeds powder, milk casein powder and mushroom powder than yellow corn grits may be due to the higher ash content of the above mentioned sources than yellow corn grits as present in Table (1). Milk casein powder showed the highest concentration of calcium (320.49 mg/100g) followed by chickpea seeds powder (96.25 mg/100g) and mushroom powder (82.52mg/100g). Mushroom powder recorded the highest content of potassium (1167.19 mg/100g), phosphorus (534.17 mg/100g), zinc (4.48 mg/100g), copper (1.26 mg/100g), iron (8.02 mg/100g) and manganese (2.30 mg/100g) compared with other sources. Magnesium levels had different trend, in which the lowest level was 20.34 mg/100 g for milk casein powder, but the highest was 161.50 mg/100g for chickpea seeds powder. These data are similar with those reported by (Ejigui *et al.,* 2005 and El-Adawy, 2002).

Table 2: Minerals content of yellow corn grits, chickpea seeds powder, milk casein powder and mushroom powder.

Samples	Macro elements (mg/100g)					Micro elements (mg/100g)			
	Na	K	Ca	Mg	P	Zn	Cu	Fe	Mn
Yellow corn grits	108.00	243.25	48.75	34.25	210.00	0.76	0.39	2.93	0.48
Chickpea seeds powder	159.75	297.50	96.25	161.50	398.67	3.30	1.10	6.83	1.91
Milk casein powder	620.32	160.58	320.49	20.34	280.03	0.18	0.02	0.36	0.12
Mushroom powder	148.62	1167.19	82.52	54.30	534.71	4.48	1.26	8.02	2.30

Amino acid composition:

Data presented in Table (3) showed that the essential amino acids and non-essential amino acids content of yellow corn grits, chickpea seeds powder, milk casein powder and mushroom powder.lt was observed that, yellow corn grits was the least content of all essential amino acids, compared with chickpea seeds powder, milk casein powder and mushroom powder.

Among all essential amino acids, Lysine was found to be of the highest content of milk casein powder which contains 12.70 g/100 g protein followed by chickpea seeds powder and mushroom powder7.72 and 6.77 g/100 g protein, respectively. The amounts of other essential amino acids were found to vary in chickpea seeds powder, milk casein powder and mushroom powder. Milk casein powder recorded the highest total essential amino acid being 65.76 g/100g protein followed by mushroom powder and chickpea seeds powder 49.58 and 43.36 g/100 g protein, respectively.

The results also showed that glutamic acid was present in maximum concentration followed by aspartic acid and arginine in yellow corn grits, chickpea seeds powder and mushroom powder samples. These results are in accordance with Boye *et al.,* (2010) reported that glutamic acid was present in maximum concentration followed by aspartic acid and arginine. Chickpea seeds powder contains 20.64 g/100 gm protein of glutamic acid followed by yellow corn grits and mushroom powder 17.33 and 11.82 g/100 g protein, respectively.

Similarly, the amount of remaining non-essential amino acids analyzed were found to vary in the chickpea seeds powder, milk casein powder and mushroom powder.

Table 3: Amino acids composition of yellow corn grits, chickpea seeds powder, milk casein powder and mushroom powder.

Amino acids	(g/100g protein)				
	*FAO/WHO/ UNU	Yellow corn grits	Chickpea seeds Powder	Milk casein Powder	Mushroom powder
Essential amino acid					
Lysine	5.8	3.02	7.72	12.70	6.77
Leucine	6.6	6.91	7.08	9.18	8.49
lsoleucine	2.8	3.07	4.17	6.69	4.49
Threonine	3.4	3.82	3.65	7.54	5.30
Histidine	1.9	2.32	3.42	4.42	2.90
Valine	3.5	4.17	4.13	6.35	5.96
Methionine	-	3.22	1.32	5.22	3.42
Cysteine	-	2.42	0.98	1.07	1.41
Total sulfur amino acids	2.5	5.64	2.30	6.29	4.83
Phenylalanine	-	4.67	5.90	6.86	5.09
Tyrosine	-	3.95	3.71	4.39	4.13
Total aromatic amino acid	6.3	8.62	9.61	11.25	9.22
Tryptophan**	1.1	1.11	1.28	1.34	1.62
Total essential amino acid	33.9	38.68	43.36	65.76	49.58
Non-essential amino acid					
Glutamic acid	-	20.64	17.33	8.80	11.82
Aspartic acid	-	10.15	11.25	7.33	9.69
Proline	-	8.32	4.62	4.24	4.55
Ariginine	-	9.21	10.21	4.67	8.08
Glycine	-	4.50	4.12	3.22	4.51
Alanine	-	4.70	4.40	3.36	6.35
Serine	-	3.80	4.71	2.62	5.42
Total non-Essential amino acid	-	61.32	56.64	34.24	50.42

