Middle East Journal of Applied Sciences
ISSN 2077-4613
Volume : 09 | Issue :02 April-June| 2019
Pages: 494-501

Development and evaluation of nutritional value of sesame crackers for Supplementing primary school children

Hassan H.A. Khalaf[1], Raouf M.A. Elsadany[1], Galal A.I. Ghazal[1], Mohamed F. M. Afifi[2] and Nady A.M. Fayed[2]

[1]*Department of Food Technology, Faculty of Agriculture Moshtohor, Benha University, Egypt.*
[2]*Food Technology Research Institute, Agricultural Research Center, Giza, Egypt.*

Received: 15 Dec. 2018 / Accepted 21 Jan. 2019 / Publication date: 30 May 2019

ABSTRACT

This study aimed to produce sesame crackers as food supplements for primary school children. Wheat flour (72% extraction) was substituted with sesame paste to prepare crackers at three substitution levels, i.e. 5, 10 and 15% then compared with cracker control sample (100% wheat flour). Sesame paste characterized with its higher nutrition values, where its protein, fat, and fiber reached to 24.1, 58 and 6.48%, respectively. Therefore, increasing the level of substitution sesame paste led to increase the nutritional value of crackers, whereas the ratio of protein, fat and fiber were maximized in crackers of 15% sesame. Furthermore, it was noticed that sesame crackers characterized with its higher minerals content, i.e. calcium, iron and zinc were maximized in crackers of 15% sesame paste to reach 99.512, 2.83 and 2.45 mg/100 g sample, respectively. It could be recommended to produce sesame crackers for school children, where it provide children with a part of their daily requirements of protein, dietary fiber, carbohydrate, calcium, iron and zinc.

Keywords: sesame paste, crackers, nutritional value.

Introduction

Snack foods are popular and very well exploited throughout the world. They are handy and light and usually eaten between regular meals (Lusas, 2001). Novel functional snack foods, especially bakery product, with potential health benefits are in are high demand by consumers. Numerous studies have assessed the production of bakery products like crackers (Ahmed and Abozed, 2015). The flour, used as raw materials, plays a crucial role in the bakery industry, and these are obtained from a wide of range of plants (Graham and Vance 2003).

Baked products are economical to run and have built in marketability. The texture of a cracker is usually described as being more crunchy or crispy, depending on the ingredients and recipe used. Tunick *et al.* (2013) found that consumers describe crackers as having a crisp texture.

Legumes are used in a variety of food preparations either as such or in combination with cereals, because cereal proteins are generally deficient in some essential amino acids. The use of legumes as a cheap and concentrated source of proteins, due to the high cost of proteins of animal origin and their inaccessibility by the poorer part of the population (Tharanathan and Mahadevamma, 2003).

The proximate chemical composition of sesame seeds (*Sesame indicum*) indicates that it has significant amounts of proteins that can be used to produce composite flour with improved protein content for bread production. In addition, sesame has been reported to be a good source of calcium, magnesium, iron, phosphorus, zinc, copper, manganese, selenium, molybdenum, vitamin B1 and dietary fiber. Sesame seeds also contain lignans (sesameol and sesamolin) with cholesterol lowering effect, ability to prevent high blood pressure, protect the liver from oxidative damage and increase vitamin E supplies in humans (Quasem *et al,* 2009 and Pathak *et al*, 2014).

The current study aimed to prepare and determine the nutritional value of the sesame substituted crackers as natural source of nutrients for school children.

Materials and Methods

Materials:

Wheat flour (72% ext.) was obtained from El-Mokhtar Mill (Cairo governorate, Egypt). The other stating materials used in preparation of crackers i.e., salt, sugar, butter, fresh milk, starch, sodium

Corresponding Author: Nady A.M. Fayed, Food Technology Research Institute, Agricultural Research Center, Giza, Egypt. E-mail: nady_azez@yahoo.com

bicarbonate and baker's yeast were procured from a local market. White sesame seeds (*Sesamum indicum* L.) were purchased from a local market in Giza governorate, Egypt.

Methods:

Preparation of sesame paste:

Sesame seeds were roasted at 120°C for 10 min to bring out the nutty flavor followed by cooling at room temperature. Roasted sesame seeds were then ground to get a thick paste using grinding mill.

