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NUTRITIONAL AND TECHNOLOGICAL STUDIES ON USING OKARA AS BY-PRODUCT FOR FORTIFIED COMMON FOODS FALAFEL AND BISCUIT

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ABSTRACT

Okara is the by-product of soymilk and tofu manufactures. It is cheap and nutritious, thus has great potential to be applied health snack and common food. This study was conducted to evaluate the proximate composition of fresh and dried okara and their nutritional evaluation after utilized in fortification of biscuit and falafel. Not only but also evaluation those physicochemical and nutritional evaluation by using calculation protein quality and biological evaluation on rats. The effect of different levels of either wet or dried okara (0, 10, 20 and 30%) on the chemical analysis were showing that, okara higher in protein ratio, ash, fiber and containing mineral content. Addition okara up to 20% into biscuit formula increase the protein content from 6.04% in wheat flour up to 9.9% in fortified formula containing 30% okara. The sensory evaluation indicated that, the higher scores for overall acceptability was recorded for level 20% addition of okara in falafel and biscuit formula. Okara protein and fortified formula of biscuit with 20% okara showed higher values of essential amino acids as lysine (5.83), threonine (4.10), isoleucine(4.86), leucine(8.10), aromatic acids (9.70), valine (4.93), tryptophan (1.35) and essential amino acids for such group of children 2-5 years of histidine (2.88) (g amino acids/16 g N). Therefore, it could be recommended that okara amino acid is sufficient for supplemented biscuit dough's with essential and lower cost for amino acids. In the okara flour and their supplemented products, the first and second limiting essential amino acids were methionine and cystein, with chemical score raged from 14.41 -24.70 in okara and their products. The nutritional evaluation of okara based on estimated PER showing that, the okara products such as biscuit and falafel have 2.78 and 2.76, respectively, while PER of okara was 1.51.It is concluded that based mainly on nutritive value okara and their products in falafel and biscuits may be considered for fortification of widely consumed cereal-based food and faba bean products. The biological evaluation was investigated by albino rats on okara and their products formula and taken casein as control reference protein diet. Expectedly, the true digestibility (TD), Net protein utilization (NPU) and Biological Value (BV) all indicated nearest ratio corresponding values obtained by casein reference diet. Farinograph test was applied to determine the effect of fortified okara on the rheological properties of wheat flour dough, and characterization of relationships between the results of the tests was performed. The applied additions of 0, 10, 20 and 30% okara into biscuit formula, (15.7–31%) increased the water absorption of the biscuit doughs. Similar was happened in the Dough stability and dough development in fortified wheat flour with okara at different level of addition. Okara is a rich source of nutrients that could be utilized in bakery industry and falafel. The sensory attributes and physico-chemical characteristics of okara-substituted biscuit and falafel at 10 % and 20% level were not differ than that of the control wheat flour. Therefore okara could be utilized to improve the nutritional quality of biscuits and falafel as well as various okara products. The okara substitution in bakery industry would be beneficial in reducing the usage of wheat flour and also overcome the waste disposal problem prevailing in the soya milk industries. Also, using okara in falafel could be reduced faba bean in formula to

improve nutritional quality and decline nutritional inhibitor. This only but also was increase economical values of valuable soy bean by-products. Finally, the conducted results indicate that, okara forms in fresh or dried can be used up to 20% for production cheaper and healthier falafel and biscuits formula more nutritionally sufficient for children 2-5 years old.
Keywords: Amino acids, biscuit, by-product, chemical composition, falafel, fortification, farinograph, nutritional evaluation, okara and rheological properties.

INTRODUCTION

Scientific knowledge of the beneficial role of various food ingredients (nutrients) for the prevention and treatment of specific diseases is rapidly accumulating; nevertheless, the new frontier in food research is the role in human health of non-nutritive components of the diet (Goldberg 1984). Human growth metabolism depends on a balanced diet containing protein, lipids, and carbohydrates. Soya bean containing proteins, isoflavone, dietary fiber, lignans, phytosterols, coumestans, saponins and phytase have been reported to affect cholesterol metabolism (Matsumoto *et al.,* 2007). Soy foods are associated with health claims for improved cardiovascular health. Yokota *et al.,* (1996) studied that, the oral administration of a crude antioxidant preparation from fermented products of okara (bean curd residue), on experimentally induced inflammation. Their preparation promoted free radical scavenging activities both in vitro and in vivo*,* and demonstrated protective effects against oxidative degradation in both unsaturated fatty acids and cells (Hattori *et al.,* 1995).

Okara is the by-product of soy milk and contains valuable components including soy fiber and soy protein, this attentively used in last decade. The high moisture by product is commonly used as animal feed. Okara is just treated as industrial waste with little market value because it's short life. Grizotto *et al.,* (2006) estimated that from each ton of processed soybeans around seven tons of soymilk are produced and two tons of okara. For each kilogram of soy bean processed into different types of tufu and soy milk an equal weight or more of okara is produced. Fresh okara may have about 75-80% moisture on wet basis, and is usually in semi solid form (Taruna and Jindal 2002). Dried okara consist of fat (10%), protein (24%), dietary fiber (52.3%), ash (4%), and considerable amount of vitamin (Rinaldi, *et al.,* 2000). The okara content as dry material is nutritious and mainly contains protein and dietary fiber (Villanueva *et al.,* 2011).The main components of okara, dietary fiber and high quality of protein (Liu, 1997), could be related with the total lipids and cholesterol decrease in the plasma and liver, as well as with the fecal output increase in high-fat fed hamsters. Dried okara contains 25.4-28.4% proteins, 9.3-10.9% oil, 40.2-43.6% insoluble fiber, 12.6-14.6% soluble fiber and 3.8-5.3% soluble carbohydrates (Tudthong *et al.,* 2007). Okara might play an interesting role in the prevention of hyperlipidemia and could be used as natural ingredient or supplements for functional food preparation (Villanueva *et al.,* 2011). Currently okara is being utilized as a miscellaneous food ingredient, feed ingredient, or as a source of fertilizer. Although okara is a rich source of nutrients, it has not been fully exploited as an important food source (Wickramarathna and Arampath 2003).

Several positive effects have been attributed to soy beans including the hypocholestrolemic effect (Kerckhoffs *et al.,* 2002 and Zhuo *et al.,* 2004). Ma *et al.,* (1997) reported that okara is a high nutritive quality and superior protein efficiency ratio, suggesting that it is a potential source of low coast vegetable protein of human consumption. Isoflavones of soy beans have antioxidant properties and they can contribute to health effects. These compounds have various physiological and therapeutic functions such antioxidant activity prevention of cardiovascular disease and effective chemopreventive agents for certain types of cancer (Quitain *et al.,* 2006). Several suggest indicated that isoflavons are responsible for the beneficial effects on plasma lipids (Rossi *et al.,* 2008).

Meitauza (*Mucor*-fermented okara) is a traditional Chinese fermented food made from okara, and it's also widely consumed by Chinese people as a health food due to its high content of dietary fiber (O'Toole 1999). The utilization of okara as a food ingredient is still in development stage, wet okara can successfully be used to make and enrich extruded wheat products (Rinaldi *et al.,* 2000). Waliszewski *et al.,* (2002) reported that effect of okara supplementation on certain physical, chemical and sensory properties of corn tortilla, and recommended its use in dried form up to 10% for tortilla enrichment. Major prospect of okara in food for a dietary food, by replacing some portion of flour in confectionary, will be refreshed into a healthy dessert rich of fiber and reducing calories (http://www.saitoku.com /okara/okara.html). Recently, in Egypt, there are some small industries produce soy milk, tofu and other soy products producing okara meal as waste (Farhat *et al.,* 1998). In a few years ago the by-products generated during the processing of plant food constituted an economic and environmental problem, today they are considered a promising source of functional compounds (Carle *et al.,* 2001). Science okara is a cheap and rich source of good quality protein and dietary fiber, various methods to isolate pure protein and amino acid fractions from okara for its solubility as food protein was studied (Ma *et al.,* 1997 and Chan and Ma 1999). Various studies have shown that okara proteins are high in nutritional value, have a high protein efficiency ratio, optimum essential amino acid profiles and a high in vitro digestibility (Jackson *et al.,* 2001).

