Jurnal Teknologi

Full Paper

POTENTIAL USE OF OKARA AS MEAT REPLACER IN BEEF SAUSAGE

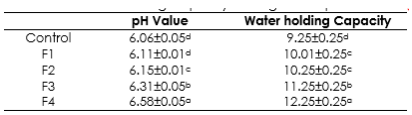
Noriham, A. [a,b*], Muhammad Ariffaizuddin, R.[a], Noorlaila, A.[a,b], Faris Zakry, A. N[a]

[a]Department of Food Science and Technology, Faculty of Applied Sciences, Universiti Teknologi MARA, 40450 Shah Alam, Selangor, Malaysia
[b]Malaysia Institute of Transport, Universiti Teknologi MARA, 40450 Shah Alam, Selangor, Malaysia

Article history
Received
1 September 2015
Received in revised form
30 November 2015
Accepted
22 January 2016

*Corresponding author
noriham985@salam.uitm.edu.my

Graphical abstract



	pH Value	Water holding Capacity
Control	6.06±0.05[d]	9.25±0.25[d]
F1	6.11±0.01[d]	10.01±0.25[c]
F2	6.15±0.01[c]	10.25±0.25[c]
F3	6.31±0.05[b]	11.25±0.25[b]
F4	6.58±0.05[a]	12.25±0.25[a]

Abstract

Processed meat products are particularly unhealthy because of high fat, preservative and salt content. This study is carried out with the aim to determine the physicochemical and sensorial properties of sausage incorporated with okara flour. There were four different sausage formulations labelled as Control (0% okara flour, 100% beef), F1 (10% okara flour, 90% beef), F2 (20% okara flour, 80% beef), F3 (30% okara flour, 70% beef) and F4 (40% okara flour, 60% beef). Formulations were subjected to proximate, water holding capacity, color, texture and sensorial analysis. Results for proximate composition, revealed that carbohydrate, ash and fiber content increased while moisture, fat and protein content decreased as the okara flour addition were increased. Water holding capacity (WHC) was found to increase as the incorporation of okara flour increased. In term of color analysis, increased in okara flour content in sausage significantly increased lightness (L*) and yellowness (b*) values while decreasing in redness (a*) value. As for textural properties, the values for hardness, cohesiveness, springiness and chewiness were decreased as the incorporation of okara flour increased. Sensorial results showed that F4 had the lowest overall acceptability due to its poor texture and unacceptable taste. Hence this study concludes that okara flour has the potential to replace meat at certain levels in sausage formulations which is not more than 20% okara flour.

Keywords: Okara, Sausage, Meat Replacer, Physicochemical Analysis, Sensory Evaluation

1.0 INTRODUCTION

Okara is the excess left from ground soybean after extraction of the water extractable fraction used to produce bean curd (tofu) or soy milk. It is generally white or yellowish in color. It is part of the traditional cuisines of Japan, Korea and China and also been used in the vegetarian cuisines of Western nations. The large usages of soybean lead to the rise of the quantities of okara production in the worldwide as in China about 2 800 000 tones of okara are produced from the tofu production industry every year (Ahn *et al*., 2010). A significant disposal problem is made by the yearly huge amount of production of okara. Sausages are consumed worldwide because of their convenience. All-beef or beef and pork-blend sausages contain approximately 24-28% fat and 320-325 kcal/100 g (Feiner, 2006; Giese, 1992). Over the past decades, there has been an increased interest in healthier food choices and health organizations have planned that the total fat intake should consist of less than 30% of the total calories to prevent high blood cholesterol, hypertension, obesity and colon cancer. Processed meats, such as bacon, ham and sausage

are particularly unhealthy because of their high fat, preservative and salt content. The addition of dietary fiber to meat products improves the nutritional value and enhances quality characteristics such as texture by increasing water and fat binding capacities. Hence this study was conducted with the aim to evaluate the potential use of okara as a meat replacer in beef sausage.

