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PRODUCTION AND EVALUATION OF HIGH NUTRITION VALUE SNACKS

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ABSTRACT

The current study was carried out to demonstrate that grist corn acceptable extruded products with high protein content can be prepared from varying blends from defatted wheat germ, mushroom and defatted soybean flour under optimized extrusion conditions by incorporating 5, 10 and 15% substitution.

The results showed that the soya snacks had higher protein, fiber and ash content than the control. Fat contents for wheat germ extruded products samples were increased by increasing of substitution levels. On the other hand, carbohydrates decrease with increase of substitution levels in all extruded products.

The minerals composition of grits corn snacks increased with increasing of the added soya, wheat germ and mushroom flours. The data revealed that 15% soya substitution grits corn snacks had the highest Zn and Ca contents. Meanwhile 15% mushroom supplemented grits corn snacks had the highest Fe content.

Water absorption index values (WAI) were increased by increasing the added raw materials compared to snacks food control. Water-soluble index values (WAI) were decreased for all the extruded products by increasing substitution levels by raw materials. The sensory evaluation is imperative for the success of a newly developed food product.

From the results it could be concluded that the snacks made with the addition of defatted soy meal, wheat germ and mushroom, can improve the quantity and quality of the protein present in corn-based snack and its sensory characteristics.

Key wards: *wheat germ, mushroom, defatted soybean, extruded snacks.*

1. INTRODUCTION

According to studies on consumer trends, more consumers are frequently replacing the traditional three meals a day with snacks (Hirst and Wohl, 2014). This trend is due, but not limited to, busy lifestyles, increased the number of working hours, and more time travelled between home and work (Sade and Aderonke, 2013 and Beswa *et al.,* 2016).

The most consumed ready-to-eat (RTE) foods are increasingly the consumer demand for RTE snacks are showing consistent growth due to the convenient nature of snack products and also the appeal of RTEs for texture and sensory properties (Brennan *et al.,* 2013).

Currently, there are on-going efforts to produce affordable nutritious and healthy snacks by using high nutrient content maize varieties as well as incorporating locally available natural sources of essential nutrients (Beswa *et al.,* 2016).

Mushrooms have also been reported as having a wide range of health benefits, such as their antioxidative, antifungal, antiviral, antitumor properties and hypocholesterolaemic effects (Kim *et al.,* 2014). Shiitake mushrooms have high nutritional values and contain several bioactive compounds, such as polysaccharides, antioxidants, dietary fiber, ergo sterol, minerals, vitamins B1, B2 and C, folates and niacin (Li *et al.,* 2014 and Jiang *et al*., 2015).

Protein Energy Malnutrition (PEM) of the Bangladeshi population can be reduced through the development of biscuits prepared by substituting wheat flour with 15% soy flour and addition of mushroom powders *(*Farzan*a* and Mohajan, 2015*).*

The potential glycemic response from including 5% (w/w) of mushrooms in extruded snacks exceeds 20%. Thus, the incorporation of mushrooms in ready-to-eat snack foods may be of considerable interest to the food industry in

trying to regulate the glycemic response of foods mushrooms are a common vegetable product that have also been linked to pharmaceutical and medicinal uses (Brennan *et al*., 2012). Moreover, wheat germ is a potential nutritious food supplement; in particular, defatted wheat germ which contained natural high-grade protein and amino acids fortification substance (Yiqiang *et al.,* 1999).

Today the nutritional value of the meals, including snacks has increased because of consumer demand for healthy food *(*Davoodi *et al.,* 2017).

This study was carried out to investigate the effect of the addition of defatted soya, wheat germ and mushroom flours to grist corn -based extrudate on its physical, chemical and sensory properties.

2. MATERIALS AND METHODS

2.1. Materials

Defatted wheat germ was obtained from North Cairo flour Mills Company El-Salam City, Egypt. Mushroom "*Pleurotus ostereatus (Oystar sp.)"* and defatted soybean were obtained from Food Technology Research Institute, Agricultural Research Center, Giza-Egypt. Corn (*Zea mays* L.) was purchased from Field Crops Research Institute, Agricultural Research Center, Giza-Egypt.