Preparation of crackers:

For making crackers, the procedure of Han *et al.* (2010) was followed but with some modification. Table (1) shows the formula for crackers.

Butter, sugar, salt and water were mixed for 1 minute in a dough mixer using the flat beater then scraped down, and continued to mix at high speed for 3 minutes. Dry ingredients soft wheat flour (or its blends) and baking powder were added to mixture gradually and mixed at low speed for 3 minutes, and the resulted dough was let to rest for 5 min., then sheeted to 3 mm. Pieces cut of dough were formed using the templates with an outer diameter of 5 mm. The crackers were baked at 170º C for 15 min, after baking; crackers were allowed to cool at room temperature for 1 hr before evaluation.

Table 1: Formula of crackers samples

Ingredients	Formulas (per g).			
	1	2	3	4
Wheat Flour (72% extraction)	100	95	90	85
Sesame paste	-	5	10	15
Butter	10	10	10	10
Salt	3	3	3	3
Sugar	3	3	3	3
Yeast	3	3	3	3
Fresh milk	50	50	50	50
Starch	4	4	4	4
Sodium Bicarbonate	0.2	0.2	0.2	0.2

Chemical composition:

Moisture, crude protein, crude fiber, crude fat, ash contents and minerals (Fe, Ca, Zn, Mg, Na, P and K) of the prepared formula were determined according to the method described in A.O.A.C. (2016). Available carbohydrate were calculated by difference. Calorific value of the prepared formulas was calculated by using the factors as described by FAO / WHO/ UNU (1985) according to the following equation:

Total Calorific value = 4 (protein % + carbohydrate %) + 9 × Fat%

Physical characteristics of crackers:

Crackers were evaluated for weight (g), thickness (mm), diameter (mm), density (g/cm^3) and spread ratio as described by Gaines (1991). Six crackers edge-to-edge were used for the evaluation and the average was noted. Diameter and thickness were measured using a Vernier Caliper. Spread ratio was calculated from the ratio of diameter to thickness. Density was calculated from the ratio of weight to volume.

Crackers hardness:

Crackers hardness was determined using a Texture Profile Analyzer (TPA) according to AACC (2002). Crackers hardness was determined using Texture Analyzer machine (Brookfield Engineering Lab. Inc., Middleboro, MA 02346- 1031, USA). A 25-mm diameter cylindrical probe was used in a TPA at 2 mm/s speed. Hardness was calculated from TPA graphic in Newton (N).

Sensory evaluation:

Crackers samples were organoleptic evaluated for its sensory characteristics. Crackers sample was served on white, odorless and disposable plates and water was provided for rinsing between samples for ten panelists. Samples were scored for color, taste, flavor, texture, appearance and overall acceptability. Control crackers were used to compare with tested samples for sensory test. The evaluation was carried out according to the method of Wanyo *et al.* (2009).

Statistical analysis:

The analytical data were analyzed using SPSS 20.0. Means and standard deviations were determined using descriptive statistics. Comparisons between samples were determined using analysis of one-way variance (ANOVA) and multiple range tests. Statistical significance was defined at P≤ 0.05. (IBM Corp Released 2011).

Results and Discussion

The proximate chemical compositions of wheat and sesame paste were compared and presented in Table 2. The obtained results showed that sesame paste characterized with its lower moisture content (5.20%) than wheat flour (9.5%). This result could be due to moisture loss during roasting sesame, and consequently the chemical contents of whole sesame paste increased. Therefore, protein, fat, ash and crude fiber reached to 24.10, 58, 3.96 and 6.48%, respectively.

Table 2: Proximate chemical composition of raw materials.

Parameters	g/ 100g dry weight	
	Wheat Flour (72% extract)	Whole Sesame paste
Moisture	9.50±0.03 a	5.20±0.07 b
Crude protein	10.35±0.05 b	24.10±0.14 a
Crude Fat	0.99±0.01 b	58.00±0.53 a
Ash	0.50±0.01 b	3.96±0.06 a
Crude Fiber	0.47±0.01 b	6.48±0.03 a
Available carbohydrate*	87.69±0.53 a	7.46±0.09 b
Total energy (Kcal)	401.07±0.03 b	648.24 ±0.14 a
	Mineral mg/ 100g dry weight	
Ca	54 ± 1.00 b	445.02±0.58 a
Na	14.80 ± 1.50 a	3.96 b
K	133 ± 2.71 b	345.98±0.47 a
P	128 ± 1.73 b	428.46±0.64 a
Mg	149 ± 7.00 b	365.95±0.51 a
Zn	3.30 ± 0.17 a	3.62±0.04 a
Fe	2.50 ± 0.16 b	4.98±0.04 a

Values are means of three replicates ±SD. Values number in the same raw followed by the same letter are not significantly different at 0.05 level. *Available carbohydrates calculated by difference.