2.0 EXPERIMENTAL

2.1 Raw Materials

Okara paste was obtained from a local company in Gombak, Selangor, Malaysia. The minced beef, potato starch, white pepper, salt, sugar, beef flavor and shortening were purchased from Giant Supermarket Section 7, Shah Alam Selangor, Malaysia. Isolated soy protein (ISP), sodium tripolyphosphate (STTP), carrageenan and xanthan gum were obtained from the food processing laboratory of Faculty of Applied Sciences, Universiti Teknologi MARA (UiTM) Shah Alam, Malaysia. The oil emulsion was prepared by mixing shortening, ISP and iced water at 5:1:5.

2.2 Preparation of Okara Flour

Okara paste was dried at 60°C in cabinet drier until constant weight around 5% moisture content was obtained and then milled using a grinding mill. By using a sieve shaker, the milled flour was passed through in 120 mesh aperture size to obtain homogenized sized flour.

2.3 Ingredients

The ingredients for okara sausage are beef meat, okara flour, potato starch, white pepper, sodium tripolyphosphate (STTP), isolated soy protein (ISP), salt, sugar, beef flavor, iced water, shortening, carrageenan and xanthan gum.

2.3 Preparation of Okara Sausage

First, the beef meat was blend for 1 minute. Salt was added and was continuously blend for another 1 minute. Then, sugar and STTP were added and the batters were blend for 4 minutes. After that, other ingredients (potato starch, ISP, white pepper, beef flavor, okara flour, emulsion, carrageenan, xanthan gum and iced water) were added and blend for 4 another minutes. The mixture was transferred into cellulose casing by using stuffer and tied into 3 inch long sausage. The sausages were cooked in a Combi oven at 55°C (20 minutes), 65°C (20 minutes), 75°C (20 minutes) and 80°C (15 minutes) continuously. The sausages were then sprayed with tap water for 5 minutes and then immersed in ice water. Finally, sausage casing were removed and sausages were vacuum packed and stored at -4°C.

2.3 Methods

Proximate analysis and color measurement were determined by using methods from AOAC, 2000. Method for Water Holding Capacity (WHC) was, according to Zhang (1995) while for pH Measurement from Sallam *et al.* (2004). The method for texture profile analysis was, according to Gadiyaran and Kannan (2004) and method of sensory evaluation was, according to method from Stone and Sidel (1993). All of the data were subjected to analysis of variance (ANOVA) and Tukey's comparison of the means test.

3.0 RESULTS AND DISCUSSION

3.1 Proximate Analysis

The moisture content decreased significantly as the percentage of okara flour increased in the formulations. The moisture content of sausage ranged from 65.06% to 71.73% where Control formulation shows the highest moisture content while F4 shows the lowest moisture content. Moisture is the amount of water presence in the food as the component in relation to all the solid constituents such as protein, carbohydrates and non-liquid (Murano, 2003). The fat content of sausages ranged from 10.68% to 13.91% and the fat content decreased significantly as the okara flour increased in the formulations. The decrease in fat content was due to the addition of vegetable-based protein such as soy, wheat and peanut (Brewer, 2012). Besides, fat is mainly from the meat where it is a major contributor for fat in sausage products as compared to the plant based part which is okara flour.

The crude fiber content increased significantly throughout the formulations. The crude fiber ranged from 2.25% to 5.23%. The fiber was generally contributed by the incorporation of okara flour in the formulation, as stated by Wickramarathna *et al*. (2003), okara flour was reported to contain 6.66% fiber on dry basis. Furthermore, the increase in fiber content may occur because of soybean is a vegetable-based fiber: mixture of amylopectins and cellulosics (Brewer, 2012). The protein content ranged from 6.56% to 9.31% where the content decreased significantly as the okara flour increased in the formulations. As reported by Asgar *et al*. (2010), plant based origin has a high protein content which can increase the level of protein of a particular product. However, based on our result, the protein content decreased in content. Based on study by Quasem *et al*. (2009), the lower protein content was due to the substitution of meat protein with non-meat protein, since meat protein is more complete than non-meat protein. The ash content increased significantly from control, F1 and F2 but no significant difference were observed between F2 and F3. The ash value increased due to the incorporation of okara flour in the sausage where okara flour has higher ash content than the meat (Grizotto *et al*., 2012). According to the result, the ash content ranged from 3.25% to 7.39% where F4 has the highest ash content

while control formulation has the lowest ash content. The carbohydrate content ranged from 0.16% to 5.08%. The high amount of carbohydrate was provided mainly by the okara flour where the value is inversely related to the protein content in the sausages. Table 1 shows the results for proximate analysis of sausages incorporated with okara flour.