2.2. Methods

2.2.1. Preparation of mushroom

Mushroom was washed, cleaned, cut into small pieces, dried at 50˚C (overnight), milled using laboratory mill and sieved through 40 mesh screens.

2.2.2. Preparation of blends samples

The corn grits were replaced by 0, 5, 10 and 15% of each of defatted wheat germ, mushroom and defatted soybean flours as shown in Table (1).

2.2.3. Sample preparation for extrusion

The obtained blends were extruded at selected constant extrusion condition: screw speed of 140 rpm and barrel temperature of 140^{o}C in a Brabender laboratory Twins -screw extruder (Duisburg DCE 330, New Jersey USA) fitted with 2mm die nozzle according the methods of Nwabueze (2008). The resulting dried samples were packaged inside coded high density polyethene bag. Many grammas needed for laboratory analysis were taken and milled in a Brabender roller mill and sieved through a 75µm opening. The resulting extrudates blends were packaged inside coded high density polyethene bag and stored under room temperature (28±2^{o}C) until needed for analysis.

2.2.4. Physico-chemical characteristics of extruded blends

Fat, protein, crude fiber and ash were determined in the different extruded blends snacks as described in AOAC (2010). The total carbohydrates were calculated by difference. The mineral contents were digestion as described in AOAC (2010) and determined using the 3300 Perkin Elmer Atomic Absorption Spectrophotometer). Approximate calories value products were calculated using the appropriate factor as described by FAO/WHO (1974*)*.

Water absorption index (WAI) and water solubility index (WSI) of snack samples were determined in the different prepared blends according to the method of Anderson *et al.,* (1969).

The displacement method by Seker (2005*)* was used to measure bulk density (BD). The samples were cut into strands about 25 mm long and 15 g stands weighed (*W*ext). Then they were put in a 100-ml cylinder and yellow millet particles were added to fill up the cylinder. The samples were taken out and the volume (ml) of the samples was measured (*100 -V*ym). Bulk

Table (1): Ingredients of raw materials blends (g/100g).

Formulae	Corn grits	Addition of raw materials		
		Defatted wheat germ	Mushroom	Defatted soybean
Control	100	--	--	--
1	95	5	--	--
2	90	10	--	--
3	85	15	--	--
4	95	--	5	--
5	90	--	10	--
6	85	--	15	--
7	95	--	--	5
8	90	--	--	10
9	85	--	--	15

density (BD) was calculating as:

$$BD\ (g/ml) = Wext\ /100 - Vym$$

2.2.5. Sensory evaluation

Sensory evaluation of snacks samples was performed at zero time by ten individual panelists as follows:

Characteristics	Maximum
Showiness	20
Taste	20
Porous distribution	10
Texture	20
Color	10
Surface characteristics	10
General appearance	10
Overall acceptability	100

The overall acceptability was calculated from the total score of tested attributes. The scale used in scoring overall acceptability was (86 – 100) excellent, (76 – 85) good, (61 – 75) fair and (50 – 60) poor as described by Abu-Foul (1990).

2.2.6. Statistical analysis

The data obtained in the present study was analyzed by ANOVA. For all analyses, when a significant difference ($p < 0.05$) was detected in some variable, the data means test was applied to evaluate the difference between the samples. The results were analyzed with the aid of the software SAS System for Windows SAS (2008).

3. RESULTS AND DISCUSSION

3.1. Chemical composition of raw materials

The results of the proximate analysis (mean of three observations) on dry basis (g/100g) of corn, soy, defatted wheat germ, and mushroom flours are shown in Table (2). The obtained results indicated that the defatted soybean, defatted wheat germ and mushroom flours had the highest protein, fat, fiber and ash contents compared with corn grits. These results agreed with Olwe and Ngoddy (1998) who reported that the protein and ash contents of the soy used were found to be 50.9 and 5.7%, respectively.

