Using Okara powder as a Fiber Source in Beef Burger

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ABSTRACT:

Okara is the primary by-product of the soymilk industry, okara contains essential ingredients like soy protein and fiber, so the aim of this research was replacing of beef meat with okara powder with levels of 2.5, 5, and 10% and study the effect of the incorporation of okara powder on the physiochemical and sensory properties of a beef burger. The results showed that okara powder contains high crude fiber content of 53.97% (dry basis), also the results revealed that the calorie content (kcal/100g) of okara powder (227.77) is lower than that of meat (445.91). The results showed that protein content significantly decreased as the replacement level of meat with okara powder increased. The fat content showed a similar trend, with 44.53% for the control sample prepared without okara powder and 37.41% for the burger sample made by replacing okara powder for 10% of the beef meat. But when more beef meat was replaced with okara powder, the crude fiber content increased. In comparison to the control sample's lowest result of 5.82%, the sample of beef burgers produced by replacing okara powder for 10% of the beef meat had the highest crude fiber content, coming in at 14.64 %. The results also, showed that the replacement of beef meat with okara powder significantly decreased the energy content of burger samples The replacement of beef meat with okara powder in producing beef burgers didn't significantly affect its sensory properties but enhanced the juiciness scores for the burger.

Keywords: okara; Beef burger; Antioxidant; Dietary Fiber.

INTRODUCTION

Okara, which is typically regarded as a waste product, is a white-yellow fibrous residue made up of the insoluble fraction of soybean seeds that are left over after the extraction of the aqueous fraction during the making of tofu and soymilk (Swallah *et al.*, 2021). Okara is a component of the traditional foods of China, Japan, and Korea, and it has also been incorporated into vegetarian dishes from Western countries. The increased production of okara is a result of the increased use of soybeans (Ahn *et al*., 2010). Okara drying receives a lot of attention because of its huge production and high moisture content which make it perishable (Cuadros *et al.*, 2011). The drying process has a major impact on the functional and nutritional properties of okara.

Okara has 25% protein, 10% fat, and 50% dietary fiber, besides other nutrients (Li *et al*., 2012). According to Turhan *et al*. (2007), Okara is a rich source of phytochemicals such as isoflavone, lignan and phytosterol coumestans, saponins, and phytates (Li *et al.*, 2012; Jankowiak *et al.* 2014; and Zhong & Zhao 2015). According to Grizotto *et al.* (2012) and Stanojevic *et al.* (2013), the protein fraction is of excellent quality, has strong water-holding and emulsifying properties, and has health-improving effects (Jimenez-Encrig *et al.*, 2008). Okara contains about one-third of the isoflavones found in the soybean, showing that it is a good, cheap source of nutrients (Bowles and Demiate, 2006; Jakson *et al.,* 2001). In spite of okara's high nutritional content and outstanding functional qualities (foaming, emulsification, and binding), the ability to be employed in food items, and containing phytosterols and lignans, which are soy-derived substances (Pinto and Castro 2008), Okara is still being used as a source of fat in meat products, which is still in the experimental stage (Turhan *et al*., 2007). Compared to the control (high-fat product), meat product reformulation using fat replacement can increase water holding capacity; nevertheless, they had different effects on texture (Brewer *et al.* 1992). The primary determinant of whether beef products will be generally accepted is their texture (Saricoban *et al.*, 2008). The purpose of this research was to study how adding okara powder affected the nutritional, textural, and sensory qualities of beef burgers as well as to improve fiber content.

MATERIALS AND METHODS:

Materials:

Fresh okara was obtained from Food Technology Institute, Agriculture Research Center, and Soy Bean Center, Giza, Egypt.

Frozen beef meat and fat were imported from the local market, in Shebin El Kom city, Menofia, Egypt.

Polyethylene bags, salt, spice mixture (black pepper - red pepper - white pepper), dried onion, and dried garlic were purchased from the local market, Shebin El Kom city, Menofia, Egypt.

Chemicals used in this study were purchased from El-Gomhoria Company for Chemicals and Drugs, Tanta city, Egypt.