In fact, the use of protein rich okara flour shows promise in improving the nutritive value of the final product as well as optimum utilization of flour. Protein fortification of food is of current interest because of increasing awareness in consumer towards health and quality of food and also because of government guidelines and policies across the globe. The protein fortified biscuit contains nutrients in concentrated forms for feeding programs at institutes such as daycare centers and schools. These biscuits can be prepared from composite flours such as wheat flour fortified with soy, cottonseed, peanut, mustard or corn germ flour (Tsen, 1976). A protein ingredient for biscuit should have pleasant flavor, low water absorption capacity and high protein efficiency ratio (PER). It should not adversely affect the spread and texture (i.e., crispiness) or cause considerable changes in the dough consistency, elasticity and undesirable browning reactions (Lorenz, 1983). Enrichment of cereal-based foods with the protein sources such as okara is more economical and nutritional affect, especially legumes as general containing a higher ratio of lysine, an essential limiting amino acid in most cereals (FAO 1970).

In Egypt, Falafel is one of the most popular staple foods as daily consumed by the majority of population (Hussein 1983). Faba bean is the main constituent of falafel, with variable amount of onion, garlic and some vegetables such as Egyptian leek, herbs and parsley.

Faba beans *(Vicia faba* L.) are a good source of protein and other nutrients. They are available throughout the year to the masses in Egypt for the preparation of low cost protein meals. Beans are stewed whole or decorticated after soaking. However, it has also been recognized that the field beans contain a number of anti nutritional factors, toxic compounds; inter alia proanthocyanidins, phytic acid, protease inhibitors, favin, vicine and convicine (Schmandke and Die Ackerbohne1988), which may affect the health and the performance of animals, particularly with respect to protein utilization (Deshpande, *et al.,* 1982). The ingestion of faba beans can induce the hemolytic disease called favism in individuals with a hereditary deficiency of red cell glucose- 6-phosphate dehydrogenase. Furthermore, some of anti nutritional factors, such as tannins and phytic acid, occurring in faba beans can combine with nutrients (especially minerals such as iron) to form complexes the body cannot absorb, leading to iron deficiency anemia, the most commonly recognized form of nutritional deficiency in most populations Egyptian population, especially in the villages. Faba bean products are a major component of the diet among this population. Moreover, the continuous increase in Faba bean prices make attention that should be directed towards other cheap alternatives. Okara is one of promising in food industry can be respect (Damir, *et al.,* 1985). Ziena,*et al.,* (1988) concluded that, the soybean meal which is one of cheap by-products of food-industry can be used instead of faba bean seeds to prepare Falafel. Blending soybean with faba bean led to appreciable improvement in some essential amino acids.

The present investigation was undertaken to study the nutritional and sensory characteristics of okara flour fortified biscuits and optimize the incorporation level of okara flour for the preparation of biscuits.

The main objective of this work was to investigate effect of using okara supplementation as new source of protein and fiber in traditional food (falafel) and biscuit, for faba bean and cereals food production, physico-chemicals and sensory evaluation. Moreover, studies for estimate the nutritional quality of okara (*in vitro*) and *in vivo* biological evaluation on the okara and their products by albino rats.

MATERIALS AND METHODS

Materials:

Fresh okara was kindly provided by the Food Technology Institute, Agriculture Research Center Soy Bean Center, Giza Egypt. Part of raw okara was preserved in freeze at -20 ° C until use. Other fresh wet okara was dried in an aerated oven dryer at 50-60 ° C until constant weight for 16 hrs. The dried okara (OK) was fin ground into flour and sieved at size 40 mesh. Other ingredients such as onion, basely, faba bean decorticated, spices, salt, garlic, coriander, bicarbonate, shortening, sugar, egg and flour extraction ratio 72 % ER were purchased from local markets in Giza.

Preparation of Falafel (Vegetable patties):

The methods adapted for Falafel patties (vegetable patties) preparation are those used in Egyptian described according to Hussein and Bruggeman (1997). The traditional recipe of Falafel processors made from faba beans in addition to other five recipes were formulated on the basis of substitution of decorticated dry faba bean by 0% (F0), 10% (FO1), 20% (FO2) and 30% (FO3) of wet fresh okara (moisture 78.6%). The decorticated dry faba bean were soaked in about twice their volume of boiled water, and simmered for 6-12 hrs until the faba become soft, and the water drained off. Falafel was divided into four batches. Small amounts of garlic, onion, salt, coriander, parsley and spices were added for seasoning in every batch. The individual mixture of batches was then crushed into a thick paste. When ready, the, the mass was removed from the mortar and allowed to stand for little time. The paste was finally about 25 g portioned and shaped into small round handle and deep fried in mixed sunflower with soya oil (1:1 v:v), for 5 min and received to sensory attributes and chemical analysis.

Falafel samples were presented simultaneously to a panel of ten panelists. Panelists were asked to rank the samples on a hedonic scale of 1 (very poor) to 10 (excellent) for color, flavor taste, softening of texture and overall acceptability of individual Falafel formula according to the method investigated by Turhan *et al.,* (2009). The data of sensory evaluation were subjected to analysis of variance by ANOVA test. Besides, the best recipes belonging to different blends together with control.

Blend formulation and preparation of biscuits:

Blends of dried OK flour containing 0 (WF) , 10 (B1), 20 (B2) and 30 % (B3) OK on a replacement basis were prepared with wheat flour (72% Extraction Ratio). The amounts of OK which replaced WF were those needed to improve protein and fiber content in biscuits formula, furthermore OK nourished by micronutrient and isoflavones. Biscuits were prepared according to cookie method 10-52-02 (AACC 2010) without ascorbic acid. The basic formula used was prepared as shown in the Table .1

Table.1 Preparation of various ingredients used in biscuit preparation.

Ingredients	Quantity
Wheat flour /blend with dried okara flour (0, 10, 20 and 30%)	40.0 g
Sugar	24.0 g
Shortening	12.0 g
Sodium carbonate	0.2 g
Sodium chloride	0.18 g
Water (based on water amount recorded from farinogram)	27.0 ml
Whole egg	5.0 g

The dry ingredients were weighed and thoroughly mixed. Shortening was added and mixed until uniform. The egg and water were added and dough thoroughly kneaded. The dough was then placed on a cutting board, rolled out until uniform thickness and textures were obtained. Biscuit cutter was used to cut the sheet of rolled dough into desired shapes and sizes. The shaped dough pieces were then baked at about 220 °C for 15 min, allowed to cool, packed and stored according to Kure *et al.,* (1998). Individual samples of biscuits were subjected to and sensory evaluation (such as color, flavor, taste, softening and overall acceptability) using 9-point hedonic scale by a panel of 10 judges according methods described by Hooda and Jood (2005). Proximate analysis of biscuits according to methods were described by AOAC (2005).

Measurements of biscuit dough consist:

Farinograph test:

Consistency of the biscuit dough was measured using a Brabender Farinograph (CW Brabender Instruments, Duisberg, Germany), according to AACC (2000) Approved Method No. 54-21. A 300 g capacity mixer bowl was used in the experiment and the third lever position was used to measure the biscuit dough consistency. The mixing speed of the farinograph was 63 rpm. Three hundred grams of biscuit dough pre-mixed in a Hobart mixer was transferred to the farinograph bowl and the instrument was run for 20 min and the farinogram pattern was studied. Biscuit dough consistency and farinogram bandwidth was recorded at 0 min mixing. The dough water absorption, mixing consistency index, and stability profile were manually calculated. Dough development time, maximum consistency and dough stability were recorded manually according to the method ISO 5530-1:1997 (ISO, 1997b), the properties of water absorption, the time of dough development and the stability of the paste were determined. The water absorption of the flours corresponded to the quantity of water to obtain 500 BU (an arbitrary consistency). Dough development time was defined as the time in minutes measured from the addition of water to the point on the curve immediately before the first sign of decrease in consistency. The maximum consistency was defined as the consistency in BU, measured at the development time and in the middle of the curve band width, while the dough stability was defined as the drop of the curve (BU) during the first 2 min after dough development time.