3.2 pH and Water Holding Capacity (WHC)

The pH values of sausage formulations ranged from 6.06 to 6.58 where the value increased significantly as the okara flour increased throughout the formulations. F4 formulation had the highest pH value compared to control, F1, F2 and F3. Yilmaz and Daghoglu (2003) stated that the addition of dietary fiber resulted in an increased in the pH of the meatballs (processed meat product). WHC increased significantly from control, F1, F2, F3 and F4 as the okara flour addition increased throughout the formulations. F4 had the highest WHC compared to the control and those of F1, F2 and F3. According to Thebaudin *et al*. (1997), significant increased in WHC may occur because of the addition of dietary fiber that improved the water binding properties in meat products. Table 2 shows the results for pH values and WHC of sausages incorporated with okara flour.

3.3 Color Measurement

The L* value increased throughout the formulations from 50.12 to 62.36 but no significant difference was observed between F2 and F4. The higher the L* value, the lighter the color of the sausage. According to the value obtained, the F4 has the lightest color as compared to the other sausages. As for sausages, a higher L* value indicates a lighter color, which is desirable and has high consumer acceptance (Dingstad *et al*., 2005). The lower the a* value, the lighter is the red color of the final product. The incorporation of okara flour in F1, F2, F3 and F4 had reduced the redness value of the sausages as compared to control that has 100% of meat constituent. In addition, an increased in plant constituents may result in the dilution of meat heme-pigment which is responsible for a darker red color of meat product (Pereira, 2011). Based on the b* value, the data increased significantly from 14.07 to 23.58 as the okara flour incorporation was increased in the formulation. Increased in b* value results in lighter yellow color. Sanjeewa *et al*. (2010) stated that an increased in b* value is due to the carotenoid pigment from okara flour. Table 3 shows the color of sausage formulations incorporated with okara flour.

3.4 Texture Profile Analysis

Based on the data obtained on the hardness of sausages (Table 4), it shows a significant decreased in value as the okara flour was increased in the formulation. A decrease in the hardness of sausage by the addition of texture-modifying ingredients may be associated with the water binding properties of the ingredient, such as soy protein, oat bran and starch where the ingredient may help absorb and retain moisture and finally give a tender end product (Yang *et al*., 2007). The lowest values were recorded for cohesiveness and springiness of the sausages as the okara flour incorporation was increased. This is because of the decrease in protein content of myofibril proteins, particularly myosin, which are responsible for the cohesiveness of cooked sausage ultimately affects mechanical properties; tensile and compressive strength (Daros, 2005). Another study done by Daros (2005), stated that substitution of common bean in meat muscle, dilutes the quantity of connective tissue in common bean-extended beef sausages and accounts for lower shear force values which result in lower cohesiveness, springiness as well as the chewiness values.

3.5 Sensory Evaluation

Based on the data obtained in Table 5, there were no significant difference ($p<0.05$) in appearance among Control, F1 and F2 (the scores ranged between 6.23 – 6.67 indicating the category of 'like slightly' to 'like moderately'), however there was a significant difference with F3 and F4 where the scores were in the category of 'like slightly' to 'neither like or dislike'). For color attributes Control sample was comparable with F4 in the category of 'like very much'. The least preferable sample was F3 while no significant difference were observed between F1 and F2 samples where both were in the category of 'like moderately'.
For odor attributes, F1 and F2 were comparable to Control where the panelist 'like very much' while they rated 'neither like or dislike' for F3 and F4. This could be due to the beany taste of okara flour. Brewer (2012) stated that the addition of large amounts of soy flour may cause the product to be soft and have undesirable taste. Acceptance of taste, reduced as the incorporation of okara flour increased throughout the formulations. This is mainly due to the beany taste contributed by the okara flour and also the consumer's perception where they are used to the meaty taste of commercialized sausage. For texture attributes, the mean score decreased significantly as the okara flour increased throughout the formulations.
Hoek *et al*. (2011), in their study reported that meat substitutes was not preferred by the panelist in overall sensory attributes.

