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EFFECT OF USING DIFFERENT LEVELS OF CAMEL FAT (HUMP FAT) ON PHYSIOCHEMICAL COMPOSITION OF SAUSAGE FROM BEEF CAMEL AND CHICKEN

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ABSTRACT

This study was conducted to determine the effect of various levels of hump fat (HF) used in manufacturing of camel, beef and chicken sausage to understand the effect of (HF) on physicochemical composition sausage, Different levels of hump fat (5, 7, and 10 %) were used, physicochemical compositions like (moisture, protein, fat, Ash, water holding capacity, shrinkage, cooking loss and pH) were determined. Results of the study revealed that moisture content showed high significant differences (P≤0.01)among treatments groups, Camel sausage and beef sausage tended to have highest values while chicken sausage reported the lowest value. The study showed no significant difference (P≤0.05) among the treatment groups although 7% HF reported the highest value of moisture. Crude protein values showed no significant differences depending on sausage type, while it exhibited significant differences (P≤0.05) among the treatments groups and 7% HF reported the highest value. Ether extract values showed no significant difference (P≤0.05) among the treatments groups due to both sausage type and Hump fat level. Due to sausage types ash values showed significant differences (P≤0.05) among treatments where camel sausage samples showed the highest value while chicken sausage samples showed the lowest value. Concerning to Water Holding Capacity (W.H.C) sausage type factor reported no significant differences (P≤0.01)among treatments group. Due to hump fat levels the study showed highly significant differences (P≤0.05) among the treatment groups although 7% HF reported the highest value. On the other hands Cooking Loss, Shrinkage and pH showed no significant difference (P≤0.05) among the treatment groups in both factors types of sausage and different levels of hump fat. Hump fat in percentage 5%, 7% and 10% could be incorporate in sausage formulation and the best level of fat in sausage formulation has 7%.

Keywords: Sausage, beef, camel, chicken, hump fat, physiochemical.

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تأثير استخدام مستويات مختلفة من دهن الإبل (HUMP FAT) على التركيب الفيزيوكيميائي للنقانق من لحوم البقر والجمل والدجاج

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الخلاصة

أجريت هذه الدراسة لمعرفة تأثير المستويات المختلفة لدهن سنام (HF) المستخدمة في تصنيع سجق الإبل ولحم البقر والدجاج لفهم تأثير (HF) على التركيب الفيزيوكيميائي للسجق، تم استخدام مستويات مختلفة من دهن السنام (٥، ٧ و ١٠) ٪، وتم تحديد التركيب الكيميائية والخواص الفيزيائية مثل (الرطوبة، البروتين، الدهن، الرماد، سعة الاحتفاظ بالماء، الانكماش، الفاقد في الطبخ ودرجة الحموضة). أظهرت نتائج الدراسة أن المحتوى الرطوبي سجل اختلافًا معنويًا عاليًا($P\leq 0.01$)بين مجموعة المعاملة واظهر ان سجق الإبل وسجق لحم البقر تميل إلى أعلى القيم بينما سجلت نقانق الدجاج أدنى قيمة، وبينت الدراسة عدم وجود فرق معنوي ($P\leq 0.05$) بين مجموعة المعاملة على الرغم من أن ٧٪ HF سجلت أعلى قيمة للرطوبة، أظهرت قيم البروتين الخام عدم وجود فروق معنوية تبعاً لنوع السجق، بينما أظهرت الدراسة فروقاً معنوية ($P\leq 0.05$) بين مجموعات المعاملة اذ سجلت معاملة ٧٪ HF أعلى قيمة.. أظهرت قيم مستخلص الأثير عدم وجود فرق معنوي ($P\leq 0.05$) بين مجموعات المعاملة يعزى ذلك إلى كل من نوع السجق ومستوى دهن السنام. نتيجة لأنواع النقانق أظهرت نتائج قيم الرماد في هذه الدراسة فروق معنوية ($P\leq 0.05$) بين المعاملات حيث أظهرت عينات نقانق الإبل أعلى قيمة بينما أظهرت عينات نقانق الدجاج أقل قيمة. اما بما يتعلق بسعة الاحتفاظ بالماء، لم يلاحظ ا نوع النقانق أي اختلاف معنوي($P\leq 0.01$)بين مجموعة المعالجة. أظهرت الدراسة فرقاً معنوياً عالياً ($P\leq 0.05$) بين مجموعات المعالجة بسبب مستويات دهون السنام بالرغم من أن ٧٪ HF سجلت أعلى قيمة. من ناحية أخرى ، لم يظهر فقدان الطهي والانكماش ودرجة الحموضة أي فرق معنوي ($P\leq 0.05$) بين مجموعات المعالجة في كلا النوعين من أنواع السجق ومستويات مختلفة من دهون السنام. اظهرت الدراسة يمكن اضافة دهن السنام بنسبة ٥ و٧ و ١٠٪ في تركيبات السجق وكان أفضل مستوى للدهن في صناعة السجق هو ٧٪.