The obtained results indicated that the protein content of sesame paste is represent more than twice value of wheat (10.35%). This results agreed with those obtained by Namiki (2007) who reported that sesame seed contained 22.3% protein. Also, sesame paste characterized with its higher fat content (58%). Tashiro *et al.*, 1990 also reported that the average content of fat was 55.0% in white-seed strains; and this variation could be due to species and cultivation conditions. Also, the increase in fat and fiber content in roasted sesame paste is the direct result of the concentration (moisture loss) of the constituents during roasting. Dietary fiber has a number of beneficial effects related to its non-digestibility in the digestive tract (Asp, 1996). Also, fat is important in diets because it promotes fat soluble vitamin absorption and as such sesame seed can be considered as a potential source of vegetable oil for domestic and industrial purposes. The increase in fat content was in good agreement with those found in roasted peanut as stated by several authors (Damame *et al*., 1990; El-Badrawy *et al*., 2007).

On the other hand, sesame paste contains low amount of available carbohydrates (7.46 gm/100 gm) if compared to wheat carbohydrate (87.69%). Namiki (2007) showed that most carbohydrates in sesame seeds seem to be present as dietary fibers, and the content of the dietary fibers has been reported to be 10.8% (STA Japan, 2000).

Furthermore sesame seed is rich in various mineral constituents, which is often deficient in modern diets. The predominant mineral was calcium (445.02 mg/100g), followed by phosphorus (428.46 mg/100g), magnesium (365.95 mg/100g) and potassium (345.98 mg/100g). It was noticed that most of the calcium contained in the hull is lost by hulling and only about 20% of the total calcium remains (Namiki, 1995). Mohini and Eram, (2005) stated that, digestibility of nuts and oilseed could be increased by roasting, this might be responsible for the release and increment in some mineral content. The results also showed that iron content in sesame paste was 4.98 mg /100g. Similarly, the manganese content was 2.29 mg /100g. Results on sesame paste agreed with those obtained by Makinde *et al.,* (2016).

Chemical composition of crackers:

Proximate chemical composition of the crackers is given in Table 3. All the tested parameters showed that the sesame paste crackers had significantly higher nutrient content compared to control crackers.

Table 3: Chemical composition and caloric values of the tested crackers samples (dry weight basis).

Nutrients (g /100g)	F1 (Control)	Amount of sesame substitution F2 (5%)	F3 (10%)	F4 (15%)
Moisture	3.84 ± 0.03 [b]	3.475±0.13 [c]	3.11±0.51 [d]	3.89±0.35[a]
Protein	10.43 ± 0.075 [d]	10.81±0.10 [c]	11.15±0.07 [b]	11.36± 0.08[a]
Fat	9.47 ± 0.35 [d]	11.52± 0.25 [c]	13.57± 0.20 [b]	15.43± 0.32 [a]
Ash	1.42±0.03 [d]	1.55±0.025 [c]	1.68± 0.03 [b]	1.85± 0.38 [a]
Fiber	1.12±0.035 [d]	1.82± 0.095 [c]	2.54±0.08 [b]	3.21± 0.065 [a]
Available carbohydrate*	77.56 ± 1.23 [d]	74.30± 0.46c	71.06±0.30 [b]	68.15 ±0.51 [a]
Total Energy (Kcal /100g)	437.19±0.50 [d]	444.12± 0.38 [c]	450.97± 0.27 [b]	456.91± 1.03 [a]

Values are means of three replicates ±SD. Values number in the same raw followed by the same letter are not significantly different at 0.05 level. *Available carbohydrates calculated by difference.