Proximate chemical analysis:

All determinations were performed by using method of AOAC (2005). The moisture content of okara and different samples (biscuit and falafel) were determined by weight loss after oven-drying to a constant weight at 105 ◦C. Total nitrogen was determined using the micro-Kjeldahl method and protein was calculated as nitrogen × 5.71. While the calculation of biscuit and falafels were calculated as N × 6.25. Ash content was measured as the residue obtained after incinerating at 550 ◦C for 3 h. Fat content was determined by extraction with petroleum ether using the Soxhlet method. Dietary fiber was analyzed using the Association of Official Analytical Chemists enzymatic–gravimetric method described by AOAC (2005).

Amino acid analysis:

Amino acid determination was performed according to method of the method of the AOAC, (2005) in the Regional Center for Food and Feed, ARC. Oxidation with performic acid, to protect methionine and cystine from distraction during acid hydrolysis with 6 M HCL) were carried out in closed conical flash for determine all amino acid other than tryptophan. Sample of 20-30 mg weighted in conical flask and 5 ml of performic acid was added. The flask was closed and placed in ice water bath for 16 hr. Sodium metabisulfate and 25 ml HCL 6 N were added to the oxidized mixture. The flask was placed in an oven at 110 ° C for 24 hr. The flask was then opened and all removed by evaporating samples to dryness in rotary evaporator. A suitable volume of sodium citrate puffer (pH 2.20) was added to the dried film of hydrolyzed sample. After all soluble material completely dissolved, the samples analyzed for amino acids using Amino Acid Analyzer (BIOCHROM 30, serial 103274), software used for data collection and processing. The results were calculated as percentage of total crude protein. Determinate tryptophan was carried out using method described by Miller (1967) after hydrolysis of samples with barium hydroxide.

Minerals

Determination of minerals content zinc, iron , sodium , calcium, potassium, phosphorus , magnesium and manganese were analyzed by using Atomic Absorption 3300 Perkin Elmer U.S.A., air acetylene according to analytical methods for atomic absorption (Perkin Elmer).The mineralization was carried out in a muffle at 500 °C/30 min with minimize the volatilization of minerals. The ash content was dissolved in 1 ml of 50% HCl plus 1 ml of 50% HNO_3, filtered and completed to volume (25 ml) with distilled water according to AOAC official method (2005).

Selenium and copper were determined using Zeeman Atomic Absorption 4100 Perkin Elmer, U.S.A., according to AOAC official method (2005).This results were calculated as percentage and part per billion.

Chemical prediction of protein and nutritional quality:

Chemical estimation:

Protein and nutritional quality assessment of the hibiscus, jojoba and pumpkin kernel seeds flour were performed using amino acids profile and using egg amino acid pattern as reference protein (Mitchel and Block 1946), Sarwar *et al.,* (1985) and Human pattern of amino acid requirements (FAO/ WHO 1973) suggested pattern of amino acid requirements for human.

Calculation of protein and nutritional quality indexes:

Chemical score of amino acids was calculated according to (FAO/ WHO/UNU 1985) reference pattern to estimate chemical score % and first, second and third limiting amino acids. Calculation of amino acid score as follows:

Calculation of A/E Ratio: the relationship between the content of individual essential amino acid in the food protein (A) and the total essential amino acid contents (E) was conducted by according to FAO (1965) as follows:

$$\frac{A}{E}ratio = \frac{\text{mg of the individual essential amino acid}}{\text{gm of total essential amino acids}}$$

Essential amino acids index (EAAI) for okara samples and their products were determined from the formula expressed by Mente *et al.,* (2002): The amino acids results were expressed as µmoles of amino acid per gram of samples (µmole / g) and as grams per 100 g determined amino acid for reference egg protein.

EAAI = $\sqrt[n]{\alpha\alpha 1/AA1 \times \alpha\alpha 2/AA2 .... \times \alpha\alpha 11/AA11}$

Where: aa1 is the A/E ratio in the flour samples (EAA/ Total EAA + tyrosine x 100), AA1 is the A/ E ratio in the composition amino acid of egg as standard, (EAA/ Total EAA + tyrosine x 100).

Predicted biological values (BV): the predicted BV values was calculated by using the following equation of Oser (1959)

BV= 1.09 × EAAI -11.7

Where: EAAI: Essential amino acids index

Protein efficiency ratio (PER): was estimated according to the following equation purposed by Alsmeyer *et al.,* (1974), equation NO (1;2). Equation NO 2 for legumes and NO 1 for cereals.

$$PER1 = -0.684 + 0.456(LEU) - 0.047(PRO) \quad (1)$$
$$PER2 = -0.468 + 0.454(LEU) - 0.105(TYR) \quad (2)$$

Protein quality by Biological evaluation:

The experimental procedure has been described by Eggum (1973). A total 10 albino rats, 6 weeks old, were used in the experiment. The animals were divided into control and treated group, each with five male rats, within average weight 70 g. The experiment started by preliminary period of 4 days and balance period of 5 days. The rats were housed individually in plexiglass cages with stainless steel mesh bottoms in an environmentally controlled room. Temperature and relative humidity were maintained at 2-4° C and 60% respectively, lighting 12hr day light/dark. The diets were composed of a N-free mixture (starch, 80.7%; sucrose, 8.9%; cellulose, 5.2% and fresh corn oil, 5.2%), vitamins (1.6%), minerals (4%) and dried okara, added to provide 15 g N/kg dry weight. Each animal received 10 g dry matter (150 mg N) of diet daily. Body weight and diet intake were daily recorded up to the end period. During the balance period, urine and faces were collected separately. Total nitrogen was determined using the micro-Kjeldahl method and protein was calculated as nitrogen × 6.25 and in the obtained diet, faces and urine. The following criteria were calculated: true protein digestibility (TD), Biological value (BV) and net protein utilization (NPU) were used as biological indices and were determined as already described, including appropriate correction factors.

The calculation also was carried out according to Eggum (1973) as follows:

$$\mathbf{TD = [N_i - (NF_1 - NF_2)] \div [N_i] \times 100}$$

$$\mathbf{BV = [N_i - (NF_1 - NF_2)] - [(NU_1 - NU_2)] \div [N_i - (NF_1 - NF_2)] \times 100}$$

Where: N_i, Nitrogen intake of animal fed test diet; NF_1, Nitrogen excreted in feces of animals fed test diet; NF_2, Nitrogen excreted in feces of animal fed protein-free diet; NU, Nitrogen excreted in urine of animals fed test diet; NU_2, Nitrogen excreted in urine of animals fed protein-free diet.