These results are in the line of Nelson (1985) who mentioned that wheat germ was reported to be contained about 30% protein, 10% fat and 45% carbohydrate and it was known by its high content of minerals. Also, Jadhav and Vali (2009) mentioned that wheat germ contained 5.1% moisture, 24.8% protein, 1.65% ash, 6.55% crude fat, 1.44% crude fiber and 60.49% carbohydrate.

The obtained results were also found to be agreed with those obtained by Singh *et al*. (1995). They reported that mushroom had a great potential due to its high and good protein quality, since protein content varied between 20 to 40% on dry weight basis.

Minerals content, *i.e*, Fe, Zn and Ca were determined in corn, defatted soybean, defatted wheat germ, and mushroom flours and the obtained results are tabulated in Table (2). The obtained results indicated that the Fe and Ca contents were 11.0 and 9.10 mg/100g for Fe in defatted soybean and mushroom whereas Ca content was 220.0 and 183 mg/100g, respectively. Moreover, the Zn content showed lower values in the corn, defatted soybean, defatted wheat germ, and mushroom flours compared to Fe and Ca contents.

3.2. Chemical composition of extruded snacks

Protein, crude fiber, ash, fat and total carbohydrates were determined in the different extruded blends snacks and the results are reported in Table (3). From the obtained results, it could be noticed that the snack blends that contained 10% and 15% defatted soybean were the highest amounted in protein (13.62 and 15.33respectively) compared with other snacks and control. Also, crude fiber and ash content in the soya snack showed the same trend.

The obtained results in Table (3) also indicated that fat content of the produced snacks were increased as the level of added defatted wheat germ was increased and the percentages of increase were 2.58, 44.21 and 63.52% for substation levels 5, 10 and 15%, respectively.

Table (2): Chemical composition of raw materials g/100g.

Chemical composition	Corn grits	Defatted soybean	Defatted wheat germ	Mushroom
Protein	8.40	50.6	25.9	19.47
Fat	1.07	1.22	10.4	7.63
Fiber	0.98	8.71	4.20	6.88
Ash	1.25	5.70	3.20	4.23
Carbohydrate	88.30	33.77	56.30	61.79
Minerals content				
Fe mg/100gm	4.60	11.00	3.50	9.10
Zn mg/100gm	2.72	3.25	2.80	0.57
Ca mg/100gm	20.85	220.0	20.50	183.3

Table (3): Chemical composition of extruded snacks (g/100g).

Item	Moisture	Protein	Fat	Crude fiber	Ash	Total carbohydrates
Control corn grits	4.63	7.91	2.33	1.03	1.60	87.13
Percentage of defatted soybean						
5% of soybean	4.23	10.32	2.37	1.42	1.83	84.06
10% of soybean	4.21	13.62	2.43	1.85	2.13	79.97
15% of soybean	3.55	15.33	2.47	2.30	2.34	77.56
Percentage of defatted wheat germ						
5% of wheat germ	4.55	9.17	2.39	1.27	1.73	85.44
10% of wheat germ	4.51	10.32	3.36	1.42	1.93	82.97
15% of wheat germ	4.00	11.58	3.81	1.66	2.04	80.91
Percentage of mushroom						
5% of mushroom	4.58	8.97	2.71	1.36	1.81	85.15
10% of mushroom	4.55	9.82	3..01	1.73	1,99	83.45
15% of mushroom	4.12	10.66	3.34	1.99	2.19	81.82

Ash content and crude fibers increased for all extruded products by increasing the substitution levels. On the other hand, carbohydrates content decreased with increasing of all substitution levels. Moreover, the protein content in the snacks product were increased when the level of added defatted soybean was increased to reach 10.32, 13.62 and 15.33 g/100g for substation levels 5, 10 and 15%, respectively.

Coutinho *et al.* (2013) reported that protein content of the extrudates increased at all substitution. This verifies that it is the proportion of ingredients that influence the total protein content of the extruded.