Methods:

Preparation of Okara Flour:

The fresh pulpy okara was dried in an air oven dryer at 50-60 °C until constant weight for 16 hrs. The dried okara was finely ground into flour and sieved to pass through a 40 mesh sieve, and stored in polyethylene bags for further use.

Preparation of Beef burger:

Beef burgers were prepared according to the method of Aleson-Carbonell *et al.*, (2005). By using the formulas shown in Table (1) as follows: The frozen meat was thawed overnight at 4ºC prior to use. The thawed meat was trimmed of visible fat, cut into small pieces, and ground by a meat grinder equipped with a 6 mm plate (Moulinex, ME 205, made in France), then water, salt, dried onion, dried garlic, and spices were added and mixed with the ground meat for 3 min. The burger treatments containing okara powder were formulated to contain 2.5, 5, and 10 % okara powder which was added to the burger mixture and mixed for an additional 5 min to obtain a homogenate mixture. The final mixtures were shaped using a commercial burger machine (Italmans type: made in Italy) 9cm internal diameter to obtain patties of approximately 70gm and 1cm thickness of plastic, polyethylene film was used to help burger shaping prior to freezing at -18ºC in a deep freezer for 15 min, the burger packed in polyethylene package and stored at -18ºC until analysis.

Cooking of burger samples:

Burger samples were cooked according to the method of (Ou and Mittal, 2006) by using an electric grill (SBG-7110, Sinbo, Turkey) at 180 ° C) for 5 minutes per side until the internal temperature reached 73-75 ° C.

Chemical analysis:

Proximate composition and Caloric value:

Moisture, protein, fat, crude fiber, and ash contents (g/100 g) of raw samples were determined according to the methods of AOAC (2005). Total carbohydrates were calculated by the difference. All determinations were performed in triplicate. Total energy was calculated according to the Mercosur Technical Regulation on Nutrition labeling of packaged foods (Del Sur, 2003).

The determination of minerals content of iron, sodium, calcium, potassium, phosphorus, magnesium, and copper was analyzed according to AOAC (2005).

α–tocopherol and water-soluble vitamins were also determined as described in the method by AOAC (2005).

Determination of Cholesterol and PH:

Cholesterol content was determined according to the enzymatic method described by Saldanha *et al*. (2004).

The pH values were determined according to Turhan *et al.* (2005).

Determination of Total phenols, Flavonoids, and DPPH:

Total Phenol content was determined by the Folin–Ciocalteu micro-method according to (Wu *et al.*, 2007).

Flavonoid content was determined by the modified method of Baba and Malik (2015).

The DPPH assay proceeded according to the method described by Park et al. (2017). The scavenging activity was calculated by using the following equation:

DPPH radical-scavenging activity (%) = [(Ab control – Ab sample) / Ab control] × 100 where Ab is the absorbance at 515 nm, absorbance was measured by using a spectrophotometer (properties).

Sensory evaluation

Sensory evaluation of freshly cooked burger samples was carried out according to the procedure of Larmond (1973). Panelists were asked to score the color, odor, Texture, Taste, Appearance, and overall acceptability properties according to a 10-point hedonic scale.

Statistical analyses.

The obtained data were subjected to ANOVA analysis using SPSS (2001) program. The significant difference between means was calculated at level P<0.05.

RESULTS AND DISCUSSION

Physicochemical properties and caloric value of raw material:

The proximate chemical composition of a food exhibits the different components contained in it which reveals its nutritional quality and to any extent provides the human with the necessary nutrients (Elmadfa and Meyer, 2010). Table 2. Showed the approximate chemical composition of meat and okara powder. The results showed that okara powder contains 10.5 % moisture, 29.61 % protein, 11.37 % crude fat, and 53.97% total crude fiber contents (dry basis), which agreed with the results of Li *et al*. (2012) and Azanza and Gascon (2015). On the other hand, the results revealed that beef meat had 68.5% moisture, 70.48% protein, 9.87% crude fat, 0.70% ash, and 18.79% carbohydrates, which on line with the results of Williams *et al*. (2007a).

The data in Table 2, also showed that the pH value of okara was 6.80 while the pH value of frozen meat was 5.50, The pH values of this study agreed with the values of pH obtained by Dabasso *et al.* (2018) who indicated that the pH value was 5.71 in the thigh of beef while Ray *et al*.(1984) found that the pH value was 5.6.