Net protein utilization (NPU) was calculated according to Eggum (1973) as follows:

$$\mathbf{NPU = [BV \times TD] \div 100}$$

RESULTS AND DISCUSSION

Physico-chemical evaluation by Farinograph:

Data in Table 2 observed that, the development times of composite dough's containing okara flour at 10 and 20% were close to that of the control contain zero % okara, when the levels of okara flour substitute did not exceed 20%, but above this amount, their development times notably felt. On the contrary, the degree of softening of composite dough made from okara - wheat flour with different levels of okara (10, 20, and 30%) sharply decline with okara flour substitution from 85±1.4 in control without okara into 70±0.9 after fortified biscuit formula with 30% okara . This reduction in degree of softening is regarded to characteristics of substitute of okara contain of different protein, starch and fibers ratios. The dough development time increased from 2.0 min (no addition of okara) to 6.8 min at 30% addition of okara flour. Increased dosage of the additions above those different okara flour levels caused a gradual shortening of the dough development time. A similar character of changes was observed in the case of dough stability. The stability initially increased from 5.0 min to 7.1 in control up to 30% addition of okara flour.This also agreed by Sudha *et al.* (2007b), who enriched wheat flour, with wheat, rice, oat and barley bran. With increase in the doses of the bran from 10% to 40% there was a gradual increase in water absorption, development time and softening. When wheat flour is mixed with water, a complex protein called gluten is formed. This component is, in reality, the skeleton of wheat flour dough, and plays an important role in gas retention, which makes the biscuit forming appearance and shape. The gluten development is what gives wheat dough an elastic structure that allows it to be worked in a variety of ways. This is also agreed by Aboaba and Obakpolor, (2010). Therefore, the substitution of a part of wheat flour for flours containing no-gluten-forming proteins decreases the total weight of wheat protein, resulting in a skeleton weaker than that of 100% wheat flour dough. The dough development time was shortened, and that might be due to a decrease of cohesively and swelling capacity of the dough, as the wheat flour substitution for different sources of okara flour was over 20%.

Table 2: Effect of supplemented biscuit dough with OK at 0, 10, 20 and 30% on the Farinograph test

Samples	Water absorption (WA)	Dough development time (min)	Dough stability (min)	Degree of softening (DS) brabender unit (BU)
Control WF 100% with 0% OK	50.3± 1.0	2.0± 0.8	5.0± 0.5	70± 0.9
Dough contain 10% OK	58.2± 0.8	2.5± 0.3	5.5± 0.2	75± 1.0
Dough contain 20% OK	64.2± 2.1	3.1± 0.4	6.5± 0.6	80± 0.5
Dough contain 30% OK	65.8± 2.2	6.8± 0.8	7.1± 0.6	85± 1.4

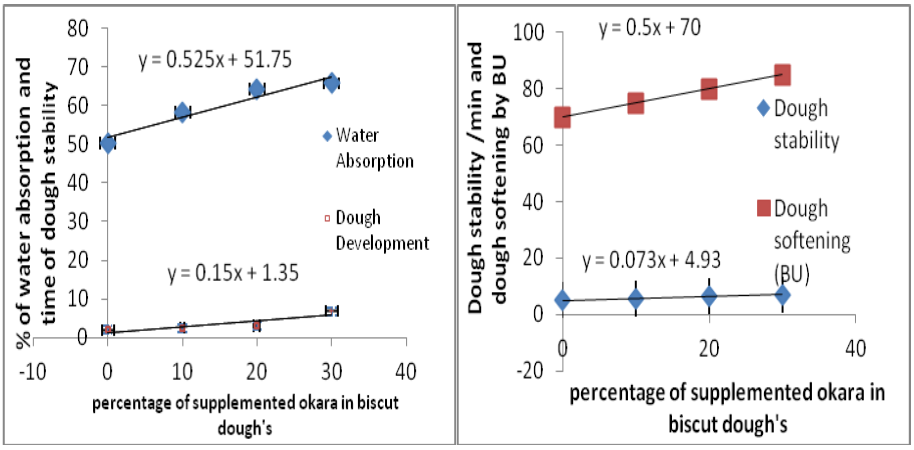

Fig. 1: Correlation of Farinograph curves for rheological properties of biscuit dough's.

Analysis of correlation of the farinograph indices under study (Table 2) and Fig. 1 revealed a close relation between the water absorption and dough stability. According to ratio of okara addition extension of water absorption and dough stability time was conducive positively correlation r = + 0.525for water absorption and r=+ 0.15for dough stability. That relation could have been caused by a regularity observed by the authors. The same to the cause might apply in the case of positive correlations r= +0.5between dough stability with various ratio of okara addition, whereas a lower correlation (r=+ 0.073) was recorded between dough stability and percentage of supplemented okara in biscuit dough's.

Proximate composition:

The main components of okara flour (OK) are protein, carbohydrates, fiber and fat. Nearly 40% corresponds to proteins, 17.3% fat and 16.70% to crude fiber (Table 3). Rinaldi *et al.,* (2000), Redondo-Cuenca, *et al.* (2008) and Villanueva *et al.,* (2011) indicated that dried okara containing a considerable amount of protein approximately 24-40% protein and 21.1 % fat, approximately half of the carbohydrate are structural polysaccharide.

(Redondo-Cuenca, *et al.* 2008) indicated that okara rich in fiber and also protein in 28.52 g/100g. Okara protein is one of the most important vegetable protein resources due to its functional properties and high nutritional value (Liu, 1997). Okara is rich in fat content 17.3%, being especially important, and its high content of polyunsaturated fatty acids, linoleic and linolenic acids. Okara could be suggested that a good source responsible to increase intake of linolenic acid among people whom demand linolenic acid in their meals. Correspondingly to the ash (3.7%) content in okara flour is containing appreciable quantity of ash.

The sample of okara is promise to a good source of fiber, ash and protein that counts very superior to majority of food usually consumed, similar agreed by O'Toole, (1999) and Surel and Couplet, (2005) those obtained in this work with respect to proteins (20–30%), ash (3–4%) and fiber (more than 50%). Proximate composition of refined wheat flour (WF), okara blends with flour at different blends levels B1 consist of 10 OK: 90 WF, B2 consist of 20 OK: 80 WF and B3 consist of 30 OK: 70 WF, are given in Table 2. Data presented shows that B3 had a considerably higher in protein content (9.90%) than control of WF (O% OK), B1 and B2 as 6.04 % , 7.43% and 9.10% , respectively .

Table 3: Proximate composition of okara flour (OK), blends of biscuit and vegetable patties Falafel (OKF) on a dry matter basis.

		Okara blends				Vegetable Pattie (Falafel)			
	OK	**Control biscuit 100% WF (% ER)**	**10 % OK + 90% WF (B1)**	**20 % OK + 80% WF (B2)**	**30% OK + 70% WF (B3)**	**Control 0% WOK (F0)**	**OKF 10 % WOK (FO1)**	**OKF 20 % WOK (FO2)**	**OKF 30 % WOK (FO3)**
Moisture %	3.00 ± 0.48	2.50± 0.92	4.40± 0.63	2.90± 0.22	3.30± 0.28	5.20± 0.45	5.30± 0.14	5.40± 0.40	5.40± 0.35
Protein %	40.00± 0.28	6.04± 0.43	7.43± 0.18	9.10± 0.15	9.90± 0.19	25.80± 0.45	24.90± 0.19	24.70± 0.33	25.70± 0.38
Fat %	17.30± 0.21	24.01± 0.90	25.07± 0.48	25.30± 0.51	24.84± 0.22	1.16± 0.45	1.30± 0.49	2.37± 0.41	2.94± 0.14
Crude fiber %	16.70± 0.45	6.27± 0.25	10.9± 0.41	11.01± 0.15	16.26± 0.46	3.99± 0.45	4.27± 0.47	4.96± 0.41	5.11± 0.18
Ash %	3.70± 0.12	0.32± 0.45	0.45± 0.20	0.32± 0.27	0.46± 0.44	5.28± 0.45	9.70± 0.50	10.90± 0.81	10.32± 0.27
Carbohydrate %	19.30± 0.31	60.86± 0.82	51.75± 0.45	51.73± 0.45	45.24± 0.40	58.57± 0.45	54.5± 0.43	51.67± 0.44	50.53± 0.60
Calorie value (Kcal/100g)	392.9	483.69	462.35	471.02	444.12	347.92	329.42	326.81	331.38