Results in table (3) showed that moisture content in crackers of 15% sesame paste was slightly higher than other samples. These results agree with those obtained by Agrahar-Murugkar *et al*., (2018). The protein content of the sesame paste crackers was significantly higher than control sample. This variation could be related to the presence of sesame, where protein maximized in crackers of 15% sesame (11.36%) while it declined to reach 10.43% in control sample. The same trend was also noticed in fat content of tested crackers, where percentage of fat was maximized to reach 15.43% in crackers of 15% sesame while it was 9.47% in control sample. This result might be attributed to higher fat content in sesame paste (58%, Table 2).

Table 4: Mineral content of crackers samples (mg/100g on dry weight basis).

Minerals	F1 (control)	Amount of sesame substitution F2 (5%)	F3 (10%)	F4 (15%)
Fe	2.00 ±0.02 [d]	2.35± 1.03 [c]	2.61± 0.035 [b]	2.83±0.031 [a]
P	80.24 ±2.08 [d]	114.23± 1.76 [c]	147.24± 2.28 [b]	179.28±2.06 [a]
Ca	86.58 ±1.27 [d]	91.287± 1.02 [c]	95.989± 1.33 [b]	99.512±1.10 [a]
Zn	1.31 ±0.04 [d]	1.70± 0.019 [c]	2.101±.0.085 [b]	2.45±0.016 [a]
Mg	8.77 ± 0.92 [d]	23.873± 1.06 [c]	38.832± 1.03 [b]	53.63±1.87 [a]
Na	1054.46 ±0.445[c]	1056.35± 0.305[b]	1057.84± 0.08 [a]	1047.221±0.66 [d]
K	120.77 ±0.58 [d]	138.44± 1.02 [c]	156.16± 0.83 [b]	171.78±1.88 [a]

Values are means of three replicates ±SD. Values number in the same raw followed by the same letter are not significantly different at 0.05 level.

Fiber content showed a significant difference between formulas, where fiber content increased with increasing sesame paste substitution levels. These results agreed with those obtained by Agrahar-

Murugkar *et al*., (2018). As expected, the total energy increased with the increase of sesame paste level, where the higher value was noticed in crackers of 15% sesame.

The calcium content was higher in crackers of 15% sesame (99.512 mg/100 gm). This may be due to the higher content of calcium in sesame paste (table 5). The same is true for iron and zinc, the values showed significant increase with increasing the sesame levels.

The percentages of the recommended dietary allowances (% RDA) are provided from 100g of crackers for children are showed in table 5. It could be observed that supplementation of crackers with 15% sesame paste covers up to 59.80% of protein requirement, 28.40% of iron requirement, 24.69% of zinc and 12.44% of calcium, for children of age 4-8 years. Whereas, crackers cover up to 33.42% of protein requirement, 28.40% of iron requirement, 24.69% of zinc and 12.44% of calcium, for children of age 9-12 years. Therefore, it could be recommended to consume sesame crackers to provide children with part of their daily requirements of protein, dietary fiber, carbohydrate, calcium, iron and zinc.

Table 5: Nutritional Value of Crackers /100g.

	Children 4-8 years						**Children 9-12 years**					
	Energy	**Protein**	**Fiber**	**Ca**	**Fe**	**Zn**	**Energy**	**Protein**	**Fiber**	**Ca**	**Fe**	**Zn**
F1 (Control)	26.33	54.74	4.49	10.82	20.00	13.10	20.13	30.59	3.62	10.82	20.00	13.10
F2 (5%)	26.75	56.90	7.33	11.41	23.50	17.10	20.44	31.80	5.91	11.41	23.50	17.10
F4 10%)	27.16	58.69	10.17	12.00	26.10	21.02	20.76	32.80	8.19	12.00	26.10	21.02
F4 (15%)	27.26	59.80	12.85	12.44	28.40	24.69	20.54	33.42	10.36	12.44	28.40	24.69

Physical properties

Physical analysis of crackers is very important for both consumers and manufacturers. The spread of the crackers should be according to specification. Too much elasticity (gluten) in the dough will spring back to give thicker crackers with smaller diameter; while too little elasticity may cause dough to flow after molding, resulting in thin crackers with larger diameter (Mian *et al.*, 2009).