Regarding, the Cholesterol content of frozen meat data showed that it was 48.1 (mg/100 g) which agrees with Williams *et al.* (2007a).

The results also revealed that the calorie content of okara powder was 227.77%, whereas it recorded 445.91% for meat. These findings concur with Williams *et al.* (2007b).

Total phenolic content and antioxidant properties of okara:

TPC and antioxidant properties of okara are shown in Table 3. The results indicated that TPC content was 19.24 (GAE mg/100g) (dry weight basis), flavonoids were 12.55 (CE mg/100g) (total flavonoids were 12.55 CE mg/100g), and DDPH was 5.2%. On the other hand, frozen beef exhibited a total phenolic level of 0.9 GAE mg/100g, 2.2% DDPH, and 0.20 CE mg/100g for flavonoids.

Total volatile nitrogen and trimethylamine (mg/100g) of okara powder and beef meat.

The changes in TVN could be taken as a relatively good index of the changes in protein solubility (El-Gharbawi, *et al.,* 1996). Results given in Table 4 showed that the total volatile nitrogen (TVN) of okara was 2.7mg/100g, while frozen beef had 5.2 mg/100g. The reported total volatile nitrogen concentrations of samples remained within the acceptable level of 20 mg /100 gm) which were recommended by The Egyptian Standard Legalization (EOS, 2005).

The results also showed that trimethylamine contents of okara and frozen meat were 2.5 mg/100g and 6.7 mg/100g, respectively.

Proximate Analysis of burger.

The proximate composition of raw beef burgers formulated with replacing beef meat with different levels of dry okara is given in Table 5. Data indicated that the moisture content of beef burger is decreased significantly as the replacing level of beef meat with okara powder is increased. The moisture content of burger samples ranged from 61.81% to 52.74% where the Control showed the highest moisture content whereas burger sample formulated by replacing beef meat with 10% okara powder showed the lowest moisture content which agreed with the result reported by Noriham *et al.* (2016) in beef sausage**.**

The results showed that protein content is significantly decreased as the replacing level of meat with okara powder is increased, since the control protein content was the highest (38.55%) whereas the burger sample formulated with replacing 10 % of beef meat with okara recorded the lowest protein content (31.97%).

Regarding fat content of burger samples, the results showed that fat content of beef burger was decreased significantly as the replacing level of beef meat with okara powder was increased. Since it recorded 44.53 % for control sample formulated without okara powder compared to 37.41 % for burger sample formulated with replacing 10 % of beef meat with okara powder which is explained with the low-fat content of okara powder as compared to beef meat. These results were similar to that reported by Turhan *et al*. (2009).

Regarding the ash content in beef burger samples formulated with replacing beef meat with okara powder,data showed that ash content decreased from 8.13% for control sample to7.68% for burger sample formulated with replacing 10% of beef meat with okara powder.

On the other hand, the crude fiber content increased significantly with increasing the replacing level of beef meat with okara powder. The crude fiber of control sample recorded the lowest value of 5.82%, while beef burger sample formulated with replacing 10% of beef meat with okara powder recorded the highest crude fiber content, 14.64%,. The increasing of fiber content in beef burger was formulated by replacing beef meat with okara powder due to the high fiber content of okara powder as stated by Wickramarathna *et al*. (2003).

The pH values of raw beef burgers increased from 6.04 for control sample to 6.18 for burger sample which is formulated with replacing 10% of beef meat with okara powder. The pH values are increased as the okara content is increased, although the pH value of okara is lower than that of meat (6.8 for meat and 5.5 for okara powder). These results are on the line with that reported with Norihamet *al*. (2016) who obtained similar results in beef Sausage.

The results also showed that the replacing of beef meat with okara powder significantly decreased the energy content of the burger, which is decreased from 566.65 kcal/100 g for control sample to 543.42, 527.12 and 493.77 kcal/100 g for burger sample formulated with replacing beef meat with Okara with the following replacing levels; 2.5, 5, and 10%, respectively.