OKF : falafel pattie by addition WOK. OK: Dried okara flour WOK: Fresh okara

The crude fiber is higher in B3 (16.26%) than each other of WF(6.27%) , B1 (10.9%) and B3 (11.01%). Similar finding, the ash content is in higher ratio at B3 corresponding to WF and B2. In vise reverse, the total carbohydrate was obvious decreased from 60.86% in WF into 45.24% in B3 and follows by B1 and B2 that are approximately 51.7%. From these obtained results in Table. 1, it could be found that fat content in all blends have considered stable in all samples with a minor difference less than 5%. The higher crude fat content in by product of okara and their blend due to the presence in the rich origin of soya bean seeds according to type of soya and kind of soya bean processing. These obtained results agreed by Van der *et al.,* (1989) and Wickramarathna and Armopath, (2003). The higher content in the protein, fiber and ash in biscuit blends flour in this current study especially in B3 were promise that okara as an excellent nutritional improving material could be using in food functional processing. These also agreed by Liu, (1997) , Redondo-Cuenca, *et al.,* (2008) and Villanueva *et al.,* (2011), whom reported that, the okara ingredient had a high protein content, an interesting profile of fat, and a high fiber content with a much higher proportion of insoluble than soluble dietary fiber (Redondo- Cuenca, *et al.,* 2008).

The proximate composition (dry matter basis) of falafel formulated with different levels of wet okara is given also in Table 2. The moisture contents in different blends are lower than 6% on dry basis. Both control F0 and FO3 showings the highest ratio of protein content were 25.8 % ± 0.45 and 25.70 %± 0.38, respectively. Fat levels increased as okara content increased in FO2 (2.37% ± 0.41) and (2.94 % ± 0.14), this could be attributable to the increase oil content in okara . Crude fiber and ash levels recorded a highest content in blend FO2 and FO3. This also considers increasing level of substitute faba bean with okara. The carbohydrate content of wet okara in falafel was highest in control F0 and decreased with more addition of okara, especially in blend FO2 and FO3 of falafel formula. This is also corresponding to increasing okara content in blends. Results clearly showed increasing of protein, fat, and ash fiber percent in all falafel formulation. Similar results obtained by Youssef, *et al.,* (1986).

The higher content of protein and ash content in blends of okara by-products were richen in essential elements which absolutely improve the nutritional quality of processed biscuit using okara blends. Therefore, the linoleic acid in fat content of okara and its blend improve the nutritional quality of biscuit. Moreover, the importance of fiber especially dietary fiber play important role in many physical processes, in prevention of disease and impart role to decrease hypercholestrol content in the human body (Jones *et al.,* 2006). The higher content of dietary fiber in okara and their blends with flour had a characteristics required to be considered as an important ingredient in biscuit formulation and functional foods (Heredia *et al.,* 2002). Finally the okara ingredient as by products generated during the processing of soya bean constituted an economic and environmental problem, today okara is consider a promising source of functional compounds (Carle *et al.,* 2001).

Data in Table 3. showed, that the calorific value (per 100g of dried sample) was higher in okara blends of biscuits , especially as appears in control 483.69 and follows by B2 471.02 and B1 462.35 Kcal/100g. Meanwhile calories from BF3 recorded the lowest level comparison to control of biscuit formula. Similar of trend, it could be found in falafel blends; the F0 has 347.92 Kcal/100g and follows by FO3 and FO1 as 331.38 and 329.42, respectively. Generally, the okara 10, 20 or 30 % substitute of biscuit was found to a lower calorific value than that of control of biscuit formula zero % okara.

Minerals all have several roles in human biochemistry and physiology and all the minerals mentioned above are essential in the diet of humans. Many are co-factors for different enzymes and we are dependent on them for energy efficiency, fertility, mental stability and immunity.

Table 4: Mineral composition of okara flour (OK), blends of biscuit and vegetable patties (Falafel)

	WF	OK	Biscuit (B2)	Falafel (FO2)
Calcium µg/g	212.4± 0.92	656.0± 1.45	422.80± 0.48	1830.00± 0.49
Copper µg/g	1.68± 1.1	1.40± 0.90	1.98± 0.97	12.59± 0.41
Iron µg/g	38.2± 0.46	7.20± 0.45	4.36± 0.86	110.80± 1.1
Potassium µg/g	1122.0± 1.17	801.00± 0.28	2428.00± 1.08	14760.00± 0.85
Magnesium µg/g	244.3± 0.55	38.30± 1.02	314.60± 0.98	1481.00± 0.75
Manganese µg/g	2.8± 0.68	3.70± 0.92	6.97± 0.78	37.82± 0.86
Sodium µg/g	28.3± 0.65	26.10± 0.84	154.4± 0.35	288.70± 0.09
Selenium µg/g	1.8± 0. 98	8.50± 0.89	9.8± 0.24	15.20± 0.14
Zinc µg/g	4.8± 1.22	3.20± 1.13	8.5± 0.80	31.00± 0.92
Phosphorus µg/g	1145± 0.45	477.80± 0.84	1900.00± 0.74	5000.00± 1.04

WF : Wheat Flour 72% ER, OK: Dried okara flour , B2: 80% WF + 20%OK , FO2: 80% faba bean + 20%wet okara, Values are mean ± SD

The mineral content of okara flour and their products recorded an excellent sensory evaluation formula which containing either 20% okara flour or 20% wet okara are summarized in Table 4.These data can be observed that, macronutrient as potassium , calcium , phosphorus and sodium show the highest levels of concentration in okara and their products of B2 and FO2. It remarkable that, falafel has a appreciable amount of potassium, phosphorous, calcium and sodium as macro elements in comparison to okara flour. The content of these macro-elements have potassium 14760, phosphorous 5000, calcium 1830 and sodium 288 µg/g. Also, these data in Table 3.was described that, the higher content of microelements such a magnesium, iron, manganese and zinc were founded in FO2. These results indicated that okara would be elevated both macro-elements and microelements in their products of biscuit and falafel. Herein, must be recorded that biscuit from okara at 20% fortification of flour was lower than added into falafel. Generally okara was improved elements status in the okara products when consumed for fortification.

Sensory evaluation:

Results of sensory evaluation (Table 5and 6) indicated that the added okara into biscuit and falafel ingredients significantly (P < 0:05) affected the sensory characteristics of these products. Results of sensory evaluation (Table 3) indicated that incorporation of 20% dried okara flour into the formula of biscuit cookies significantly (p<0.05) affected all the sensory attributes parameters. Biscuits made from OK and its various blends were heavier and had a larger diameter than those made from the blends. Results gave significantly p<0.05 increases in degrees of sensory evaluation towards fortification of biscuits by okara up to 20% in color, flavor, taste, softening and overall acceptability. Similarity sensory evaluation in Table .4, were significantly (P < 0:05) higher also in falafel which fortified with okara there were a significantly p<0.05 increases in degrees of sensory evaluation towards fortification of falafel by okara up to 20% in color, flavor, taste, softening and overall acceptability. Both of biscuits and falafel fortified with okara had significantly (P < 0.05) higher sensory scores than control WF and control falafel (0% okara). However, in general, the sensory scores of 20% okara were in the range acceptable to very acceptable (scores between 6 and 8). By ranking the falafel and biscuits from okara, the panelist indicated that most of okara fortified products ranking the first one comparing to control 100% faba bean or 100% wheat flour. These results were also indicated by Ziena *et al.,* (1988) the blends of faba bean (20%) and soybean meal and/or cotyledons (80%) were the most acceptable recipes compared to the control (100% faba bean) as well as the other substitution levels. Grizotto, *et al.,* (2010) concluded that , The okara was provided by two soymilk producing companies whose production systems are based on hot.

Table 5: Sensory evaluation of okara biscuit.