** FAO/WHO/ UNU (2007). **Tryptophan was determined calorimetrically.*

The chemical score:

The chemical score of yellow corn grits, chickpea seeds powder, milk casein powder and mushroom powder arc presented in Table (4), along with the amino acid score pattern for the FAO/WHO/ UNU (2007). Amino acid score is very important to evaluate the content of essential amino acids in food and also to be enough the nutritional requirements of protein. Yellow corn grits is deficient in lysine and has low chemical score of being 52.1. Milk casein powder, mushroom powder and chickpea seeds powder are rich in protein 93.00, 36.98 and 24.38%, respectively (Table 1)and had high lysine chemical score being 219.0, 116.7 and 133.1, respectively .

Also, the obtained data show that chickpea seeds powder protein, like some other legumes, is common deficient in sulfur-containing amino acids which its chemical score wase 92.0. These deficiencies need to be considered when chickpea used for nutrition purposes. Similar results were observed by Angelo-Bejaranoet *et al.,* (2008) they reported that, total sulfur (methionine + cystine) was the first limiting amino acids in chickpea .Tryptophan was not observed to be the limiting amino acid in yellow corn grits, chickpea seeds powder, milk casein powder and mushroom powder. Amino acid deficiency can be met by employing the complementarity that exists between sulphur amino acid cereals and legumes.

Table 4: Essential amino acids (g/kg protein) of yellow corn grits, chickpea seeds powder, milk casein powder and mushroom powder proteins and their chemical scores in respect to FAO/WHO/UNU, 2007.

Essential amino acid	FAO/WHO/ UNU (2007).	Yellow corn grits		Chickpea seeds powder		Milk casein powder		Mushroom powder	
		g/kg protein	**CS	g/kg protein	**CS	g/kg protein	**CS	g/kg protein	**CS
Lysine	58	30.2	*52.1	77.2	133.1	127.0	219.0	67.7	116.7
Leucine	66	69.1	104.7	70.8	107.3	91.8	139.1	84.9	128.6
Isoleucine	28	30.7	109.6	41.7	148.9	66.9	238.9	44.9	160.4
Threonine	34	38.2	112.4	36.5	107.4	75.4	221.8	53.0	155.9
Histidine	19	23.2	122.1	34.2	180.0	44.2	232.6	29.0	152.6
Valine	35	41.7	119.1	41.3	118.0	63.5	181.4	59.6	170.3
Methionine	-	32.2	-	13.2	-	52.2	-	34.2	-
Cystine	-	24.2	-	9.8	-	10.7	-	14.1	-
Total sulfur amino acid	25	56.4	225.6	23.0	*92.0	62.9	251.6	48.3	193.2
Phenylalanine	-	46.7	-	59.0	-	68.6	-	50.9	-
Tyrosine	-	39.5	-	37.1	-	43.9	-	41.3	-
Total aromatic amino acid	63	86.2	136.8	96.1	152.5	112.5	178.6	92.2	146.4
Tryptophan	11	11.1	100.9	12.8	116.4	13.4	121.8	16.2	147.3

**Limited, amino acid   **CS: Chemical scores*

Physical characteristics of extruded snacks:

The results in Table (5) shows the physical characteristics of extruded snacks prepared by incorporating different ratio of chickpea seeds powder, milk casein powder and mushroom powder with yellow corn grits. From the obtained results, it could be observed that, the increasing of replacement level of-corn grits with chickpea seeds powder, milk casein powder and mushroom powder resulted in gradually increased of bulk density. A lower expansion at higher replacement level of chickpea seeds powder, milk casein powder and mushroom powder were recorded which could also be explained by the negative association of bulk density with expansion ratio. This result is in agreement with Suksomboon *et al.,* (2011) who reported that blending higher proportion of chickpea flour to rice flour and cowpea flour to sorghum flour respectively resulted in lower expansion of blend extrudates. De Mesa *et al.,* (2009) also reported increasingly lower expansion of maize starch extrudates with the addition of 5 – 20 % soy protein concentrate and associated the phenomenon with starch-soy protein concentrate interactions affecting the expansion indirectly by system mechanical energy and directly by disrupting the continuous starch matrix which reduces extensibility of cell walls. Similar effect might have contributed to the reduction of expansion at higher chickpea seeds powder, milk casein powder and mushroom powder levels. Chinnaswarny and Hanna (1988) indicated that the expanded volume of cereal flour decreases with increasing amounts of protein and lipid. Oils and fats provide a powerful effect on lubrication effect in the compressed polymer mix during extrusion cooking IIo *et al.,*(2000).

In this study, it could be observed that, the partial replacement of corn grits with 5, 10, 15 and 20% of chickpea seeds powder and mushroom powder caused gradually increased in both of water absorption index (WAI) and water solubility index (WSI) gradually in parallel with increasing the level of replacement. This may be due to the increased in fiber content of chickpea seeds powder and mushroom powder than corn grits as shown in Table (1). Fatma *et al.,* (2009) mentioned that, the increasing of fiber content in extruded snacks blends led to increase the WS1 and WA.I of the extrudates. Also, the high of WAI is an indicator of good starch digestibility as it implies a good extent of gelatinization and dextrinisation, Guha *et al.,* (1997).

On the other side, replacement of corn grits with 5, 10, 15 and 20% of milk casein powder caused gradually decreased in both of Water absorption index (WAI) and water solubility index (WSI) by increasing level of replacement in compared to control sample. This may be due to the increased in protein content of milk casein powder than corn grits as shown in Table (1) which denaturation by heat and loss their natural properties, especially the ability to dissolved in water.

These results are in agreement with that obtained by Liu and Hsieh (2008), they mentioned that, the extrusion is known to decrease protein solubility, which has been related to the formation of insoluble aggregates, involving both covalent disulfide bonds and non-covalent interactions.

Table 5: Physical characteristics of extruded snacks prepared by incorporating different ratio of chickpea seeds powder, milk casein powder and mushroom powder proteins with yellow corn grits.

Physical characteristics		Bulk density (g/cm^3)	Expansion ratio (ER)	Water absorption Index (WAI)	Water solubility Index (WSI)
Chickpea seeds powder	Control sample	0.1684±0.00	4.840±0.01	6.57±0.01	18.65±0.05
	5%	0.1873±0.01	4.590±0.00	6.81±0.02	19.72±0.02
	10%	0.2064±0.00	4.320±0.02	7.25±0.01	20.86±0.01
	15%	0.2237±0.00	4.060±0.01	7.78±0.01	21.55±0.02
	20%	0.2508±0.00	3.900±0.00	8.14±0.06	22.83±0.04
Milk casein powder,	5%	0.2312±0.00	4.150±0.00	6.20±0.02	17.92±0.01
	10%	0.2885±0.00	3.420±0.03	5.83±0.01	17.28±0.02
	15%	0.3568±0.00	2.870±0.02	5.25±0.01	16.57±0.01
	20%	0.4197±0.01	2.290±0.01	4.95±0.04	15.87±0.06
Mushroom powder	5%	0.1936±0.00	4.500±0.02	6.92±0.01	19.97±0.01
	10%	0.2260±0.00	4.160±0.00	7.48±0.00	21.65±0.01
	15%	0.2605±0.00	3.780±0.04	8.03±0.01	22.54±0.02
	20%	0.2841±0.00	3.420±0.01	8.56±0.02	23.79±0.03