3.3. Minerals contents of the produced snacks

Minerals content of corn grits snacks with and without replacement by defatted soybean, mushroom and defatted wheat germ at different levels were determined and the obtained results are shown in Table (4).

From the results presented in Table (4) it could be noticed that replacement corn grits by defatted soybean flour resulted in an increase in Zn, Fe and Ca contents and the percentages of increase were 5.50, 33.03 and 56.88% for Zn, 7.0, 11.25 and 20.0% for Fe and 196.05, 209.24 and 300.21% for Ca at replacement levels of 5, 10 and 15%, respectively.

The results in the same table showed that replacement corn grits by mushroom flour resultant in an increase in Zn, Fe and Ca contents and the percentages of increase were 7.33, 11.01 and 31.19% for Zn, 8.75, 18.75and 25.0% for Fe and 115.30, 125.88 and 182.65% for Ca at replacement levels of 5, 10 and 15%, respectively. Moreover, the replacement corn grits by defatted wheat germ flour resultant in an increase in Zn and Ca contents and the percentages of increase were 1.83, 12.84 and 28.44% for Zn and 19.53, 28.00 and 62.41% for Ca while, a decrease in Fe content was noticed and the percentages of decrease was 13.75, 10.0 and 5.0% at replacement levels of 5, 10 and 15%, respectively.

Table (4): Minerals composition of extruded snacks (mg/100g).

Item	Zn	Fe	Ca
Control	1.09	4.00	14.18
Percentages of soybeans			
5% of soybean	1.15	4.28	41.98
10% of soybean	1.45	4.45	43.85
15% of soybean	1.71	4.80	56.75
Percentages of mushrooms			
5% of mushroom	1.17	4.35	30.53
10% of mushroom	1.21	4.75	32.03
15% of mushroom	1.43	5.00	40.08
Percentages wheat germ			
5% of wheat germ	1.11	3.45	16.95
10% of wheat germ	1.23	3.60	18.15
15% of wheat germ	1.40	3.80	23.03

3.4. Physical properties of extruded different snack blends

Water solubility index (WSI), water absorption index (WAI) and bulk density values were determined in the extruded different snack blends made from corn grits with different levels of wheat germ, defatted soybean or mushroom flours and the obtained results are recorded in Table (5).

Table(5): Physical properties of extruded snacks.

Item	Water soluble index (WSI)%	Water absorption index (WAI)%	Bulk density g/ml
Control	**19.86**	**4.65**	**0.08**
Percentages of wheat germ			
5% of wheat germ	16.75	4.88	0.07
10% of wheat germ	14.51	5.76	0.08
15% of wheat germ	12.16	6.16	0.10
Percentages of mushrooms			
5% of mushroom	19.43	5.65	0.07
10% of mushroom	16.5	5.78	0.09
15% of mushroom	15.18	6.06	0.09
Percentages of soybeans			
5% of soybean	16.73	4.85	0.07
10% of soybean	15.38	5.13	0.08
15% of soybean	10.30	6.36	0.08

Debbouz (1992) found a high correlation between WAI and starch gelatinization. Water soluble index (WSI) expresses the percentage of dry matter recovered after the supernatant is evaporated from the water absorption determination. The results presented in Table (5) showed that WSI values were decreased with increasing of the substitution levels of corn grits by defatted wheat germ, defatted soybean and mushroom flours. Decreasing of WSI may be due to the formation of some insoluble water compounds as a result of sugar caramelization and/or Maillard reaction products (El-Samahy *et al.*, 2006).

The results in the same Table showed that WAI values increased as the levels of substitution of corn grits by wheat germ, defatted soybean or mushroom flours were increased. The water absorption index (WAI) measures the volume occupied by the starch after swelling in excess water, and indicates the integrity of starch in aqueous dispersion. Water solubility index (WSI), often used as an indicator of degradation of molecular components, measures the degree of starch conversion during extrusion which is the amount of soluble polysaccharide released from the starch component after extrusion (Yang, 2008).