	Sensory attributes				
	Color	Flavor	Tast	Softening texture	Overall acceptability
Control 0 % dried okara	7.154^{B}	7.154^{B}	7.923^{A}	6.846^{AB}	7.385^{B}
Biscuit containing 10% dried okara	7.154^{B}	7.000^{B}	7.000^{B}	6.308^{B}	7.077^{BC}
Biscuit containing 20% dried okara	8.154^{A}	8.231^{A}	8.308^{A}	7.615^{A}	8.151^{A}
Biscuit containing 30% dried okara	6.538^{B}	6.385^{B}	6.077^{C}	6.231^{B}	6.538^{C}
LSD (*p*<0.05)	0.74	0.79	0.84	1.15	0.73

Means in the same raw with the same letter ('S) are not significantly different at *p*<0.05

Table 6: Sensory evaluation of falafel produced from wet and fresh okara substitute of soaked Faba bean

	Sensory attributes				
	Color	Flavor	Taste	Softening Texture	Overall acceptability
Control 0 % okara	8.231^{A}	8.231^{A}	7.769^{A}	7.538^{A}	8.077^{A}
Falafel containing 10% wet and fresh okara	7.923^{A}	7.769^{A}	7.154^{A}	7.154^{A}	7.615^{A}
Falafel containing 20% wet and fresh okara	8.154^{A}	8.000^{A}	7.769^{A}	7.615^{A}	7.923^{A}
Falafel containing 30% wet and fresh okara	6.846^{B}	6.615^{B}	5.692^{B}	5.692^{B}	6.308^{B}
LSD (*p*<0.05)	0.87	0.80	1.10	0.77	0.72

Means in the same raw with the same letter ('S) are not significantly different at *p*<0.05.

disintegration of decorticated (company B) or non-decorticated (company A) soybeans and separation of the soymilk .The formulation of the molded sweet biscuit in which 30 per cent (w/w) of the wheat flour was substituted by okara flour B was considered adequate. Okara flour B presents great potential for application in confectionery products. In addition the color, flavor and overall quality of the MSB with 30% of okara flour B did not differ significantly from those of the standard biscuit.

Amino acid compositions:

Essential amino acid composition of okara 100% and WF 100%, as well as okara products such as biscuit and falafel are given in Table 7. It was obvious from these results compared to raw okara and reference protein of egg, that lysine , threonine , tyrosine were the most predominant essential amino acids in okara 100% in comparison with egg amino acids reference. Bean protein is found to be relatively high essential amino acids, in particular lysine, threonine, isoleucine, leucine, phenylalanine and valine. But they are deficient in sulphur –containing amino acids, in particular methionine and cystine (Uebersax and Occena 2003). Okara like legumes are reported by Gupta (1982) is rich in lysine but deficient in Trp and sulfur congaing amino acids Cys and Methionine

Okara as by-product of soy bean was being richen in the essential amino acids especially lysine, therionine, isoleucine and total aromatic in legumes. This is also appreciated by (Edwards, 2000). By fortified WF with 20 % okara in biscuit formula, the total sulfur, lysine, threonine, leucine, phenylalanine, tyrosine and tryptophan were the most predominant essential amino acids when compared to WF 100%. This a decrease in essential amino acids can be explained on the basis of the effect of containing of okara elevated the nutritive value of WF 100% when fortified by flour of okara .

Considering the addition of okara at 20% into biscuit formula was appreciated increases in aspartic, argnine, histidine, serine glycine and alanine of biscuit 20% containing okara in comparison to WF100%.While in the falafel 20% containing of okara have glutamic (36.99) and proline (10.49) g amino acid/16 g nitrogen were drastically decrease into 18.46 and 5.5 g amino acid/16 g nitrogen, respectively. This is consistent with the observation of higher non-essential amino acids in okara flour. It should be noted that, in general essential amino acids and non-essential of okara represented over a one third of essential amino acids is substantially higher than that has been found in cereals.

Combining the results on amino acid profile of okara 100% and their performed formula in either biscuit or falafel, it was possible to conclude the okara have the highest level of the total essential and non-essential amino acids compared to WF and faba bean. In accordance, Damir, *et al.* (1985) and Rizk, *et al.* (1986) reported that Falafel made from faba bean and soybean mix exhibited much higher contents of essential amino acids compared to Falafel made from faba bean only. From the obtained results of amino acid composition of okara Table 7 , it could noticed that, essential amino acids of okara containing a sufficient and higher than recommended by FAO/WHO (1991) for children 2-5 years old (33.9 g EAA/100 g protein).

Table 7: Amino acid composition of substituted faba bean and wheat flour with okara in producing falafel and biscuit (g amino acid/16g nitrogen or g AA / 100 g protein)

	Type of products								
Amino acids (AA)	OK 100%	WF 100%	Faba bean*	falafel with 20 % okara (FO2)	biscuit with 20 % okara (B2)	FAO/ WHO/UNU 1985	Egg amino acids reference	Casein	Essential amino acids requirements 2-5 yeas **
Essential									
LYS	7.28	2.62	6.1	6.98	5.83	5.50	7.00	6.8	5.8
THR	5.19	2.93	4.7	4.32	4.10	4.00	5.10	4.5	3.4
VAL	4.26	4.38	5.1	5.04	4.93	5.00	6.80	4.7	3.5
MET	0.84	1.3		0.49	0.77	-	3.40	2.4	
CYS	0.65	1.98		1.31	1.52	-	2.40	0.5	
Total sulfur AA	1.49	3.28	1.4	1.80	2.29	3.50	5.80	2.9	2.5
ILE	6.25	3.98	5.1	4.56	4.86	4.00	6.30	3.9	2.8
LEU	5.36	8.64	7.7	7.87	8.10	7.00	8.80	8.3	6.6
PHE	3.98	5.45		4.93	5.60	-	5.70	4.4	
TYR	4.35	1.80		3.98	4.10	-	4.20	3.9	
Total aromatic AA	8.33	7.25	6.3	8.91	9.70	6.00	9.90	8.3	6.3
Try	1.42	1.10	1.7	1.14	1.35	1.00	1.50	0.7	1.1
Total essential amino acids	39.58	35.28	38.1	40.62	41.16	37.00	52.7	40.1	33.9
Non essential									
ASP	16.4	3.63		11.15	10.22			6.0	
GLU	11.2	36.99		17.18	18.46			18.7	
ARG	5.89	2.02		8.97	7.23			3.4	
HIS	2.33	2.72	2.1	2.93	2.88			2.5	1.9
SER	4.87	3.73		5.24	5.39			6.0	
PROLINE	9.26	10.49		4.69	5.51			18.9	
GLY	5.53	3.41		4.44	4.28			2.5	
ALAN	4.83	1.71		4.78	4.61			2.9	
Total non essential amino acids	60.4	64.70		59.38	58.58			60.90	

***Bakr and Bayomy (1997).Faba bean nutritive value and dietary protein utilization 2: Ability of faba bean products to support hemoglobin response in rats. Plant Foods for Human Nutrition 50: 81-91.**
**** FAO/WHO (1991)**

When compared with FAO/WHO (1991) reference standards, the protein from okara and fortified formula of biscuit with 20% okara showed higher values of essential amino acids as lysine, threonine, isoleucine, leucine aromatic acids, valine, tryptophan and essential amino acids for such group of children 2-5 years of histidine. Therefore, it could be recommended that okara amino acid is sufficient for supplemented biscuit dough's with essential and lower cost for amino acids.

Nutritional evaluation:

Table 8 shows the essential amino acids A/E ratio of each essential (EAA) of various formulated with okara was calculated as the percentage of total EAA in comparison to FAO reference protein pattern. Total aromatic (phenylalanine + tyrosine) was the most abundant amino acid in okara flour and follow by lysine in such okara also. Meanwhile, the falafel contains 20%

okara has a considerable A/E ratio of phenylalanine + tyrosine and follow leucine as 219 and 194 mg essential amino acid of total essential amino acids , respectively. This result in agreement by FAO (1982) conducted that, the amino acid composition of Bissara and Falafel showed an appreciable increase in methionine content compared with raw beans, which can be attributed to the effect of the soaking process practiced in their production and/or the addition of some ingredients other than faba bean, such as onion, which are relatively high in sulfur containing amino acids. From these results in Table 8 , it could be noticed that, the biscuit which substituted by 20% okara containing with abundant amino acid of phenylalanine +tyrosine follows by leucine corresponding to A/E ratio as 236 and 197 respectively.