4.0 CONCLUSION

Proximate compositions of sausages were significantly affected by the addition of okara flour. The increased in okara flour content resulted in poor textural properties in term of hardness, cohesiveness, springiness and chewiness. As for WHC, as the okara flour increased in the formulation, WHC also increased. In terms of color characteristics, the increase in okara flour content increased in L and b values but reduced

a values. According to sensorial evaluation, formulation F4 (40% okara flour, 60% beef meat) has the lowest overall acceptability score due to its poor texture and unacceptable taste). Hence it can be concluded that the incorporation of okara flour in the sausage formulations was not accepted in terms of taste and textural properties, but it has the potential to be used in the formulation of healthy sausage at a level not more than 20% okara flour. This is because it has the ability to reduce the fat content while increase in the fiber, ash and carbohydrate content. It is suggested that improvement of sensorial properties of sausages incorporated with okara flour should be conducted for future work.

Table 1 Proximate Composition of Sausages Incorporated with Okara Flour

	Moisture	Fat	Crude Fiber	Protein	Ash	Carbohydrate
Control	71.12±0.32^{a}	13.91±0.50^{a}	2.25±0.08^{e}	9.31±0.13^{a}	3.25±0.08^{d}	0.16±0.09^{e}
F1	70.13±0.41^{b}	13.01±0.54^{b}	2.76±0.12^{d}	8.82±0.32^{b}	4.23±0.34^{c}	1.05±0.34^{d}
F2	68.82±0.63^{c}	12.53±0.46^{b}	3.06±0.06^{c}	8.07±0.04^{c}	5.76±0.04^{b}	1.76±0.15^{c}
F3	66.16±0.59^{d}	11.71±0.04^{c}	3.87±0.11^{b}	7.34±0.04^{d}	7.29±0.01^{a}	3.63±0.57^{b}
F4	65.06±0.28^{e}	10.68±0.21^{d}	5.23±0.16^{a}	6.56±0.01^{e}	7.39±0.05^{a}	5.08±0.11^{a}

Means with different letter were significantly different at the level of p<0.05. Control (0% okara flour, 100% beef meat), F1 (10% okara flour, 90% beef meat), F2 (20% okara flour, 80% beef meat), F3 (30% okara flour, 70% beef meat) and F4 (40% okara flour, 60% beef meat).

Table 2 pH Value and Water Holding Capacity Sausages Incorporated with Okara Flour

	pH Value	Water holding Capacity
Control	6.06±0.05^{d}	9.25±0.25^{d}
F1	6.11±0.01^{d}	10.01±0.25^{c}
F2	6.15±0.01^{c}	10.25±0.25^{c}
F3	6.31±0.05^{b}	11.25±0.25^{b}
F4	6.58±0.05^{a}	12.25±0.25^{a}

Means with different letter were significantly different at the level of p<0.05. Control (0% okara flour, 100% beef meat), F1 (10% okara flour, 90% beef meat), F2 (20% okara flour, 80% beef meat), F3 (30% okara flour, 70% beef meat) and F4 (40% okara flour, 60% beef meat).

Table 3 Color of Sausage Formulations Incorporated with Okara Flour

	Lightness	Redness	Yellowness
Control	50.12±0.73^{d}	11.22±0.13^{a}	14.07±0.02^{d}
F1	57.74±0.06^{c}	7.65±0.02^{b}	16.58±0.06^{c}
F2	61.79±0.05^{a}	6.95±0.05^{c}	18.18±0.05^{b}
F3	60.15±0.01^{b}	4.81±0.02^{d}	23.21±0.01^{a}
F4	62.36±0.02^{a}	4.32±0.00^{d}	23.58±0.03^{a}

Means with different letter were significantly different at the level of p<0.05. Control (0% okara flour, 100% beef meat), F1 (10% okara flour, 90% beef meat), F2 (20% okara flour, 80% beef meat), F3 (30% okara flour, 70% beef meat) and F4 (40% okara flour, 60% beef meat).