Bulk density (BD) is important characteristic of extruded products and plays a role in the consumer acceptability of the product. BD is linked with the expansion ratio in explaining the degree of puffing in extruded product. It is expected that most extruded products will have a puffed structure to a certain degree Filli *et al.* (2012)

The obtained results in the same Table showed that slightly increases was observed for bulk density (BD) of snacks made from defatted wheat germ and mushroom at substituted level 15% for corn grits. Increasing of bulk density may be due to increasing of both sugars and dietary fibers by replacing the starch with the studied materials as reported by Abd El-Hady *et al.* (2002). Also, Meuser and Wiedmann (1989) reported that the density of extrudates increases as a result of liquefaction of sugar *via* melting during extrusion cooking.

3.5. Sensory evaluations

A sensory analysis is imperative for the success of a newly developed food product in the market.

From the results presented in Table (6) it could be observed that a significant differences were observed for the showiness, taste, porous distribution, texture, color, surface characteristics general appearance and overall accepted between the different produced snacks with defatted soybean level and control.

The results presented in Table (7) showed the sensory evaluation results of the different snack blends supplied with mushroom at levels of 5, 10 and 15%. These results revealed that the replacement and 15% resulted in overall acceptability values of 90.10, 85.50 and 83.20, compared to 92.60 for control. From these result, it could be concluded that the incorporating of mushroom 5% could be recommended.

Results in Table (8) showed the data of the sensory evaluation of different snack blends supplied with wheat germ at levels of 5, 10 and 15% levels. From the results in Table (8) a significant differences for the showiness, taste, porous distribution, texture, surface characteristics color and general appearance between the different snacks contained defatted wheat germ and control were observed.

From these results in Table (8), it could be noticed that the addition of wheat germ to corn grits at levels of 5, 10 and 15% resulted in

Table (6): Sensory evaluation of extruded snacks supplemented with defatted soybean flour.

Items	Showiness (20)	Taste (20)	Porous distribution (10)	Texture (20)	Color (10)	Surface characteristics 10	General appearance (10)	Overall acceptability (100)
Control	18.70 ±0.26^{b}	18.50±0.31^{b}	9.00 ±0.21^{a}	18.60 ±0.34^{b}	9.50±0.27^{a}	9.00±0.30^{b}	9.30±0.26^{b}	92.60±1.33^{b}
5% of soybean	19.05±0.26^{a}	18.90±0.29^{a}	8.80±0.20^{b}	18.90±0.28^{a}	9.20±0.25^{b}	9.40±0.22^{a}	9.55±0.22^{a}	93.80±0.93^{a}
10% of soybean	18.50±0.37^{c}	18.65±0.34^{b}	8.80±0.21^{b}	18.45±0.32^{c}	9.00±0.26^{c}	8.70±0.34^{c}	9.15±0.21^{c}	91.45±1.50^{c}
15% of soybean	18.50±0.27^{c}	18.35±0.53^{c}	8.65±0.26^{c}	17.80±0.57^{d}	8.80±0.39^{d}	7.86±0.31^{d}	8.65±0.30^{d}	89.85±1.79^{d}

✸**Each value in a column followed by the same letter are not significantly different at p<0.05**

Table (7): Sensory evaluation of extruded snacks supplemented with mushrooms.