Table 8: A/ E ratio (mg essential amino acid of total essential amino acids) Comparison between the essential amino acids content of okara and different okara products with those of FAO reference protein (1985).

Essential amino acids	FAO/ WHO/UNU1985 Protein reference	100% okara flour (OK)	WF 100%	Falafel with 20 % okara (FO2)	Biscuit with 20 % okara (B2)
Lysine	148	183	74	172	142
Isoleucine	108	158	113	112	118
Leucine	189	135	245	194	197
Cysteine + Methionine	94	38	93	44	55
Phenyl alanine +Tyrosine	162	210	205	219	236
Threionine	108	131	83	106	100
Tryptophan	27	35	31	28	33
Valine	135	108	124	124	120

Okara flour 100% was contained a lower ratio of A/E ratio in both sulfur and tryptophan amino acids when compared to FAO/WHO/UNU (1985). Similar finding in biscuit and falafel formulas those contained 20% okara, were containing a lowest ratio of A/E ratio of tryptophan and sulfur containing amino acids in comparison to FAO/WHO/UNU (1985). In generally, the falafel and biscuits which were fortified by 20% okara contains the lysine, isoleucine, leucine and aromatic acids in considerably higher ratio of A/E rather than found in FAO/WHO/UNU (1985). The story is different in the amino acids of isoleucine, leucine, phenylalanine +tyrosine and tryptophans of FAO/WHO/UNU (1985) were contained appreciable A/E ratio than found in either falafel 20% okara or biscuit 20% okara.

All of various changes that obvious in A/E ratio of okara and their products were characteristics to the original concentrates of derived amino acids in okara, faba bean and WF. All of obtained results are indicated also by Gupta and Kapoor (1980) based on the amino acid composition, the protein of falafel was found, on the average, to be of higher nutritive value than those of other grain legumes. Therefore, the consumption of 150 g of falafel will cover about 77% of the daily requirements of adult man in limiting essential amino acids; other essential amino acids will be covered at higher levels, showing that 150 g of each faba bean product should be adequate for essential amino acids as well as for the daily requirements of protein (Bakr And Bayomy 1997).

Calculated of nutritional quality of protein:

The nutritional evaluation of protein of investigated okara and various fortified okara products are shown in Table 9. Protein efficiency ratio (PER) is 1.51 for okara flour. Meanwhile, the PER of fortified falafel with 20% okara is high into 2.84 and near to the result calculated to casein (2.89). Both of WF and formula of biscuit fortified with 20% okara have a similar PER about 2.8.

Table 9: Nutritional evaluation of supplemented Faba bean and wheat flour with okara for producing falafel and biscuit at different levels (g amino acid/16g nitrogen or g AA / 100 g protein)

Parameter	OK 100%	WF 100%	Falafel with 20 % okara (FO2)	Biscuit with 20 % okara (B2)	Casein as reference protein**
EAAI% *	67.03	72.80	67.58	72.92	78.97
Amino acid score (CS)	24.70	37.42	14.41	22.65	31.89
First Limiting	Met (24.70%)	Lysine (37.42%)	Met (14.41%)	Met (22.65%)	Met+Cys (31.89%)
Second Limiting	Cys (27.08%)	Met (38.23%)	Cys (54.58%)	Cys (63.33%)	Tryptophan (38.66%)
Estimated of PER ****	1.51	2.76	2.84	2.78	2.89
Biological value (BV)***	61.36	67.65	61.96	67.78	74.38

*** EAAI%: essential amino acid index %.**
****** PER, estimated protein efficiency ratio estimated according to Alsmeyer, (1974).**
**** Casein as standard protein is obtained from Zdunczyk *et al.,* (1999)**
***** Biological value was estimated according equation of Oser (1959)**
CS: chemical score and first & second limiting according to Block and Mitchell (1946) versus egg amino acid (%)
WF: wheat flour (72% extraction)
FO2: Falafel Pattie by addition 20 % wet OK. B2: Biscuit formula contain 20% OK , OK: Dried okara flour

The data from Table (9) showed that, methionine and followed by cystein were first and second limiting essential amino acids in okara flour , not only but also similar limiting in falafel and biscuit when fortify with 20% okara. Okara had the chemical score was 24.70% while casein 31.89%. Correspondingly, fortified falafel with 20% okara had a lower chemical score 14.4, this deficiency mainly in methionine as the first limiting amino acids.

Essential amino acid index (EAAI) of okara (67.03) was lower than obtained by the reference of casein 78.97. Nevertheless, the supplemented falafel with okara showing a similar EAAI for okara flour about 67.0. Unlike, for the fortified biscuit with okara, it was higher than 72.92 okara flour and nearest to EAAI of casein.

Biological value BV of okara and their products have similar values between okara flour and their products ranged from 61-68, while BV of casein is higher than 74.Generally consider to obtain results in Table (7) that, the addition of okara did not affect in essential amino acids of okara products.

Okara is containing considerable amounts of essential amino acid; that biologically more affiance to be improve nutritional status of different products by fortified with such as falafel and biscuits.

Biological evaluation:

Amino acid profiles of okara and there fortified products at 20% indicated that the okara was rich in some essential amino acids particularly, lysine, isoleucine, leucine, threonine, valine, tyrosine and phenylalanine . However, there seems to be deficiency in the quantities of sulfur containing and tryptophan corresponding to FAO/WHO/UNU (1985). These amino acids profiles was defiantly effected on the biological evaluation on the experimental rats which fed on okara and two formulas of falafel and biscuit fortified with 20% okara, the parameter of True Digestibility (TD) , Biological Values (BV) and Net Protein Utilization (NPU) were investigated in Table 10 against the reference of casein diet. These also were graphically depicted in column chart Fig 1. All of these values were similar to casein especially okara 100% in TD (91.06± 3.68) while casein (96.818 ± 2.53). Meanwhile, the TD of diets containing 20% okara in either falafel or biscuit were impressive 85.36 ± 6.40 and 86.68 ± 7.37, respectively. The Biological Value (BV) 70.732 ± 4.67 was obtained for rats on the reference protein. A noticeable decrease was happened in BV of okara (100%) and followed by falafel and biscuits formulated with 20% okara. These has a considerable decreases in BV for rats fed on falafel formula containing 20% okara 58.80 ± 1.55 corresponding to casein 70.732 ± 4.67.

Data in Table 10 and obvious in Fig 2 that, the NPU obtained by rats, the NPU of casein 68.676 ± 5.75 and followed by biscuit formula 20% okara 62.00 ± 5.70 were remarked higher than the values obtained for the okara (100%) 56.55 ± 7.83 and falafel formula 20% 52.16 ± 4.81. Generally the results were obtained from these experiment indicated that, rats retained the same amount of nitrogen in casein and for okara flour (100%) ,but okara products have defiantly a nutritional value arrived to okara and casein. Nevertheless, the above parameters had similar to values for rats when comparable with results obtained for soybean based diet (Agbed and Aletor, 2003). The presence of some anti nutritional factors such as saponin and oxalate which could be found in okara was probable factor that militated against the digestibility of crude protein and amino acids, by inhibiting a number of digestive enzymes in the gastrointestinal tract such as pepsin and trypsin (Cadwell, 1992 and Fasuyi, 2005).