Table 4 Texture Profile of Sausage Formulations Incorporated with Okara Flour

	Hardness (N)	Cohesiveness	Springiness	Chewiness (N)
Control	2336.62±89.14^{a}	0.67±0.02^{a}	0.91±0.02^{a}	71.73±0.32^{a}
F1	1732.98±41.76^{b}	0.59±0.01^{b}	0.86±0.02^{b}	69.53±0.33^{b}
F2	1261.98±46.76^{c}	0.51±0.01^{b}	0.82±0.02^{b}	68.83±0.63^{c}
F3	481.05±9.389^{d}	0.43±0.00^{c}	0.66±0.04^{c}	66.17±0.59^{d}
F4	461.99±15.59^{d}	0.37±0.00^{d}	0.61±0.02^{c}	65.06±0.28^{e}

Means with different letter were significantly different at the level of p<0.05. Control (0% okara flour, 100% beef meat), F1 (10% okara flour, 90% beef meat), F2 (20% okara flour, 80% beef meat), F3 (30% okara flour, 70% beef meat) and F4 (40% okara flour, 60% beef meat).

Table 5 Sensory Evaluation of Sausage Formulations Incorporated with Okara Flour

	Appearance	Color	Odor	Taste	Texture	Overall Acceptability
Control	6.67±1.57^{a}	8.00±0.91^{a}	8.13±0.71^{a}	8.03±1.33^{a}	8.03±1.56^{a}	8.13±0.33^{a}
F1	6.43±1.61^{a}	7.00±0.87^{b}	8.00±0.52^{a}	7.53±0.35^{b}	7.05±0.31^{b}	7.13±0.36^{b}
F2	6.23±1.31^{a}	7.00±0.57^{b}	8.00±0.82^{a}	6.23±0.61^{c}	6.00±0.51^{c}	6.49±0.61^{c}
F3	5.77±0.78^{b}	3.00±0.96^{c}	5.00±0.56^{b}	5.67±0.91^{d}	5.17±0.30^{d}	5.00±0.31^{d}
F4	5.00±0.91^{c}	8.00±0.82^{a}	5.13±0.71^{b}	3.13±0.28^{e}	3.13±0.22^{e}	3.00±0.28^{e}

Means with different letter were significantly different at the level of p<0.05. Control (0% okara flour, 100% beef meat), F1 (10% okara flour, 90% beef meat), F2 (20% okara flour, 80% beef meat), F3 (30% okara flour, 70% beef meat) and F4 (40% okara flour, 60% beef meat).

Acknowledgement

The authors are grateful to the Universiti Teknologi MARA for granting this project (Grant No: 600-RMI/FRGS 5/3 (147/2013)) and Rubiga Heritage Sdn. Bhd. for the supply of wet okara.

References

[1] Ahn, S. H., Oh, S. C., Choi, I., Han, G., Jeong, H., Kim, K., Yoon, Y. and Yang, I. 2010. Environmentally Friendly Wood Preservatives Formulated with Enzymatic Hydrolyzed Okara, Copper and/or Boron Salts. *Journal of Hazardous Materials.* 178: 606-611.

[2] Alison, J. M., Emeir, M. M., Geraldine, J. C., Bruce, W. M., Julie, M. W. W., Maxine, P. B.and Anna, M. F. 2010. Red Meat Consumption: An Overview Of The Risks And Benefits. *Meat Science*. *84*: 1-13.

[3] Akoh, C. C. 1998. Fat Replacers. *Journal of Food Technology*. 52: 47-53.

[4] Angor, M. M. and Al-Abdullah, B. M. 2010. Attributes of Low-Fat Beef Burgers Made from Formulations Aired at Enhancing Product Quality. *Journal of Muscle Foods.* 21(2): 317-326.