Table 6 showed that diameters, weights and spread ratio of crackers were reduced and thickness was increased with increasing level of replacement with sesame paste. These results were similar to those reported by Agrahar-Murugkar *et al*., (2018). Gernah and Anyam, (2014), where they reported a reduction in spread factor and weight of cookies by increasing the enrichment levels of flour with sesame paste. Also, Fuhr (1962) suggested that spread ratio is affected by the competition of ingredients for the available water; flour or any other ingredient which absorbs water during dough mixing, so will reduce it. Alobo, 2001 suggests that sesame proteins may have low affinity for water resulting in increase in the spread ratio of the biscuits. Also, he reported that it is possible that fat and other functional properties may also affect spread.

Table 6: Physical characteristics of prepared crackers.

Parameters	**F1 (control)**	**Amount of sesame substitution**		
		F2 (5%)	**F3 (10%)**	**F4 (15%)**
Weight	3.08±0.06^{a}	2.95± 0.01 ^{b}	2.82± 0.02^{c}	2.75±0.07^{c}
Diameter	4.60±1.85^{a}	4.33±0.65^{ab}	4.12±0.13^{bc}	3.90±1.65^{c}
Thickness	0.20±0.98^{d}	0.26±0.05^{c}	0.29±0.65^{b}	0.31±0.06^{a}
Spread Ratio (D/T)	23.00±0.65^{a}	16.7±0.13^{b}	14.21±0.07^{c}	12.60±0.98^{d}
Specific Volume (cm ^{3}/g)	1.38±0.03^{a}	1.64±0.06^{b}	1.67±0.98 ^{a}	1.85±0.07^{a}
Density (g/cm^{3})	0.73 ± 0.02^{a}	0.61 ±0.06^{b}	0.54 ±0.07^{b}	0.59±0.03^{b}
Hardness (N)	26.00±1.85^{a}	20.35 ±1.03^{b}	18.03±1.65^{c}	16.11±0.98^{d}

Values are means of three replicates ±SD. Values number in the same raw followed by the same letter are not significantly different at 0.05 level.

Table 6 showed also that, crackers of 5% sesame paste affected similarly on specific volume of the control sample. In contrast, crackers containing 15% sesame paste had a significantly higher specific volume compared to control sample. The reduction of specific volume in the crackers containing 15% sesame paste may be a result of the increase in fiber levels. Inclusion of highly fibrous ingredients can have detrimental effects on the volume of baked products such as crackers. This can occur because of the dilution of gluten and, thus, a reduction in the extensibility of the dough. Large fibrous particles such as bran can also have a shearing effect on the gluten structure formed, resulting in a weaker gluten network and a reduced product volume after baking (Li *et al.,* 2013). The control crackers had a higher density compared with other samples. Crackers containing sesame paste had similar density, but lower than control.

Crackers hardness is defined as the maximum force required to break or fracture the product. Table (6) showed that the addition of different levels of sesame paste reduced crackers hardness compared to control cracker. Also, Crackers containing sesame paste had a higher total fiber content compared to control cracker. O'Shea *et al.* (2017) found that, as the level of sesame paste increased, the biscuit hardness or breaking strength decreased. Li *et al.,* (2014) attributed this finding to the cracker structure, which was uneven and had an internal structure with a reduced level of puffing, giving a more fragile cracker compared to control crackers.

Sensory evaluation of the prepared crackers:

The preference of the products, in terms of the sensory parameters used in assessing the product. Sensory evaluation is a unique discipline that makes use of experimental design and statistical analysis concepts to human senses, with the aim of evaluating consumer products. The mean scores of sensory attributes of the crackers are given in Table 7.

Table 7: Sensory evaluation of the crackers samples.

Parameters	F1(control)	Amount of sesame substitution		
		F2 (5%)	F3 (10%)	F4 (15%)
Color	$7.70 \pm .029^{d}$	8.12 ± 0.47^{c}	8.72 ± 0.32^{b}	8.95 ± 0.28^{a}
Taste	9.12 ± 0.39^{a}	9.10 ± 0.31^{a}	9.15 ± 0.41^{a}	8.00 ± 0.33^{b}
Flavor	9.00 ± 0.33^{a}	8.82 ± 0.53^{a}	8.81 ± 0.42^{a}	8.80 ± 0.35^{a}
Texture	8.92 ± 0.39^{a}	8.77 ± 0.35^{a}	8.70 ± 0.48^{a}	8.27 ± 0.56^{b}
Appearance	9.25 ± 0.48^{a}	9.10 ± 0.32^{a}	8.98 ± 0.79^{ab}	8.70 ± 0.48^{b}
Overall acceptability	43.99 ± 0.98^{a}	43.94 ± 0.89^{a}	44.16 ± 0.25^{a}	42.72 ± 0.56^{b}

Values are means of three replicates ±SD. Values number in the same raw followed by the same letter are not significantly different at 0.05 level.