الكلمات المفتاحية: سجق، لحم بقر، جمل، دجاج، دهون سنام، فيزيوكيميائية.

INTRODUCTION

Meat define as the part or whole of the carcass of any buffalo, cattle, camel, sheep, goat, hare, deer, rabbit or poultry slaughtered, but does not include fetuses or eggs. Meat is high energy and contains high-value biological protein type of food; considered to be the food of choice due to its nutritional value **(Williams, 2007)**. Noticed **Ali (2018)** that meat and meat products provide essential components in the diets of human beings. However, their consumption is affected by various factors, the most important of which are product characteristics (nutritional and sensory properties, price, safety, convenience, etc.).

Meat manufacturing comprise activities and processes used to modify the characteristics of fresh meat and this comprise freezing, drying, cooking, smoking, curing, canning, production of moderate moisture products and the used of specific additives like chemicals and enzymes **(Karmlich *et al.*, 1975)**. Manufacturing provides domain to mingle desirable parts of many substances in addition to incorporating other food items like cereals in meat products **(FAO, 1992).**

According to (**Elkreeny, 2000)** manufacturing of meat increases the nutritional level of the product, with reduced costs and ease to preparation of meals in simple and quick ways. Meat is still considered an essential component in a balanced and healthy diet, being an excellent source of high quality proteins, minerals, trace elements and vitamins **(Biesalski, 2005)**. In recent years, when referring to meat products manufacture, an increased attention has been paid to its physiological characteristics, viewed as an issue of a healthy diet, because of the high incidence of nutritionally related diseases. Consumers began to realize that a healthy and balanced nutrition is primordial step in order to maintain a good health condition. It is known that for a healthy diet essential nutritional components have to be found in a well-defined percentages of 55-60% for carbohydrates, 15-20% for proteins and 20-25% for fat. **(Wycherley *et al.*, 2012)**.

Sausages as processed meat products are used in different and diverse cultures around the world **(Savadkoohi *et al.*, 2014).** Sausage has evolved as a very diverse meat product. Many varieties have been developed, influenced by climate, religion, and availability of ingredients. Although sausage has been around for hundreds of years, food science, borne from both financial and public health interests, is a relatively new development. **(Marapana *et al.*, 2018).**

However, processed meat products contain high levels of saturated fat and salt and high consumption leads to the risk of obesity, diabetes and cancer. Due to chemical composition of different types of sausage **(Abdelmageed, 2013)** studied comparison between gizzard Sausage, beef and gizzard and reported a significant different between the raw beef, raw gizzard and gizzard sausage for moisture, protein, fat and ash. Several authors have done many researches on meat and meat processing **(Ali, 2018; Abdelmageed, 2013)**. The objective of this study was to assess and evaluate chemical and physical composition of different types of sausage with different types and levels of fat.

MATERIALS AND METHODS

Site of the study

This study was conducted in Meat laboratory, Department of Meat Production and Technology- Faculty of Animal production, University of Gezira76 kilometers west Wad Medani, Gezira State.