[5] AOAC. 2000. *Official Methods of Analysis of The Association of The Analytical Chemists.* 17th Ed. Inc. Virginia, USA.

[6] Arihara, K. 2006. Strategies for Designing Novel Functional Meat Products. *Meat Science*. 74: 219-229.

[7] Asgar, M. A., Fazilah, A., Huda, N., Bhat, R. and Karim, A. A. 2010. Nonmeat ProteinAlternatives as Meat Extenders and Meat Analogs. *Comprehensive Reviews in Food Science and Food Safety*. 9: 513-529.

[8] Ayo, J., Carballo, J., Serrano, J., Olmedilla-Alonso, B., Ruiz-Capillas, C. and Jiménez-Colmenero 2007. Effect of Total Replacement of Pork Backfat Withwalnut on The Nutritional Profile of Frankfurters. *Meat Science. 77*: 173-181.

[9] Batista, K. A., Prudencio, S. H. and Fernandes, K. F. 2010. Changes in The Functional Properties and Antinutritional Factors of Extruded Hard-To-Cook Common Beans (*Phaseolus vulgaris*, L.). *Journal of Food Science.* 75: 286-290.

[10] Biesalski, H. K. 2005. Meat as A Component of A Healthy Diet — Are There Any Risks or Benefits If Meat Is Avoided in The Diet? *Meat Science.* 70(3): 509-524.

[11] Brewer, M. S. 2012. Reducing The Fat Content in Ground Beef without Sacrificing Quality: A Review. *Meat Science.* 91: 385-395.

[12] Campagnol, P. C. B., dos Santos, B. A., Wagner, R., Terra, N. N. and Pollonio, M. A. R. 2011. Amorphous Cellulose Gel as A Fat Substitute in Fermented Sausages. *Meat Science.* 90(1): 36-42.

[13] Cengiz, E. and Gokoglu, N. 2005. Changes in Energy and Cholesterol Contents of Frankfurter-Type Sausages With Fat Reduction and Fat Replacer Addition. *Food Chemistry*. 91: 443-447.

[14] Cierach, M., Modzelewska-Kapitula, M. and Szaciło, K. 2009. The Influence of Carrageenan On The Properties of Low-Fat Frankfurters. *Meat Science*. *82*: 295-299.

[15] Chang, H. C. and Carpenter, J. A. 1997. Optimizing Quality of Frankfurters Containing Oat Bran and Added Water. *Journal of Food Science.* 62: 194-202.

[16] Daros, F. G., Masson, M. L. and Amico, S. C. 2005. The Influence of The Addition of Mechanically Deboned Poultry Meat on The Rheological Properties of Sausage. *Journal of Food Engineering.* 185-189.

[17] Day, L. 2013. Proteins from Land Plants-Potential Resources for Human Nutrition and Food Security. *Trends in Food Science & Technology*. *32*: 25-42.

[18] Dingstad, G. I., Kubberoda, E., Naesa, T. and Egelandsdal, B. 2005. Critical Quality Constraints of Sensory Attributes in Frankfurter Type Sausage to be Applied in Optimization Model. *LWT. 38*: 665-676.

[19] Dzudie, T., Scher, J. and Hardy, J. 2002. Common Bean Flour as An Extender in Beef Sausages. *Journal of Food Engineering. 52*: 143-147.

[20] Egbert, R. and Borders, C. 2006. Achieving Success with Meat Analogs. *Food Technology Chicago.* 60: 28-34.

[21] Endres, J. G. 2001. Protein Quality and Human Nutrition. In J. G. Endres (Ed.). *Soyprotein Products: Characteristics, Nutritional Aspects, And Utilizatio.* AOCS. 10-19.

[22] Essien, E. 2003. *Sausage Manufacture:Principles and Practice*. Woodhead Publishing Ltd and CRC Press LLC. 15-20.

[23] Eva, H., de la H., Lorenzo and Juan, A. O. 1997. Contribution of Microbial and Meat Endogenous Enzymes to The Lipolysis of Dry Fermented Sausages. *Journal of Agricultural and Food Chemistry.* 45(8): 2989-2995.