Items	Showiness 20	Taste 20	Porous distribution 10	Texture 20	Color 10	Surface characteristics 10	General appearance 10	Overall acceptability
Control	18.70±0.26^{a}	18.50±0.31^{b}	9.00±0.21^{a}	18.60±0.34^{a}	9.50±0.27^{a}	9.00±0.30^{a}	9.30±0.26^{a}	92.60±1.33^{a}
5% of mushroom	18.70±0.47^{a}	18.80±0.25^{a}	8.40±0.40^{b}	18.50±0.54^{a}	8.50±0.45^{b}	8.30±0.30^{b}	8.70±0.37^{b}	90.10±1.87^{b}
10% of mushroom	18.00±0.49^{b}	18.00±0.50^{c}	8.20±0.42^{c}	18.00±0.51^{b}	8.00±0.52^{c}	7.80±0.49^{c}	8.30±0.50^{c}	85.50±2.37^{c}
15% of mushroom	17.80±0.74^{c}	17.80±0.55^{d}	8.00±0.42^{d}	17.70±0.54^{c}	7.40±0.50^{d}	7.45±0.40^{d}	7.70±0.42^{d}	83.20±2.54^{d}

✸**Each value in a column followed by the same letter are not significantly different at p<0.05**

Table (8): Sensory evaluation of extruded snacks supplemented with wheat germ.

Items	Showiness 20	Taste 20	Porous distribution 10	Texture 20	Color 10	Surface characteristics 10	General appearance 10	Overall acceptability
Control	19.30±0.30^{a}	19.15±0.26^{a}	9.20±0.25^{a}	19.20±0.29^{a}	9.50±0.21^{a}	9.00±0.33^{a}	9.30±0.21^{a}	92.60±1.38^{a}
5% of wheat germ	18.70±0.26^{b}	18.50±0.31^{b}	9.00±0.21^{b}	18.60±0.34^{a}	9.30±0.27^{b}	9.00±0.30^{a}	9.30±0.26^{a}	92.40±1.33^{b}
10% of wheat germ	18.85±0.37^{b}	19.10±0.32^{a}	9.20±0.29^{a}	18.45±0.35^{b}	9.10±0.23^{c}	8.40±0.37^{b}	8.65±0.41^{b}	91.65±1.51^{c}
15% of wheat germ	18.50±0.40^{c}	18.30±0.45^{c}	8.45±0.32^{c}	18.35±0.51^{c}	8.60±0.31^{d}	8.20±0.39^{c}	8.10±0.44^{c}	88.50±1.52^{d}

✸**Each value in a column followed by the same letter are not significantly different at p<0.05**

overall acceptability values of 92.40, 91.65 and 88.50 respectively compared to 92.60 for control. Due to the high temperature-short time process, extrusion technology retains considerable amounts of nutrients and eliminates anti-nutritional factors. Moreover, there was an improvement in the textural properties of the snack. This is because as the amount of soy tends to increase in the mixture, the textural properties of the snack shift to consistent hardness (Table 6). This is in agreement with Veronica *et al.* (2006) who reported that the addition of protein to starch-rich flours produced harder extruded. The breakfast cereal/snack extruded with 30% soy had greater protein content, a harder texture, and a lighter color compared to that extruded with 22% soy and 15% soya (Navam *et al.* (2014).

Conclusion

From the results of this study it could be revealed that defatted soybean, defatted wheat germ or mushroom flours can be used to replace corn grits at levels 5%, 10% and 15%, respectively to produce snacks with good quality and with high overall acceptability.

4. REFERENCES

Abu- Foul N. S. I. (1990). Physico-Chemical, Nutritional and Technological studies on Food uses of O-landed and glandless cottonseed Protein. Ph. D. Thesis, Fac. Of Agric., Alex. Univ., Egypt.

Abd El-Hady E. A., El-Samahy S. K., Mostafa G. A. and Youssef K. M. (2002). Use of date pulp and concentrate in rice-based extrudates. GetreideMehl und Brot., 56(3): 179-185.

Anderson R. N., Conway, H. F, Pfeifer, V. H. and Griffin, E. L. (1969). Gelatinization of corn grits by roll and extrusion cooking. Cereal Sci. Today, 14: 4-8.

AOAC (2010). Official Methods of Analysis of Association of Official Chemists. 18th Ed., Washington, D.C., USA.

Beswa D., Dlamini N. R., Amonsou E. O., Siwela M. and Derera J. (2016). Effects of amaranth addition on the provitamin A content, and physical and antioxidant properties of extruded provitamin biofortified maize snacks. J. Science of Food and Agriculture, 96(1), 287-294.