Scores for color increased significantly with increase in sesame substitution, where scores was 7.90 in control sample then increased gradually to reach 8.95 in cracker of 15% sesame paste. Color changes might be due to caramelization, dextrinization of starch or Millard reactions involving the interaction of reducing sugars with proteins (Omran and Hussien, 2015). The change in color could therefore, have resulted from the decreasing level of carbohydrate (sugar) with the addition of sesame thereby reducing the level of caramelization, which brings about the brown color. Scores for taste showed no significant difference between 100% wheat and sesame paste crackers up to 10% sesame paste. Gernah and and Anyam, (2014) said that taste is a sensation perceived by the tongue and is influenced by texture, flavor and the composition of the food. Scores for flavor showed no significant difference. Texture is extremely important to the consumer. Texture is used by the consumer as an indicator of food quality (Mian *et al.*, 2009). Texture scores showed no significant difference between control treatment and sesame paste crackers up to 10% substitution but a decrease in values was seen with 15% substitution levels. The decline in texture scores could be due to the decrease in gluten content with increased sesame paste there by reducing the crispiness of the crackers. The overall acceptability scores showed no significant difference between control treatment and sesame paste crackers up to 10% substitution but a decrease in values was seen with 15% substitution levels. Flavor, taste and color were found to be the determining factors for acceptability of the crackers. Crackers of 10% sesame paste were significantly more acceptable than all the others including control treatment. This cloud be due to the enhanced flavor (nutty aroma) imparted by the sesame paste (Gernah and and Anyam, 2014).

Conclusion

This study has shown that substitution of wheat flour with sesame paste, up to 15%, can give crackers with enhanced nutritional value in terms of protein, fat, fiber and minerals content, and could be even more acceptable than 100% wheat flour crackers.

References

AACC, 2002. Approved Method of American Association of Cereal chemists. Approved Methods the AACC published by the American Association of Cereal Chemists. 13th edition.Inc. St. Paul, Minnesota, USA.

Agrahar-Murugkar, D., S. Dwivedi, P. Dixit-Bajpai, and M. Kumar, 2018. Effect of natural fortification with calcium and protein rich ingredients on texture, nutritional quality and sensory acceptance of cookies. Nutrition & Food Science.

Ahmed, Z.S. and S.S. Abozed, 2015. Functional and antioxidant properties of novel snack crackers incorporated with Hibiscus sabdariffa by-product. J. Adv. Res. 6:79.

Alobo A., 2001. Effect of sesame flour on millet biscuit characteristics. Plant Foods for Human Nutrition 56(2):195-202 ·

A.O.A.C., 2016. Official Methods of Analysis of the Association of Official Analytical Chemists, 20thed, Arligton, Virginia, USA.

Asp, N.G., 1996. Dietary carbohydrate, classification by chemistry and physiology. Food Chemistry 1: 9-14.

Damame, S.V., J.K. Chavan and S.S. Kadam, 1990. Effects of roasting and storage on proteins and oil in peanut kernels. Plant Foods for Human Nutrition 40: 143–148.

El-Badrawy, E.E.Y., A.R.M. El-Zainy, A.O. Shalaby and N.Y. El-Sayed, 2007. Effect of microwave roasting on chemical composition of peanut seeds and comparing it with the ordinary roasting process. Proceeding of Annual Conference Credit and Accreditation, Faculty of Specific Education, Mansoura University, Egypt, 938-957.

FAO/WHO, 1985. Food and Agriculture Organization / World Health Organization. Energy and protein requirrments, Reporr of a Joint FAO /WHO /UNU Expert Consultation Technival Report, Series No. 724, Geneva.

Fuhr, F.R., 1962. Cookie spread. Its effects on production and quality. Bakers Digest 36(4): 56–60.

Gaines, C.S., 1991. Instrumental measurement of the hardness of cookies and crackers. Cereal Foods World, 36: 989–996.

Gernah, D. I. and K. Anyam, 2014. Production and quality assessment of protein–rich crakersfrom blends of wheat and defatted sesame flours. International Journal of Food Processing Technology, 1, 27-31.