[24] Granato, D. and Masson, M. L. 2010. Instrumental Colour and Sensory Acceptance of Soy-Based Emulsions: A Response Surface Approach. *Journal of Science and Technology*. 30: 1090-1096.

[25] Grizotto, R. K., de Andrade J. C., Miyagusku, L. and Yamada, E. A. 2012. Physical, Chemical, Technological and Sensory Characteristics of Frankfurter Type Sausage Containing Okara Flour. *Ciencia e Tecnologia de Alimentos.*

[26] Hoek, A. C., Luning, P. A., Weijzen, P. A., Engels, W., Kok, F. J. and Graaf, C. 2011. Replacement of Meat By Meat Substitutes. A Survey on Person- and Product-Relatedfactors In Consumer Acceptance. *Appetite*. 56: 662-673.

[27] James, C. S. 1995. Analytical Chemistry of Food. Seale-Hayne Faculty of Agriculture, Food and Land use. Department of Agriculture and Food studies. University of Plymouth, UK. 1: 96-97.

[28] Jiménez-Escrig, A., Tenorio, M. D., Espinosa-Martos, I. and Rupérez, P. 2008. Health Promoting Effects of A Dietary Fiber Concentrate from The Soybean By-Productokara in rats. *Journal of Agricultural and Food Chemistry.* 56: 7495-7501.

[29] Jones, J., Lineback, D. and Levine, M. 2006. Dietary Reference Intakes: Implications for Fiber Labelling and Consumption. *Nutrition Reviews.* 64: 31-38.

[30] Kurokochi, K., Matsuhashi, T., Nakuzawa, M. and Nakazawa, A. 1977. Use of Okara Powder for Bread. *New Food 2nd.* 19(12): 49-53.

[31] Mansour, E. H. and Khalil, A. H. 1997. Characteristic of Low-Fat Beef Burger as Influenced By Various Types of Wheat Fibers. *Food Research international.* 30: 199-205.

[32] Maskus, H. 2010. Pulse Processing, Functionality and Application. *Food Science.* 146.

[33] Mateos-Aparicio, I., Redondo-Cuenca, A. and Villanueva-Suárez, M. J. 2010. Isolation and Characterisation of Cell Wall Polysaccharides from Legume By-Products: Okara(soymilk residue), Pea Pod and Broad Bean Pod. *Food Chemistry.* 122: 339-345.

[34] McAfee, A. J., McSorley, E M., Cuskelly, G. J., Moss, B. W., Wallace, J. M. W., Bonham, M. P. and Fearon, A. M. 2010. Redmeat Consumption: An Overview Of The Risks And Benefits. *Meat Science.* 84: 1-13.

[35] Murano, P. S. 2003. *Understanding Food Science and Technology*. Thomson Wadsworth. 159: 167-168.

[36] Nurul, H., Alistair, T. L. J., Lim, H. W. and Norhayati, I. 2010. Quality Characteristics of Malaysia Commercial Beef Frankfurters. *International Food Research Journal.* 17: 469-476.

[37] Ordóñez, M., Rovira, J. and Jaime, I. 2001. The Relationship Between The Composition and Texture of Conventional and Low-Fat Frankfurters. *International Journal of Food Science and Technology*. *36*: 749-758.