** Means of triplicate ± SD.*

Sensory evaluation of extruded snacks:

Organoleptic properties play an important role for a food to be acceptable to its target market Francis, (1991). The results in Table (6) showed that, there were no significant differences (p>0.05) in taste of produced snacks between the control sample and 5, 10% level of substitution with different sources. On the other hand, significant differences (p<0.05) in taste between the control sample and 15 and 20% substitution level with mushroom powder were recorded. Concerning the odor, no significant difference (p>0.05) was recorded between control sample and snacks samples which substituted with 5, 10 and 15% of chickpea seeds powder, milk casein powder and mushroom powder, but there were significant differences (p<0.05) between control sample and snacks sample contained 20% substitution level with mushroom powder.

The obtained results indicated that there were no significant differences (p>0.05) in color between control sample and snacks samples which substituted with 5, 10, 15 and 20% of chickpea seeds powder and milk casein powder. While, snacks color was significantly reduced by increasing the level of substitution with mushroom powder, it became darker than the control sample. In addition, the obtained results indicated that, there were no significant differences (p>0.05) between control sample and snacks samples contained 5% level of substitution with chickpea seeds powder, milk casein powder and mushroom powder for hardness. While, addition of 15, 20% of chickpea seeds powder, milk casein powder and mushroom powder significanity affected (p<0.05) the hardness of prepared snacks. The increase in hardness (low crispness) with increase in chickpea seeds powder, milk casein powder and mushroom powder levels may be due to reduction in expansion of extrudates. Cheng *et al.,* (2007) also reported increased level of whey protein isolate resulted in reduced crispiness score of corn starch-whey protein isolate blend extrudate.

On the other hand, there were no significant differences (p>0.05) between control sample and all snacks samples for bitterness. Also, the obtained results indicated that, there were no significant differences (p>0.05) between control snacks sample and snacks samples contained 5, 10% level of substitution with chickpea seeds powder and mushroom powder for porous texture and porous distribution.

The mean total score values of control snacks sample which produced by using 100% yellow corn grits was higher than those of other samples and decreased gradually with non significant differences compared with control sample until 10% substitution level with chickpea seeds powder, milk casein powder and mushroom powder. These results are in agreement with those obtained by Sadik (2015).

Table 6: Sensory evaluation of extruded snacks prepared by incorporating different ratio of chickpea seeds powder, milk casein powder and mushroom powder proteins with yellow corn grits.

