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PHYSICOCHEMICAL AND SENSORIAL EVALUATION OF OKARA CRACKERS

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ABSTRACT

Various types of natural fiber-rich ingredients are added into bakery-based products to improve their fiber content for health promotional purposes. However, most of these products are frequently added with imported dietary fiber ingredients. The aim of this study was to develop bakery products incorporated with okara and to evaluate the effects on physicochemical properties and sensory acceptability. Dried okara was used to substitute wheat flour in crackers at different levels (0, 25, 50 and 75%). The effect of okara incorporation on proximate compositions, physical characteristics, texture profile and sensory evaluation of crackers were investigated. The present results showed that okara had significantly increased protein and fiber contents of crackers. Hardness decreased in line with the level of okara addition. Interestingly, crackers containing 25% okara received better score than other formulations for most of the sensorial attributes judged. In conclusion, okara can be potentially be used as an alternative functional ingredient for partial replacement of wheat flour in formulating cracker biscuits because of its ability to improve the nutritional quality without jeopardizing sensorial palatability.

Keywords: crackers – okara - nutritional composition- sensory evaluation.

INTRODUCTION

Agro industries are focused in the transformation and processing of raw materials from agricultural source (plant or animal) and contribute to the generation of large amounts of organic residues. These are solid or liquid materials, which are not used in the production chain, and constitute a serious problem because, apparently without valuable application, they are discarded directly into the environment and, if not properly treated, can cause pollution in soil, surface water and groundwater **(Tavares *et al*., 2016).**

Okara is a by-product generated during tofu or soymilk production processes. It contains about 50% dietary fiber, 25% protein, 10% lipid, and other nutrients. Due to its high fiber content and low production costs, okara is a good raw material and rich source for preparing fiber and could also be used as a dietary supplement to prevent diabetes, obesity, and hyperlipidemia **(Li *et al*.,2012).**

Large quantities of okara produced annually pose a significant disposal problem but it is a suitable dietary additive in biscuits and snacks because it reduces calorie intake and increases dietary fiber. The high-quality protein fraction has good water holding and emulsifying qualities and contains a peptide with anti-hypertension effects **(Toole, 1999).**

Okara contains mainly insoluble fiber and complex carbohydrates that provides a low glycemic index; its proteins are of high quality, having the ability to reduce triglycerides and cholesterol. Also, it contains polyunsaturated fatty acids and isoflavones. An important characteristic is that okara flour does not contain gluten, so it is suitable for celiac **(Ostermann-Porcel *et al*.,2017).**

The aim of this study was to develop bakery products incorporated with okara and to evaluate the effects on physiochemical properties and sensory acceptability.

MATERIALS AND METHODS

1. MATERIALS

Soybean residue (okara)

Okara, a byproduct obtained during the processing of soybeans for the production of soy milk, was obtained from Soybean Factory, Food Technology Research Institute, Agriculture Research Center,

Ministry of Agriculture, Giza, Egypt. Okara was dried in an oven at 50 ±1ºC for 24 h and powdered using lab grinder. Then stored at -4°C. The other ingredients that composed the formulations of crackers (wheat flour, fat, salt, sugar and baking powder) were purchased in local shops of Giza, Egypt.

2. METHODS

Chemical composition of the dried okara

Chemical composition of dried okara such as moisture, ash, crude protein, crude fiber, total lipid and total carbohydrate (by difference) were determined according to the methods of **A.O.A.C. (2005).**

Preparation of okara crackers

The procedure for preparation of okara cracker was carried out according to **Bose and Shams- ud Din (2010).** The wheat flour, okara flour and other ingredients were mixed. Water was added to form a dough. The dough was rolled to a thickness of 3mm. The crackers were cut with a round cutter of 5.5 cm diameter and baked at 200 °C for 10-15 min. then they were cooled at ambient temperature and packed in high density polyethylene bags. The basic formulations of cracker biscuits was 100 g flour, 6 g fat, 2g salt, 4 g sugar, 2 g baking powder and 30 g water . Four formulations were developed: one with wheat flour (without okara) as control (C) and three others with different proportions of okara: 25% , 50% and 75% in place of wheat flour.