Cholesterol intake should be kept at under 300 mg per day, according to recommendations (WHO, 2003). Meat, especially red meat, is commonly considered a major source of dietary cholesterol. The control burger had the highest cholesterol content (82.24 mg/100 g), while the lowest content was recorded for 10 % okara powder burger sample (49.12 mg/100 g), since the samples' cholesterol contents significantly ($P < 0.05$) reduced as the replacing level of meat with okara is increased.

DPPH, Total volatile nitrogen (TVN) and trimethylamine of beef burger.

Table 6 showed that the DPPH values of beef burger samples formulated without/with replacing beef meat with different levels of okara powder was as follows, 5.87 % for control and 26.39, 28.12 and 30.00 % for 2.5, 5 and 10% okara samples, respectively.

Also, the data recorded in Table (6) indicated that the TVN value was significantly decreased from 8.20 mg/100g for a control burger to 7.40, 6.98 and 6.23 mg/100g for 2.5, 5 and 10% okara samples, respectively.

The same trend was also observed with Trimethylamine contents of beef burger samples which decreased with increasing the meat replacing level, since it recorded 3.20mg/100g for control sample and 2.80, 1.86 and 1.34mg/100g for 2.5, 5 and 10% okara samples, respectively.

Sensory properties of a beef burger.

The results in Table 7 indicated that replacing beef meat with okara powder in producing beef burgers didn't significantly affect its sensory properties. This was obvious with odor, taste, appearance, tenderness, and overall acceptability. On the other hand, juiciness scores for the burger with okara were significantly higher than this of the control (P 0.05). This might be explained by soy protein's high ability to hold water.

CONCLUSIONS

From the above-mentioned results, it could be concluded that replacing beef meat with okara powder in producing burgers was found to have a positive impact on some quality parameters. The incorporation of okara powder into burgers decreased levels of cholesterol, enhanced the juiciness, didn't affect the other sensory properties, and increased the fiber content which is lowering the caloric value of burgers formulated by replacing beef meat with okara powder.

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Table 1: Formulas of beef burger Treatments.

Ingredients	Treatments			
	Control	2.5 % Okara	5% Okara	10% Okara
Beef meat	65.00	62.50	60.00	55.00
Fat	15.00	15.00	15.00	15.00
Water	10.50	10.50	10.50	10.50
Spice mixture	1.50	1.50	1.50	1.50
Dried onion	3.00	3.00	3.00	3.00
Dried garlic	3.00	3.00	3.00	3.00
NaCl	2.00	2.00	2.00	2.00
Okara Powder	0.00	2.50	5.00	10.00

Table 2: Proximate composition and Physical properties of okara powder and beef meat

Materials constitutes	Meat	Okara
Moisture(%)	68.50	10.50
Fat (%)	9.87	11.37
Ash (%)	0.70	3.30
Protein (%)	70.48	29.61
Crude Fibers (%)	-	53.97
Carbohdrates (%)	18.79	1.75
Energy (Kcal/ 100g)	445.91	227.77
Cholesterol (mg/100 g)	48.10	-
pH	6.80	5.50

Table 3: Total phenolic compounds (TPC), flavonoid contents (FC), and DPPH of okara powder and beef meat**.**

Parameters	Okara	Meat
TPC (GAE mg/100g)[4]	19.24	0.90
Total flavonoids (CE mg/100g)[3]	12.55	0.20
DPPH (Radical Scavenging Activity %)	5.20	2.20

Table 4: Total volatile nitrogen and trimethylamin (mg/100g) of okara powder and beef meat.

Parameters	Okara	Meat
Total volatile nitrogrn	2.70	5.20
Trimethyl amin	2.50	6.70

Table 5: Physiochemical properties of beef burger formulated with/without different levels of Okara powder (dry basis).