Samples		Taste (20)	Oder (10)	Color (10)	Hard-ness (10)	Crispness (10)	Bitterness (10)	Porous texture (15)	Porous distribution (15)	Over all Acceptability (100)
Control sample		19.8 ^{a}	9.5^{a}	9.6^{a}	4.6^{d}	10.0^{a}	5. 0^{a}	14.2^{a}	14.6^{a}	87.3^{a}
Chickpea seeds powder	5%	19.8^{a}	9.5^{a}	9.6^{a}	5.2^{cd}	9.8^{a}	5. 0^{a}	14.0^{a}	14.1^{a}	87.0^{a}
	10%	19.6^{a}	9.3^{a}	9.6^{a}	5.8^{cd}	9.5^{a}	5. 0^{a}	13.7^{a}	13.8^{ab}	86.3^{a}
	15%	19.2^{a}	9.0$^{'a}$	9.4^{a}	6.6^{bc}	8.9^{ab}	5. 0^{a}	12.9^{b}	13.0^{b}	84.0^{ab}
	20%	18.8^{ab}	8.8^{a}	9.4$^{a'}$	7.2^{bc}	8.7^{ab}	5. 0^{a}	12.1^{bc}	12.4^{bc}	82.4^{ab}
Milk casein powder	5%	19.6^{a}	9.5^{a}	9.6^{a}	5 .8^{cd}	9.4^{a}	5. 0^{a}	13.8^{a}	13.8^{ab}	86.5^{a}
	10%	19.0^{a}	9.0^{a}	9.6^{a}	6.5^{bc}	8.8^{ab}	5. 0^{a}	12.2^{bc}	12.5^{bc}	82.6^{ab}
	15%	18.7^{ab}	8.7^{a}	9.4^{a}	7.9^{ab}	8.2^{b}	5. 0^{a}	10.7^{cd}	10.8^{cd}	79.4^{b}
	20%	18.2^{ab}	8.4^{a}	9.2^{a}	8.8^{a}	7.6^{c}	5. 0^{a}	9.4^{d}	9.6^{d}	76.2^{b}
Mushroom powder	5%	18.9^{ab}	9.2^{a}	9.0^{a}	5.5^{cd}	9.6^{a}	5. 0^{a}	13.8^{a}	14.0^{a}	85.0^{a}
	10%	18.2^{ab}	8.6^{a}	8.5^{ab}	6.1^{c}	9.0^{ab}	5. 0^{a}	13.5^{a}	13.7^{ab}	82.6^{ab}
	15%	17.5^{b}	8.0^{ab}	7.3^{b}	6.9^{bc}	8.5^{ab}	5. 0^{a}	12.8^{b}	13.0^{b}	79.0^{b}
	20%	16.8^{c}	7.5^{b}	6.2^{c}	7.4^{b}	8.2^{b}	5. 0^{a}	11.3^{c}	11.9^{c}	74.3^{b}

** Means followed by different letters in the same column are significantly different by Duncan's multiple test (p<0.05).*

Conclusion

According to our results, it could be concluded that, the increasing of replacement level of yellow corn grits with chickpea seeds powder, milk casein powder and mushroom powder resulted in gradually increased of bulk density and decreased expansion ratio and sensory crispness. In the same time, the partial replacement of yellow corn grits with 5, 10, 15 and 20% of chickpea seeds powder and mushroom powder caused gradually increased in both of water absorption index (WAI) and water solubility index (WSI)with increasing the level of replacement. But, the replacement of yellow corn grits with 5, 10, 15 and 20% of milk casein powder caused gradually decreased in both of WAI and WSI by increasing level of replacement in compared to control sample. For sensory analysis, the results revealed that, both of chickpea seeds powder, milk casein powder and mushroom powder were successfully replaced yellow corn grits in production of snacks up to 10%, without any unfavorable change in its sensory characteristics. Thus extrusion of yellow corn grits blended with 10% of chickpea seeds powder, milk casein powder or mushroom powder would produce an acceptable snacks enhanced by protein.

References

A.O.A.C. 2000. Official methods of Analysis of Association of Official Analytical Chemists. edited B, Kenesseth Helrick. Fifteenth Edition. Washington DC.

Ahmed, M., N. Abdullah, K. U. Ahmed and M. H. M. Borhannuddin-Bhuyan 2013.Yield and nutritional composition of oyster mushroom strains newly introduced in Bangladesh.Pesquisa Agropecuaria Brasileria, 48(2):197-202.

Alarcon-Valdez, C., J. Milan-Carrillo, O.G. Cardenas-Valenzuela, R. Mora-Escobedo, L.A. Reno-Pertez and C. Reyes-Moreno 2005 . Infant food from quality protein maize and chickpea: optimization for preparing and nutritional properties. Int. J. of Food Sci. and Nutrition, 56 (4): 273-285.

Anderson, R.A. 1982 .Water absorption and solubility and amylograph characteristics of roll-cooked small grain products. Cereal Chemistry, 59: 265-269.

Angulo-Bejarano, P.1., N.M. Verdugo-Montoya, E.O. Cuevas-Rodrguez, J. Milan-Carrillo, R. Mora-Escobedo, Lopez-Valenzuela, J.A. Garzon-Tiznado and C. Reyes-Moreno 2008 . Tempch flour from chickpea (Cicer arietinum L.) nutritional and physicochemical properties. Food Chemistry, 106: 106-112.