Chemical composition of okara crackers

Chemical composition of okara crackers such as moisture, ash, crude protein, crude fiber, total lipid and total carbohydrate (by difference) were determined according to the methods of **A.O.A.C. (2005).**

Physical properties of crackers

The color of the okara crackers was measured using the HunterLab ColorFlex Colorimeter. A chronometer was calibrated with the standard black and white color. The results reported are averages of three measurements in each sample using L*, a*, and b* values. L* value is the lightness variable from 100 for perfect white to zero for black, while a* and b* values are the chromaticity\ values,

+redness/−greenness and +yellowness/−blueness, respectively **(Ostermann -Porcel *et al.*,2017).**

The hardness of the biscuits was determined with the TA-XT2i Texture Analyzer and the data was expressed in Newtons (N). Water activity was determined using an Aqualab apparatus (Aqualab CX-2) at 30 °C. To determine the rupture force of the developed okara crackers.

Sensory Evaluation

The sensory analyses of okara crackers were carried out 2 h after baking in a uniformly illuminated room by 30 untrained 25–50-year-old panel members. The samples were coded digit numbers and were presented in a randomized order. The attributes were estimated on a ten-point scale (from 10 = I like very much to 1 = I dislike very much) . The sensory attributes evaluated were odor, taste, color and crispy. Water was provided between samples to cleanse the palate. Then, a statistical analysis was performed.

Statistical analysis

Data were subjected to the convenient statistical analysis methods. Where, mean and standard error was calculated. Data were analyzed using two way-classifications ANOVA followed by Duncans multiple comparison tests to find the statistical significant difference between treated groups. Mean separation was done according to the Least Significant Differences (L.S.D 5%) Duncans multiple range tests according to **Waller and Duncan (1969).**

RESULTS AND DISCUSSION

Proximate composition of okara

Data in **Table (1)** shows the proximate analysis of okara. The moisture content was found to be 4.37%. This result is nearly similar to those of **Grizotto *et al*. (2010)** who found 6.51% moisture in okara. The protein content was found to be 33.64%. This result is slightly lower than that of **Elreffaei *et al*. (2014)** who found 40.0% protein in okara and was nearly similar to that found by **Pr´estamo *et al*. (2007)** who found 33.4% protein in okara.

Okara contained ash (4.67%), fat (21.08%), crude fiber (18.58%) and carbohydrate (22.03%). Total dietary fiber of okara was 45.03%.

Grizotto *et al.*, (2010) reported that okara contained 35% protein, 17% lipid and 17 to 21 % fiber which was comparable to our results.

Table 1. Proximate analysis of okara (%dry weight)

Chemical composition %	okara
Moisture	4.37±0.31
Ash	4.67±0.09
Protein	33.64±0.38
Total lipid	21.08±0.23
Crude fiber	18.58±0.08
Total dietary fiber	45.03±0.19
Total carbohydrate	22.03±0.72

Proximate composition of okara crackers

Data on the chemical composition of crackers are presented in **Table (2).** As expected, the protein and fiber content increased paralleled to the level of substitution of okara flour.

Table(2) : Proximate composition of crackers (%)

Samples	Moisture	Ash	Protein	Fat	Crude fiber
Control	5.78^{c}±0.09	1.72^{d}±0.05	9.19^{d}±0.02	3.77^{d}±0.19	0.31±0.02
25%okara	6.52^{b}±0.12	2.58^{c}±0.03	14.92^{c}±0.01	6.88^{c}±0.15	2.66±0.05
50% okara	7.13^{a}±0.01	3.12^{b}±0.09	18.99^{b}±0.27	13.93^{b}±0.17	4.34±0.03
75% okara	7.19^{a}±0.01	3.99^{a}±0.35	23.79^{a}±0.01	15.68^{a}±0.09	6.68±0.07
LSD	0.14	0.34	0.25	0.29	0.08

The replacement with okara flour caused a decrease in carbohydrates and an increase in fat and ash content. The moisture content was insignificantly affected by the partial replacement of

wheat flour with okara. Similar results were reported with **Ostermann-Porcel *et al*.(2017).**

Physical properties of crackers

Table (3) displayed the physical properties of crackers prepared with different okara concentration. Hardness was measured by peak force to break the crackers. The fracture force of crackers was significantly affected by the increase in okara content.

Table (3) showed also that when the color surface of crackers was evaluated across the space CIELAB, darkening was verified due to the incorporation of okara. However, when comparing L* values, statistically significant differences were found between samples: control in comparison with 25% okara , 50% okara and 75% okara. When comparing a* and b*, an increase in the values with the replacement of okara was observed. This result indicates a browning of the crust with the incorporation of okara, demonstrating a marked reddish-dun color and an increased yellowness. According to **Chevallier *et al*.(2000)** protein content was negatively correlated with lightness of crackers, indicating that the Maillard reaction played a major role in color formation. The surface color of a baked product is, together with texture and taste, a very important element for the initial acceptability of baked goods by consumers. The increase in color values may be attributed to interaction of protein and sugar at baking temperatures resulting in a higher degree of Maillard reaction.