Experimental Design

A total of 12 kg each of beef, camel and chicken meat were selected from Almanagil butchery house and Wad Medani, Supermarket. Hump fat and mutton fat were obtained from Almanagil slaughter- house. The experiment was designed as factorial arrangement (3×3×3) with CRD design.

Sausage formulation

Table (1): Sausage formulation

	Sausage Type		
	Beef	Camel	Chicken
Ingredients (%)			
Lean meat	70	70	70
Hump fat	5, 7 and 10	5, 7 and10	5, 7 or 10
Ice water	6.5	6.5	6.5
Rice	4.4	4.4	4.4
Potato	4.4	4.4	4.4
Chickpea	3	3	3
Skim milk	2.7	2.7	2.7
Spices	2.2	2.2	2.2
Salt	1.5	1.5	1.5
Sugar	0.3	0.3	0.3
Total	100	100	100

Sausage manufacturing

Beef and camel meat were selected from hindquarter, shoulder fillet muscle but chicken meat was obtained from all muscles after deboning the carcass. Fat was added at different levels 5.0, 7.0 and 10.0%, and were used after grinding through a plate of 0.5 cm diameter. Potatoes as a filler was cooked under pressure for 15 min and ground through plate of 0.5 cm diameter. Additives and spices like cinnamon, black pepper, and garlic were cleaned, crushed and added to the mixture. All ingredients were mixed and homogenized manually for emulsification, followed by stuffing using conventional casings (sheep small intestine) with stuffer machine (model and manufacturer), after which the product was kept inside labeled sacs and kept in deep freezer at -18°C for analysis.

Chemical and physical analysis in sausage

A proximate chemical analysis of moisture, ash, ether extract, protein and fat was done according to Association of Official Analytical Chemists **(AOAC, 1990)** method. For the eighteen sausage samples transported hygienically to laboratory of Faculty of Agriculture, University of Khartoum -Shambat. Chemical analysis included moisture, protein, fat and water content. The chemical composition of sausage was determined in the following manner: protein content by Kjeldahl method and multiplying by factor 6.25; fat content by Soxhelt method, and water content by drying samples at 105°C. The physical analyses was performed in duplicate. W.H.C, shrinkage, cooking loss and pH were determined.

Statistical Analysis.

Data were analyzed using factorial arrangement (3×3×3) with a completely randomized design (CRD) and Univariate of variance, Analysis were performed in duplicate, Differences in treatment means were compared by Duncan multiple range tests **(Steel & Tories, 1980)** and (**ANOVA**) with confidence level of 5($P \leq 0.05$), by using SPSS version 23 computer programs.

RESULTS AND DISCUSSION

Chemical composition

The result in (Table 1) shows chemical composition of different types of sausage with different levels of fat. Concerning moisture content sausage type factor reported high significant different (P≤0.01) among treatments group, camel sausage and beef sausage tended have the highest values while chicken sausage reported the lowest moisture value. This is because of lowest value of chicken moisture content compared to beef and camel meat **(Carvalho *et al.*, 2013)**. Due to hump fat levels the study showed no significant difference (P≤0.05) among the treatment groups although 7% HF reported the highest value. These differences might be resulted from variations in pre-slaughtering and post-slaughtering or the various source of meat, age of animals, the site of muscles and source of nutrition. Crude Protein values showed no significant differences depending on sausage type, while it exhibited significant differences (p≤0.01) due to hump fat levels. the inclusion of HF at 7% resulted in higher protein contents compared using 10% HF. These differences might have resulted from variations source of meat, age of animals, the type of muscles and source of nutrition. Ether extract values showed no significant difference (P≤0.05) among the treatments groups due to both of the sausage type and hump fat level. Due to sausage types Ash values results in this study showed significant differences (P≤0.05) among treatments where camel sausage sample showed the highest value while chicken sausage samples showed the lowest value. When results depend on hump fat level the ash value showed significant differences (P≤0.05) among treatments where the sample of 7% hump fat showed the highest value while 10% hump fat showed the lowest value , These differences might be resulted from variations source of meat, age of animals, the type of muscles and source of nutrition.