Brennan M. A., Derbyshire E., Tiwari B. K. and Brennan C. (2013).Integration of β-Glucan Fibre Rich Fractions from Barley and Mushrooms to Form Healthy Extruded Snacks. Plant Food Human Nutr; 68(1): 78-82.

Brennan A., Derbyshire E., Brijesh K. T. and Charles S. B. (2012). Enrichment of Extruded Snack Products with Coproducts from Chestnut Mushroom (*Agrocyb eaegerita*) Production: Interactions between Dietary Fiber, Physicochemical Characteristics, and Glycemic Load Journal of Agricultural and Food Chemistry 60:4396−4401.

Coutinho L. S., Batista J. E. R., Caliari M. and Soares M. S. J. (2013). Optimization of extrusion variables for the production of snacks from by-products of rice and soybean. Food Science and Technology, 33(4), 705-712.

Davoodi G. M., Karimi M., Sheikholeslami Z., Sahraiyan B. and Naghipour F. (2017). Evaluation of physicochemical and functional characteristics of un-extruded snacks fortified with stabilized wheat germ by saturated steam Iranian. J. Food Sci. and Technol., 14 (62): 115-122.

Debbouz A. (1992). Influence of raw material and processing on couscous quality. Ph. D. Thesis, North Dakota State Univ., Fargo, ND.

El-Samahy S., Abd El-Hady E., Habiba R. and Moussa T. (2006). Chemical and rheological characteristics of orange-yellow cactus-pear pulp from Egypt. J. Profess. Assoc. Cactus Develop., 8: 39-51.

Farzana T. and Mohajan S. (2015) Effect of incorporation of soy flour to wheat flour on nutritional and sensory quality of biscuits fortified with mushroom. Food Science and Nutrition 2015; 3(5): 363–369

FAO/WHO (1974). Energy and protein requirement. FAO nutrition meeting report series No.52 FAO, Rome.

Filli K. B., Nkama I., Jideani V. A. and Abubakar U. M. (2012). The Effect of Extrusion Conditions on the Physicochemical Properties and Sensory Characteristics of Millet-Cowpea Based Fura. European Journal of Food Research & Review 2:1-23.

Hirst E. J. and Wohl J. (2014). Nation of nibblers: snacks replace meals for rising number of folks. Chicago: Chicago Tribune. Retrieved from http://articles.chicagotribune.com/2014-02-23/site/ct-snacking-all-day-0223-biz-

20140223_1_meals-mindless-munching-oreos.

Jadhav K. and Vali S. A. (2009). Proximate composition of wheat germ based products. Journal of Dairying Foods and Home Sciences. 28 (3/4): 241-243

Jiang T., Luo Z. and Ying T. (2015). Fumigation with essential oils improves sensory quality and enhanced antioxidant ability of shiitake Mushroom (*Lentinus edodes*). Food Chemistry, 172: 692–698.

Kim M.J., Lee J. and Lee J. S. (2014). Effect of ultraviolet-B irradiation on antioxidative properties of aqueous extracts from shiitake (*Lentinus edodes*) mushrooms. International Journal of Food Science and Technology, 49(10) 2276–2282.

Li Y., Ishikawa Y., Satake T., Kitazawa H., Qiu X. and Rung-Chang S. (2014). Effects of active modified atmosphere packaging with different initial gas compositions on nutritional compounds of shiitake mushrooms (*Lentinus edodes*). Postharvest Biology and Technology, 92:107-113.

Meuser F. and Wiedmann W. (1989). Extrusion plant design. Pages 128-133. In: Extrusion Cooking. C. Mercier, P. Linko and J. M. Harper, eds. Am. Assoc. Cereal Chem.: St. Paul. MN.