Astm, S. 1975. Annual Book of American Society of Testing Materials Standard Water. Part 31 Dsis-72- Philadelphia, PA.

Bernas, E., G. Jaworska, and Z. Lisiewska 2006. Ediblemushroom as a source of valuable nutritive constituents . Acta Scientiarum Polonorum , Technologia Alimentaria , 5(1):5-20.

Bernas, E. and G. Jaworska 2010 .Comparison of amino acid content in frozen *P. ostreatus* and *A. bisporus* mushrooms. Acta Scientiarum Polonorum , Technologia Alimentaria ,9(3): 295-303.

Berrios, J. J., P. Morales, M. Camara and M. C. Sanchez-Mata 2010 .Carbohydrate composition of raw and extruded pulse flours. Food Research International, 43: 531-536.

Bhattacharya, S. and M. Prakash 1994. Extrusion of blends of rice and chickpea flours: A response surface analysis. J. of Food Engineering, 21 (3): 315- 330.

Boye J., Z. Fatemeh and P. Alison 2010. Pulse proteins: Processing, characterization, functional properties and applications in food and feed. Food Research International, 43: 414 – 431.

Chapman, H.D and P.F. Pratt 1978. Methods of analysis for soils, plants and waters, Univ. California, Div. Agric. Sci., Priced !publication 4034.

Cheng, E. M. , S. Alavi , T. Pearson, and R. Agbisit 2007. Mechanical-acoustic and sensory evaluations of corn starch-whey protein isolate extrudates. Journal of Texture Studies, 38: 473-498.

Chinihaswamy, R. and W.A. Hanna 1988. Relationship between amylose content and extrusion-expansion properties of corn starch. Cereal Chemistry, 65(2): 138-143.

De Mesa, N. J. E., S. Alavi, N. Singh, Y. C.Shi, H. Dogan and Y. Sang 2009. Soy protein-fortified expanded extrudates: baseline study using normal corn starch. Journal of Food Engineering 90: 262-270.

Dileep, A., B. Sharnasundar, P. Binsi, and Howell 2010. Composition and quality of rice flour-fish mince based extruded products with emphasis on thermal properties of rice flour. Journal of Texture Studies, 41: 190-207.

Ejigui, J., L. Savoie, J. Marin and T. Desrosiers 2005. Beneficial changes and drawbacks of a traditional fermentation process on chemical composition and antinutritional factors of yellow maize (*Zea mays*). Journal of Biological Sciences, 5(5): 590-596.

El-Adawy, T.A. 2002 .Nutritional composition and antinutritional factors of chickpeas (*Cicer arietinum* L.) undergoing different cooking methods and germination. Plant Foods for Human Nutrition, 57: 83-97.

FAO/WHO/UNU, 2007. Protein and Amino Acid Requirements in Human Nutrition. Report of a Joint WHO/FAO/UNU Expert Consultation. WHO technical report series no. 935. World Health Organization Geneva.

Fatma B.A., M. EI-Din, S. A. Zahra, A.R. Abdel-Latief, A.T. El-Akel and S.H. Abou-Rays 2009. Chemical, physical, nutritional and sensory properties of high fiber healthy corn snacks. Food Global Science Books, 3 (1): 53-57.

Francis, F.J. 1991. Colour measurement and interpretation. In: Fang, D.Y.C. and Matthews, R.F. (eds.) Instrumental methods of quality assurance. Marcel Dekker Inc., New York, NY, USA, pp. 189-209.

Gimenez, M. A., R. J. Gonzalez, J. Wagner, R. Torres, M. O. Lobo, and N. C. Samman 2013.Fffect of extrusion conditions on physicochemical and sensorial propertiesof corn-broad beans (*Vicia faba*) spaghetti type pasta. Food Chemistry, 136 (2): 538¬545.

Guha, M., S.Z. Ali , and S. Bhattacharya 1997. Twin-screw extrusion of rice flour without a die: Effect of barrel temperature and screw speed on extrusion and extrudate characteristics. Journal of Food Engineering, 32: 251-267.