For chemical composition of beef sausage, the percent of moisture showed higher value when compared to the results presented by **(Hidayat *et al.*, 2018; Nafiseh *et al.*, 2010; Ibrahim, 2008)** who found that the moisture of beef sausage 61.29±1.88, 57.56 and 48.7±0.60% respectively, but, lower than that reported by **(Elhashmi *et al.*, 2021; Atef *et al.*, 2015; Alamin, 2014; Mohammed, 2009; Agnihotri & Pal, 2000)** who found that the moisture content beef sausage as 68.95±0.41, 72.43, 70.32±1.12, 68.91±0.01, 65.31 and 66.71% respectively.

Protein percentage in the present research scored higher value compare to results of many authors like **(Elhashmi *et al.*, 2021; Hidayat *et al.*, 2018; Ibrahim 2008)** were found results as follow protein content beef sausage as 14.00±0.006, 14.09 and 14.02±2.29% respectively, but, lower than that reported by **(Alamin 2015; Nafiseh *et al.*, 2010; Mohammed 2009)** who found that the protein content beef sausage as 17.55, 18.53, 22.66±0.03, 18.8 and 20.47% respectively.

The percentage of ether extract in present research scored higher value than the results of **(Elhashmi *et al.*, 2021; Alamin 2015)** who found Ether extract content of beef sausage as 0.83±0.006, 7.79, 3.45, 6.17±0.03 and 7.07% respectively, but, lower than that reported by **(Hidayat *et al*., 2018; Atef *et al*., 2015; Nafiseh *et al.*, 2010; Ibrahim, 2008)** who found that the content beef sausage as 20, 16.49, 12.16±1.87 and 16.8% respectively.

Ash percentage in present investigation showed higher values than the results of **(Ibrahim, 2008)** who found that the ash content in beef sausage was 1.07%. The result of this study similar to that finding of **(Elhashmi *et al*., 2021; Mohamed, 2009)** who found that the percentage of ash in beef sausage to be 2.04±0.02 and 2.02% respectively, but lower compared to results revealed by **(Atef *et al*., 2015)** who reported 9.5 and 2.27±0.02% respectively.

As for chemical composition of camel sausage the moisture percent showed higher value than the findings of **(Nafiseh *et al.*, 2010)** who found that the moisture of camel sausage

to be 57.56% but, lower than that reported by **(Alamin, 2014)** who found that the moisture content of camel sausage to be 73. 45 and 69.15±0.01% respectively.

The percentage of protein revealed higher value than the results of several authors like **(Alamin, 2015; Nafisa *et al.*, 2010)** whom found the percentage as 16.0 and 15.9% respectively.

The percentage of ether extract scored higher value than that reported by **(Alamin, 2015)** who found that the percentage of ether extract content in camel sausage were 2.31 and 6.13 ± 0.01% respectively, but, lower than that reported by **(Nafiseh *et al.*, 2010)** who found the percentage of ether extract content in camel as 13%.

Ash percent showed higher value than the findings of **(Alamin 2015)** who found that the who found the ash content of camel sausage as 2.0 and 2.32±0.02% respectively.

For chemical composition of chicken sausage, the percentage of moisture in the present investigation showed higher values compare to finding of **(Kwoan-Sik *et al*., 2012; Souzan *et al*., 2011)** who found that the value of moisture in chicken sausage was 55.87±0.54 and 53.41% respectively, but, lower than that recorded by **(Huda *et al*., 2010)** who reported moisture content in chicken sausage was 64.86±0.19%.

The percentage of protein showed higher values when compared to results of several authors like **(Kwoan-Sik *et al*., 2012; Huda *et al*., 2010;)** who found that the percentage of protein in chicken sausage was 14.18 ±0.83 and 9.79±0.31% respectively, but, lower than that recorded by **(Souzan *et al*., 2011)** who found that the percentage of protein in chicken sausage was 13.54%.