The results showed that the force required for breaking cookies decreased as the content of okara flour increased, as a result of the presence of fibers and proteins which compact the structure of the dough.**Tavares *et al*.(2016)** observed that the increase in water activity and in the moisture interfered on the product texture, causing softening by incorporation of water in their chemical structures. The incorporation of okara probably increased the content of fibers in the crackers, which can directly influence the texture of the product, thereby determining higher rupture levels.

Table(3) : Physical properties of crackers

Samples	Color*				
	L	a	b	Hardness (N)	Wa**
Control	78.24^{a}±0.66	1.57^{d}±0.17	30.57^{b}±0.28	46.87^{a}±4.94	0.17^{d}±0.01
25%okara	66.82^{bc}±2.63	5.75^{a}±0.54	31.03^{b}±1.21	35.76^{b}±4.95	0.22^{c}±0.01
50% okara	67.83^{b}±1.43	4.83^{b}±0.61	35.07^{a}±0.24	29.63^{b}±2.88	0.27^{b}±0.01
75% okara	64.40^{c}±0.53	3.55^{c}±0.26	33.89^{a}±0.80	19.61^{c}±3.55	0.39^{a}±0.01
LSD	2.93	0.82	1.41	**7.86**	**0.01**

*Color: L means lightness; a means redness; b means yellowness.

**Wa: water activity.

Sensory evaluation of crackers

Table (4) represented the sensory properties (odor, taste, color and crispy) of crackers with different concentrations of okara. According to the total sensory scores, the samples exhibited great acceptable sensory characteristics. Control sample was observed to have higher level of acceptance. Nevertheless, the panelist preferred the crackers with 25% and 50% okara . The addition of higher content of okara (75%) in the formulation had negative effects on the color, aroma, taste, and overall acceptability as compared to the regarding samples.

Table(4) :Sensory evaluation of crackers

sample	odor	taste	color	crispy	general
control	$9.7^{a}\pm 0.58$	$9.7^{a}\pm 0.58$	$9.6^{a}\pm 0.58$	$9.7^{a}\pm 0.58$	$9.7^{a}\pm 0.58$
25%	$8.7^{a}\pm 0.57$	$8.3^{b}\pm 0.58$	$9^{ab}\pm 0.92$	$9.3^{a}\pm 1.15$	$9.7^{a}\pm 0.58$
50%	$8.7^{a}\pm 0.58$	$8^{b}\pm 0$	$8.7^{ab}\pm 0.58$	$8.3^{ab}\pm 0.58$	$8.7^{a}\pm 0.58$
75%	$7^{b}\pm 1.0$	$6.3^{c}\pm 0.58$	$7.7^{b}\pm 0.58$	$6.7^{b}\pm 1.15$	$7^{b}\pm 1$
LSD	1.33	0.94	1.33	1.72	1.33

Conclusion

Even though okara is a byproduct, it contains many beneficial components from soybean. In this study, it was determined that okara can be used to obtain crackers with acceptable physical and sensory qualities similar to those made with whaet flour. The resulting biscuit would be expected to have better protein quality because of the protein quality of the okara flour. The economic implication of this is that biscuit of good quality could be produced at a reduced cost.

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التقيم الفيزيائي الكيميائى والحسي لمقرمشات الاوكارا

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تم دراسة التركيب الكيميائى للاوكارا الخام وكذلك التركيب الكيميائى لمقرمشات الاوكارا حيث تم عمل ثلاث نسب من الاستبدالات لدقيق القمح مع الاوكارا 25% و50% و75% . وقد لوحظ انه بزيادة نسبة الاوكارا تزيد نسبة البروتين والالياف في المقرمشات وتقل نسبة الكربوهيدرات . وتم دراسة الصفات الفيزيائية للمقرمشات حيث وجد انه تقل الصلابة بزيادة نسبة الاوكارا وعلى العكس يزيد النشاط المائي ولكن بنسب بسيطة بزيادة

نسبة الاوكارا. لكن بالنسبة للون المقرمشات فنجد انه بزيادة نسبة الاوكارا يتجه اللون للاغمق . وقد اظهر التقيم الحسي ان المقرمشات التى تحتوي على نسبة 25% و 50% اوكارا مقبولة وقريبة من الكونترول لكن مقرمشات 75% اوكارا كانت غير مقبولة حسيا.

الكلمات الداله:اوكارا – مقرمشات – تحليل كيميائي – الصفات الفيزيائية – التقيم الحسي.