Guo, L.Q., J.Y. Lin , and J.F. Lin 2007.Non-volatile components of several novel species of edible fungi in China. Food Chem., 100: 643-649.

IIo, S., R. Schoenlechner and E. Berghofe 2000. Role of lipids in the extrusion cooking processes, Cereal Chemistry, 71: 227-234.

Jukanti, A. K., P. M. Gaur, C. L. L. Gowda and R. N. Chibbar 2012. Nutritional quality and health benefits of chickpea (*Cicer arietinum L.*): a review. British Journal of Nutrition, 108: S11-S26.

Lacroix, M., C. Bos, J. Leona, G. Airinci, C. Luengo, S. Dare, R. Benamouzig, H. Fouillet, J. Fauquant, D. Tome and C. Gaudichon 2006. Compared with casein or total milk protein, digestion of milk soluble proteins is too rapid to sustain the anabolic postprandial amino acid requirement. Am. J. Clin. Nutr., 84:1070-1079.

Lahov, E. and W. Regelson 1996 .Anitibacterial and immunostimulating casein-derived substances from milk: casecidin, isracidin peptides. Food. Chem. Toxicol., 34:131-145.

Liu, K. and F. H. Hsieh 2008. Protein-protein interactions during high-moisture extrusion for fibrous meat analogues and comparison of protein solubility methods using different solvent systems. Journal of Agricultural and Food Chemistry, 56:2681-2687.

Meng, X., D.Threinen, M. Hansen and D. riedger 2010. Effects of extrusion conditions on system parameters and physical properties of a chickpea flour based snack. Food Research International, 43: 650-658.

Moore, S., D.H. Spackman and W.H. Stein 1958 .Chromatography of Amino Acid on Sulphonated Polystyrene Resins.An Improved System. Analytical Chemistry,30: 1185-1190.

Pedneault, K. P., A. Gosselia and R. J. Tweddell 2006.Fatty acid composition of lipids from mushrooms belonging to the family. Boletaceae Mycology Research, 110: 1179-1183.

Perez, A. A., S. R. Drago, C. R. Carrara, D. M. De Greef, R. L. Torres and R. J. Gonzalez 2008. Extrusion cooking of a corn grits soybean mixture: factors affecting expanded product characteristics and flour dispersion viscosity. Journal of Food Engineering, 87: 333-340.

Rampersad, R., N. Badrie and E.Comissiong 2003. Physico-chemical and sensory characteristics of flavoured snacks from extruded cassava pigeon pea flout-Journal of Food Science, 68: 363-367.

Rincon, F., B. Martinez and M.V. Ibanez 1998. Proximate composition and antinutritive substances in chickpea (*Cicer arietinum L.*) as affected by the biotype factor. J. Sci. Food Agric., 78: 382-388.

Sadik, J. A. 2015. Effect of chickpea level and feed moisture content on physical properties of teff flour extrudates. International Food Research Journal, 22(2): 539-545.

SAS 1997. Statistical Analysis System. User 's Guide: Statistics, SAS Institute Inc, Gary, Nc., USA.

Sendecor, G.W. and W.G. Cochran 1997.Statistical Methods; 7th Ed. Oxford and J.; B.H. Publishing Co. pp. 504.

Singh, U., N. Subrahmanyan and J. Kumar 1991. Cooking quality and nutritional attributes of some newly developed cultivars of chickpea (*Cicer arietinum*). J. Sci. Food Agric., 55: 37- 46.

Stojeeska, V., P. Ainsworth, A. Plunkett and S. Ibanoglu 2009. The effect of extrusion cooking using different water feed rates on the quality of ready-to-eat snacks made from food by-products. Food Chemistry, 114: 226-232.

Suksomboon, A., K. Limroongreungrat, A. Sangnark, K. Thititumjariya and A. Noomhorm 2011. Effect of extrusion conditions on the physicochemical properties of a snack made from purple rice (*Horn nil*) and soybean flour blend. International Journal of Food Science and Technology, 46: 201-208.