Table 10: Biological evaluation by experimental rats fed on okara and their products

Biological parameters	Fed group on diet contain Casein	Fed group on diet contain OK (okara 100%)	Fed group on diet contain falafel with 20 % okara (FO2)	Fed group on diet contain biscuit with 20 % okara (B2)
True digestibility (TD) %	96.818 ± 2.53	91.06 ± 3.68	85.36 ± 6.40	86.68 ± 7.37
Biological value (BV) %	70.732 ± 4.67	62.02 ± 6.97	58.80 ± 1.55	60.63 ± 3.82
Net protein utilization (NPU)	68.676 ± 5.75	56.55 ± 7.83	52.16 ± 4.81	62.00 ± 5.70

Values are mean ± SD

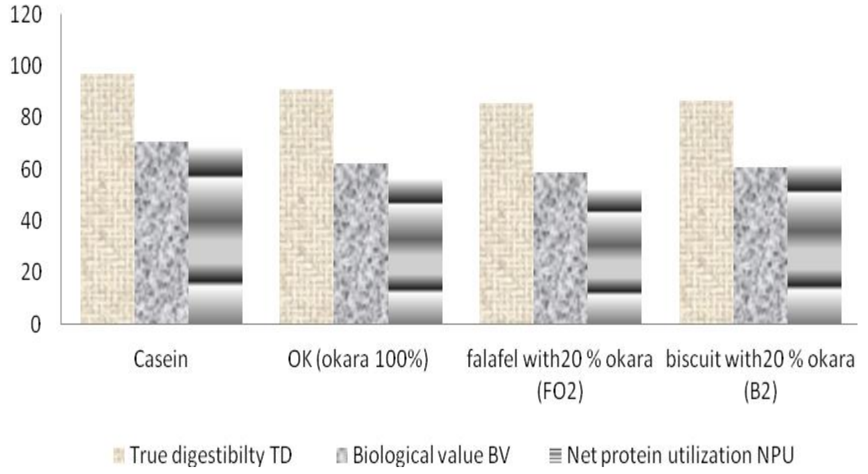

Fig. 2: Column chart of investigated biological evaluation protein of okara, and products of substitution okara flour used in falafel and biscuit formulas

CONCLUSION

Okara is a rich source of nutrients that could be utilized in bakery industry and falafel. The sensory attributes and physico-chemical characteristics of okara-substituted biscuit and falafel at 10 % and 20% level were not differ than that of the control wheat flour. Therefore okara could be utilized to improve the nutritional quality of biscuits and falafel as well as various okara products. The okara substitution in bakery industry would be beneficial in reducing the usage of wheat flour and also overcome the waste disposal problem prevailing in the soya milk industries. Also, using okara in falafel could be reduced faba bean in formula to improve nutritional quality and decline nutritional inhibitor. This only but also was increase economical values of valuable soy bean by-products.

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دراسات تغذويـة وتكنولوجية علي إستخدام المخلف الثانوي من الإوكـارا في تدعيم الإغذية المتدوالة من الطعمية والبسكويت

وائـل حلمـي موسـي الرفـاعي ، إيمـان محمـود راغـب ، حنـان محمـد أحمـد الغنـدور و شريف السيد علي بدر
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تعد الإوكارا من أهم المخلفات الثانوية والرخيصة والمغذية الناتجة عن تصنيع البان الصويا والتوفو مما قد يتح لها بدور مهم في إنتاج الأغذية المتداولة وأغذية السناك المعروفة. وإجريت هذة الدراسة بهدف تقييم الإوكارا والمنتجات الناتجة عنها غذائيا وبيولوجيا وكيماويا وكذلك الخواص الريولوجية والحسية بعد إضافتها بصورتها الرطبة للطعمية أوالمجففة لعجائن البسكويت وتروتحت نسب الإضافة من صفر و ١٠ و ٢٠ و ٣٠ % من الإوكارا في أي من صورتها .

وقد وجدت زيادة ملحوظة في محتوي البروتين والرماد والإلياف والمعادن الغذائية بنسبة بروتين ٩,٩% في حين كانت في دقيق القمح المستخدم ٦,٠٤%وذلك عند إستخدامة لعجائن البسكويت بنسبة إضافة ٣٠% أوكارا . وقد تفوقت نسبة الإضافة من الإوكارا ٢٠% لاي من البسكويت والطعمية في القابلية العامة عند تقيمها حسيا مقارنة بكل مستويات الإضافة من الإوكارا هذا بالاضافة الي أرتفاع محتوي الأحماض الأمينية الاساسية من اللايسين ٥,٨٣ و الثيرونين ٤,١٠ و الايزوليوسين ٤,٨٦ والليوسين ٨,١٠ والأروماتية ٩,٧٠ و الفالين ٤,٩٣ و التربتوفان ١,٣٥ وايضا الهستدين ٢,٨٨ (جم حمض اميني/ ١٦ جم نتروجين) وهو من أهم الأحماض الأمينية الاساسية للاطفال في سن ٢-٥ سنوات إعتمادا علي (1991) FAO/WHO وقد تفي نسبة أضافة ٢٠% لعجائن البسكويت لإحتياجات الأطفال في تلك المرحلة السنية بمصر غني ورخيص من الأحماض الأمينية الاساسية.

وقد وجد ان الاوكارا قد تفتقر الي الاحماض الإمينية الكبريتية مثل السيستئين و المثيونين بنسب تراوحت من ١٤,٤١- ٢٤,٧ جم حمض أميني/ ١٦ جم نتروجين لكلا من الاوكارا والمنتجات الناتجة عنها . أرتفع مستوي كفاءة البروتين المعروف ب PER وذلك عند تقييم الاوكارا والمنتجات المضافة لها بنسبة ٢٠% اوكارا وكانت ٢,٧٨ بالنسبة للبسكويت و ٢,٧٦ للطعمية في حين كانت للاوكارا فقط ١,٥١ ومن هنا كان لابد ان نوصي بتوسيع استخدام الاوكارا علي مدي أوسع في عجائن الحبوب والبقوليات.
بإجراء التقيم البيولوجي بأستخدام حيوانات التجارب وجد أن القيمة الحيوية للبروتين كانت عند مستويات مرتفعة تقارب كثيرا المتحصل عليه عند مقارنتها مع البروتين القياسي من الكازين وقد أتضح هذا في أرتفاع كلا من TDالمهضوم الحقيقي و BVالقيمة البيولوجية و NPU البروتين المستخدم الفعلي. ووجد ان القياسات الريولوجية او الفيزيقية الكميائية المجراة بواسطة الفارينوجراف من وجود علاقة قوية مابين زيادة القيم المتحصل عليها من الفارينو وزيادة نسبة الإضافة من الاوكارا وقد أستخدم نسب متتالية من الاوكارا مع دقيق القمح استخلاص ٧٢% بنسب للاوكارا ٠ و ١٠و ٢٠ و٣٠% فحدث زيادة امتصاص الماء تراوح الزيادة من ١٥,٧-٣١% مقارنة بعجائن الكنترول المحتوية علي ١٠٠% دقيق و كذلك زيادة كلا من زمن تطور العجينة وزيادة زمن الثبات للعجينة مع زيادة مستويات الإضافة محل الدراسة من الاوكارا. وقد أشارت الدراسة الي أن نسب الاضافة في الاوكارا عند مستوي ١٠-٢٠% سواء في عجائن البسكويت او الطعمية لها مردود في زيادة القيمة الحسية و الفزيقية الكميائية والجودة العامة هذا بالإضافة الي القيمة الغذائية لتلك المنتجات ومع زيادة الجدوي الاقتصادية للتخلص من مخلف عن صناعات الصوياوتقليل بعض المشاكل الناجمة عن إستخدام الفول فقط في الطعمية مع إيجاد منتج رخيص وصحي من البسكويت وخاصة أنه يكفي لتغذية مرحلة سنية من الاطفال عمر ٢-٥ سنوات.

بتحكيم البحث

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