[38] Pearson, A. M. and Gillet, T.A. 1996. *Processed Meat.* Technology and Engineering. 3rd Edition. Aspen Publisher, Inc. 210-238.
[39] Pereira, A. G. T., Ramos, E. M., Teixeira, J. T., Cardoso, G. P., Ramos, A. L. S. and Fontes, P. R. 2011. Effects of The Addition of Mechanically Deboned Poultry Meat and Collagen Fibers on Quality Characteristics of Frankfurter-Type Sausages. *Meat Science.* 89: 519-525.
[40] Pietrasik, Z. and Janz, J. A. M. 2010. Utilization of Pea Flour, Starch-Rich and Fiber-Rich Fractions in Low Fat Bologna. *Food Research International.* 43: 602-608.
[41] Pietrasik, Z., Jarmoluk, A. and Shand, P. J. 2007. Effect of Non-Meat Proteins On Hydration And Textural Properties Of Pork Meat Gels Enhanced With Microbial Transglautaminase. *Food Science Technology.* 40: 915-920.
[42] Prinyawiwatkul, W., Mcwatters, K. H., Beuchat, L. R. and Philips, R. D. 1997. Optimizing Acceptability Of Chicken Nuggets Containing Fermented Cowpea And Peanut Flours. *Journal of Food Science.* 62: 889-893.
[43] Quasem, J. M., Mazahreh, A. S. and Al-Shawabkeh, A. F. 2009. Nutritive Value Of Seven Varieties Of Meat Products (Sausage) Produced In Jordan. *Pakistan Journal of Nutrition.* 8: 332-334.
[44] Rebello, C. J., Greenway, F. L. and Finley, J. W. 2014. A Review Of The Nutritional Value Of Legumes And Their Effects On Obesity And Its Related Co-Morbidities. *International Association for the Study of Obesity.* 15: 392-407.
[45] Riaz, M. N. (2004). Texturized Soy Protein as An Ingredient. *Proteins In Food Processing.* Woodhead Publishing Limited and CRC Press LLC. 517-570.
[46] Riley, H. and Buttriss, J. L. 2011. A UK public health perspective: what is a healthy sustainable diet?. *British Nutrition Foundation Nutrition Bulletin.* 36: 426-431.
[47] Samadrita, S., Minakshi, C., Jayati, B. and Bhattacharya, D. K. 2012. Study On The Effects Of Drying Process On The Composition And Quality Of Wet Okara. *International Journal of Science Environment and Technology.* 1(4): 319-330.
[48] Sanjeewa, W. G. T., Janitha, P. D., Wanasundara, Z. and Phyllis, J. S. 2010. Characterization Of Chickpea (*Cicer Arietinum L.*) Flours And Application In Low-Fat Pork Bologna As A Model System. *Food Research International. 43*: 617-626.
[49] Schonfeldt, H. C. and Hall, N. G. 2012. Consumer Education On The Health Benefits Of Red Meat – A Multidisciplinary Approach. *Food Research International. 47*: 152-155.
[50] Shalene, H. M., Kerri, B.H., Thomas, G. F. and Mary, E. V. E. 2011. The Evolution Of Lean Beef: Identifying Lean Beef In Today's U.S. Marketplace. *Meat Science.* 90(*1)*:1-8.
[51] Su, Y. K., Bowers, J. A. and Zayas, J. F. 2008. Physical Characteristics And Microstructure Of Reduced-Fat Frankfurters As Affected By Salt And Emulsified Fats Stabilized Withnonmeat Proteins. *Journal of Food Science*. *65*: 123-128.
[52] USDA and USDHHS. 1995. *Nutrition and Your Health: Dietary Guidelines for Americans.* 4th Edition. Home and garden bulletin, No. 232, Washington, D.C.: U.S. Dept. Agriculture and U.S. Dept. Health and Human Services.
[53] Weiss, J., Gibis, M., Schuh, V. and Salminen, H. 2010. Advances In Ingredient And Processing Systems For Meat and Meat Products. *Meat Science.* 86(*1)*: 196-213.
[54] Wickramarathna, G. L. and Arampath, P. C. 2003. Utilization of Okara in Bread Making. *Ceylon Journal Science.* 31: 29-33.
[55] Valencia, I., O'Grady, M. N., Ansorena, D., Astiasaran, I. and Kerry, J. P. 2008. Enhancement of The Nutritional Status And Quality Of Fresh Pork Sausages Following The Addition Of Linseed Oil, Fish Oil And Natural Antioxidants. *Meat Science.* 80: 1046-1054.
[56] Youssef, M. K. and Barbut, S. 2011. Fat Reduction In Comminuted Meat Products—Effects Of Beef Fat, Regular And Pre-Emulsified Canola Oil. *Meat Science.* 87(4): 356-360.