Parameters	Treatments			
	Control	2.5 % Okara	5% Okara	10% Okara
Moisture (%)	61.87 ᵃ	58.80 ᵇ	56.72 ᶜ	52.74 ᵈ
Protein (%)	38.55 ᵃ	35.99 ᵇ	34.47 ᶜ	31.97 ᵈ
Fat (%)	44.53 ᵃ	41.46 ᵇ	40.16 ᶜ	37.41 ᵈ
Ash (%)	8.13 ᵃ	7.69 ᵇ	7.79 ᶜ	7.68 ᶜ
Crude fiber (%)	5.82 ᵃ	8.28 ᵇ	10.63 ᶜ	14.64 ᵈ
Carbohydrates (%)	2.92 ᵃ	6.58 ᵇ	6.95 ᶜ	7.30 ᵈ
Energy (Kcal/100g)	566.65 ᵃ	543.42 ᵇ	527.12 ᶜ	493.77 ᵈ
Cholesterol (mg/100 g)	82.24 ᵃ	54.6 ᵇ	52.3 ᶜ	49.12 ᵈ
pH	6.04ᵃ	6.08ᵃ	6.12ᵃ	6.18ᵃ

Table 6: Total volatile nitrogen (TVN) and trimethylamine of beef burger formulated with/without different levels of Okara powder.

Parameters (%)	Treatments			
	Control	2.5 % Okara	5% Okara	10% Okara
TVN	8.20ᵃ	7.40ᵇ	6.98ᶜ	6.23ᵈ
Trimethylamine	3.20ᵃ	2.80ᵇ	1.86ᶜ	1.34ᵈ

Table 7: Sensory evaluation of beef burger formulated with/without different levels of Okara powder.

Parameters	Treatments			
	Control	2.5%	5%	10%
Color	8.80ᵈ	8.00ᶜ	9.20ᵇ	9.40ᵃ
Taste	8.82ᵇ	9ᵇ	9.20ᵃ	8.50ᶜ
Tenderness	7.23ᵇ	7.55ᵃ	7.23ᵇ	7.94ᶜ
Juiciness	7.46ᵇ	8.12ᵃ	8.20ᵃ	8.25ᵃ
Appearance	7.53ᵇ	7.93ᵃ	7.56ᵇ	7.50ᶜ
overallacceptability	7.96ᵇ	8.12ᵃ,ᵇ	8.20ᵃ	8.10ᵃ,ᵇ

استخدام مسحوق الأوكارا كمصدر للألياف في برجر اللحم

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الملخص العربي

الأوكارا هو المنتج الثانوي الأساسي لصناعة حليب الصويا وهو يحتوي على مكونات أساسية مثل بروتين الصويا والألياف. لذلك كان الهدف من هذا البحث هو استبدال لحم البقر بمسحوق الأوكارا بمستويات 2.5 و 5 و 10٪ ودراسة تأثير استخدام مسحوق البوكارا على الخصائص الفيزيوكيميائية والحسية لبرجر اللحم البقري. وقد أظهرت النتائج أن مسحوق الأوكارا يحتوي على نسبة عالية من الألياف الخام 53.97٪ (علي أساس الوزن الجاف). كما أوضحت النتائج أن محتوى السعرات الحرارية لمسحوق الأوكارا (kcal / 100g) (227.77) أقل من محتوى اللحوم (445.91). وقد أظهرت النتائج أن محتوى البروتين انخفض بشكل كبير مع زيادة مستوى استبدال اللحوم بمسحوق الأوكارا، ولوحظ نفس الاتجاه مع محتوى الدهن حيث سجل 44.53٪ لعينة المقارنة مقابل 37.41٪ لعينة البرجر المحضرة باستبدال 10٪ من لحم البقر بمسحوق الأوكارا. من ناحية أخرى زاد محتوى الألياف الخام بشكل كبير مع زيادة مستوى استبدال لحم البقر بمسحوق الأوكارا. سجلت عينة المقارنة أقل محتوي من الالياف الخام حيث سجلت 5.82٪ بينما سجلت عينة برجر اللحم المحضرة باستبدال 10٪ من لحوم البقر بمسحوق الاوكارا أعلى محتوى من الالياف الخام 14.64٪. كما أوضحت النتائج أن استبدال لحم البقر بمسحوق أوكارا أدى إلى إنخفاض معنوي في محتوى الطاقة لعينات البرجر. لم يؤثر استبدال لحم البقر بمسحوق الأوكارا في إنتاج برجر اللحم بشكل كبير على خصائصه الحسية ولكنه زاد من عصيرية البرجر.

الكلمات الاسترشادية: الأوكارا، البرجر البقري، مضادات الأكسدة، الألياف الغذائية.