Graham P. H. and C.P.Vance, 2003. Legumes: Importance and Constraints to Greater Use. Plant Physiol. 131:872.

Han, J., J.A. Janz, and M. Gerlat, 2010. Development of gluten-free cracker snacks using pulse flours and fractions. Food Res. Inter., 43, 627–633.

IBM Corp. Released, 2011. IBM SPSS Statistics for Windows, Version 20.0. Armonk, NY: IBM Corp.

Julianti, E., H. Rusmarilin, Ridwansyah and E. Yusraini, 2017. Functional and rehological properties of composite flour from sweet potato, maize, soybean and xanthan bum. J. Saudi Soc. Agric. Sci. 16: 171.

Li, J., G.G. Hou and Z. Chen, 2013.Whole grain saltine crackers: Formulation, processing, and quality improvements. Cereal Foods World 58:180-185.

Li, J., G.G. Hou, Z. Chen, A.L. Chung and K. Gehring, 2014. Studying the effects of whole-wheat flour on the rheological properties and the quality attributes of whole-wheat saltine cracker using SRC, alveograph, rheometer, and NMR technique. LWT–Food. Sci. Technol. 55:43-50.

Lusas, E. W., 2001. Overview.In E.W. Lusas& L.W. Rooney (Eds.), Snack Foods Processing. Boca Raton: CRC Press LLC.

Makinde, F.M., A.O. Adetutu and G.O. Olorunyomi, 2016. Influence of Roasting Techniques on Chemical Composition and Physico-chemical Properties of Sesame (*Sesamum indicum*) Seed Flour and Oil. Applied Tropical Agriculture Volume 21, No.2 (Special Issue), 25-31.

Mian, K.S., S.B. Masood, M.A. Faqir and N. Haq, 2009. Preparation of fiber and mineral enriched defatted rice bran supplemented biscuits. Pakis. J. Nutri, 8 (5): 571–577.

Mohini, S. and S.R. Eram, 2005. Food Science-experiments and applications. CBS Publishers, 161:22-27.

Namiki, M., 1995.The chemistry and physiological functions of sesame. Food Rev. Int., 11:281–329.

Namiki, M., 2007. Nutraceutical functions of sesame: a review. Critical reviews in food science and nutrition, 47(7): 651-673.

Omran, A.A and H.A. Hussien, 2015. Production and Evaluation of Gluten-Free Cookies from Broken Rice and Sweet Potato. Advances in Food Sciences. 37(4):184-191.

O'Shea, N., K.N. Kilcawley, and E. Gallagher, 2017. Aromatic Composition and Physicochemical Characteristics of Crackers Containing Barley Fractions. Cereal Chemistry, 94(3):611-618.

Pathak, N., A.K. Rai, R. Kumari and K.V. Bhat, 2014.Value addition in sesame: A perspective on bioactive components for enhancing utility and profitability. Pharmacognosy Reviews. 8(13):147-155: doi: 10.4103/0973-7847.134249.

Quasem J.M., A.S. Mazahreh, and K. Abu-Alruz, 2009. Development of vegetable based milk from decorticated sesame *(Sesamum Indicum)*. American Journal of Applied Sciences. 6(5): 888-896: DOI : 10.3844/ajassp.

STA Japan, 2000. Science and Technology Agency of Japan. Standard Table of Food Composition in Japan, 5th ed.

Tashiro, T., Y. Fukuda, T. Osawa and M. Namiki, 1990. Oil and minor components of sesame (*Sesamum indicum* L.) strains. J. Am. Oil Chem. Soc., 67:506–511.

Tharanathan, R.N. and S. Mahadevamma, 2003.Trends Food Sci Technol., 14: 507-518.

Tunick, M. H., C.I. Onwulata, A.E. Thomas, J.G. Phillips, S. Mukhopadhyay, S. Sheen C. K. Liu, N. Latona, M.R. Pimentel and P.H. Cooke, 2013. Critical evaluation of crispy and crunchy textures: A review. Int. J. Food Prop. 16:949-963.

Wanyo, P., C. Chomnawang, and S. Siriamornpun, 2009. Substitution of wheat flour with rice flour and rice bran in flake products: effects on chemical, physical and antioxidant properties. World Applied Sci. J., 7(1): 49-56.