Navam S. H., Tajudini A. L., Srinivas J. R., Sivarooban T. and Kristofor R. B. (2014). Physio-chemical and sensory properties of protein-fortified extruded breakfast cereal/snack formulated to combat protein malnutrition in developing countries. J Food Process Technol; 5 (8): 1-9

Nelson J. H. (1985). Wheat: its processing and utilization. Am. J. Clin. Nutr. Suppl. 41: 1070-1076.

Nwabueze T. U., Iwe M. O. and Akobundu E. N.T. (2008). Physical characteristics and acceptability of extruded African breadfruit-based snacks. Journal of Food Quality, 31(2):142-155.

Olwe M. O. and Ngodd P. O. (1998). Proximate composition and some functional properties of extrusion cooked soybean and sweet potato blends. Plant Foods for Human Nutrition, 53: 121-132

Sade F. O. and Aderonke A. O. (2013). Physicochemical properties, vitamins, antioxidant activities and amino acid composition of ginger spiced maize snack 'kokoro' enriched with soy flour (a Nigeria based snack). Agricultural Sciences, 4(5), 73-77.

SAS System for Windows (Statistical Analysis System) (2008). Version 9.2. Cary, USA: SAS Institute

Seker M. (2005). Selected properties of native or modified maize starch/soy protein mixtures extruded at varying screw speed. Journal of the Science of Food and Agriculture, 85: 1161–1165.

Singh S., Kumar C. G and Singh S. (1995). Production, processing and consumption pattern of mushrooms. Indian Food Packer 14:38–47.

Veronica A. O., Olusola O. O. and Adebowale E. A. (2006). Qualities of extruded puffed snacks from maize/soybean mixture. Journal of Food Process Engineering, 29: 149-161.

Yang S. H. (2008). Effects of adlay species and rice flour ratio on the physicochemical properties and texture characteristic of adlay-based extrudates. Journal of Food Enginering, 84 (3): 489-494.

Yiqiang G., Aidong S. and Tongyi C. (1999). The nutrition value and application deliberation of wheat germ. China Science & Technology of Food Industry 1:52–53.

انتاج وتقيم سناكس عالى القيمة الغذائية

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ملخص

تهدف هذة الدراسة إلى اعداد سناكس صحي كوجبات سريعة للحد من أمراض سوء التغذية بين الفئات العمرية المختلفة وخاصة بين الأطفال و المراهقين التي تؤدي الي عدم قدرة الإنسان علي العمل والإنتاج لتأثيرها السلبي علي النمو العقلي والجسدي . تم تحقيقا لذلك تدعيم مجروش الذره بكل من جنين القمح والمشروم ودقيق فول الصويا منزوع الدهن بنسب 5% و10% و15%, وبتقييم السناكس المنتج (حسيا كيميائيا). أظهرت نتائج التقييم الحسي أن كل العينات الناتجة مرتفعة

فى القبول الحسي . وأوضحت نتيجة التحليل الكيميائى أن كل عينات السناكس المدعمة بفول الصويا الخالى من الدهن كانت أعلى في محتواها فى نسبه البروتين و الدهن و الرماد والألياف الخام مقارنة بالعينة القياسية, كما زادت نسبه الدهن فى السناكس بزياده نسبه الاستيدال من جنين القمح فى حين انخفضت نسبه الكربوهيدرات بزياده نسبه الاستبدال فى كل العينات.

زادت نسبه المعادن فى السناكس مع زيادة نسبه كل من الصويا، وجنين القمح والمشروم مقارنة بالعينة القياسية. كما اظهرت النتائج ان اضافه الصويا بنسبه 15% أدى الى أرتفاع محتوى العينات من عناصر الزنك والكالسيوم بينما أضافة 15% مشروم كانت الأعلى فى محتوى العينات من الحديد.

يمكن من النتائج السابقة التوصية بأستخدام كلا من الصويا والذرة وجنين القمح والمشروم فى إنتاج الوجبات الخفيفة لتحسن كمية ونوعية البروتين الموجود في السناكس وكذلك الخصائص الحسية .