Ether extract showed lower value than the results of **(Kwoan-Sik *et al*., 2012; Souzan *et al*., 2011; Huda *et al*., 2010)** who reported that the ether extract content chicken sausage as 27.40±0.88, 19.56 and 14.49±0.24% respectively.

Ash percentage showed higher value when compared to those reported by **(Huda *et al.*, 2010)** who found that the ash content in chicken sausage was 1.95±0.08% but, lower than as reported by **(Kwoan-Sik *et al*., 2012; Souzan *et al*., 2011)** who reported the percentage of ash in beef sausage were 2.28±0.02 and 3.29% respectively.

Table (1): Chemical composition of beef, camel and chicken sausage.

Factor A (Sausage Type)	Moisture	Crud Protein	Ether extract	Ash
Beef	63.83[a]	16.93	8.61	2.03[a]
Camel	63.99[a]	16.92	9.12	2.15[a]
Chicken	59.93[b]	16.94	8.43	1.72[b]
S.E	0.68	0.34	0.68	0.10
Sig	**	NS	NS	*
Factor B (Hump fat levels)				
5%	62.58	16.94[a]	8.87	1.96[b]
7%	63.14	17.97[a]	9.20	2.96[a]
10%	62.03	15.93[b]	8.10	0.96[c]
S.E	0.68	0.34	0.68	0.10
Sig	NS	**	N S	***

***Means in the same column with different superscripts are significantly different (p<0.05).**
****Means in the same column with different superscripts are highly significantly different (p<0.01).**
N S: No-significance differences

Physical composition analysis

The results in (Table 2) shows the average values of percentage water holding capacity, cooking loss, shrinkage and pH. Concerning to water holding capacity sausage type factor reported no significant differences (P≤0.01) among treatment groups, of camel sausage and beef sausage, but numerically beef sausage tended to have higher values compared to chicken sausage. Due to hump fat levels the study showed highly significant difference (P≤0.05) among the treatment groups although 7% HF reported the highest value .This differences might be due to the pre and post slaughter metabolism.

On the other hand, cooking loss, shrinkage and pH showed no significant differences (P≤0.05) between treatments in both factors types of sausage with different levels of hump fat. The results shows that beef sausage samples had the highest cooking loss and the lowest value recorded by chicken sausage samples, while the sausage samples with 7% HF showed the highest value and treatment 10% recorded the lowest value concerning to hump fat level. This differences were attributed to different properties of different meat types and differences in levels of fat on sausage formulation, the conditions of processing and the cooking method. Samples of camel sausage appear as the highest value of shrinkage while beef sausage recorded the lowest value regarding factor of sausage type of with regards to hump fat percentage concerned the samples of 7% level recorded the highest value while 10% level samples had the lowest value. Camel sausage samples as the results shows recorded the highest pH value while chicken sausage samples recorded the lowest when factor of sausage type was concerned. On the other hand sausages with 7% HF recorded as highest value and samples of sausage with 5% HF appear as lowest value regarding to the factor of hump fat percentages a factor.

Water holding capacity (W.H.C) in present research disagree with the results of (**Hidayat *et al.*, 2018)** who found that the water holding capacity of beef sausage as 86.58±1.33%, but the result of this study were lower than that found by **(Zaki, 2017)** who reported that camel sausage water holding capacity was 8.64% , and also lower than those recorded by **(Marapana *et al.*, 2018)** who recorded chicken sausage water holding capacity as 45.27±0.12%.

The results of the present investigation showed higher values of cooking loss. This finding was close to those reported by **(Nafiseh *et al.*, 2010)** who found that cooking loss of beef sausage was 30.2±2.73%. Also these results were higher than that reported by **(Nafiseh *et al.*, 2010)** who recorded loss in cooking camel sausage as 24.2±4.20%. On the other hands the results were lower compared to those recorded by **(Zaki, 2017)** who stated that the loss in cooking camel sausage was 44.4%.

The results in this current research showed higher values compare to resulted of **(Hidayat *et al.*, 2018)** who found that the pH of beef sausage was 6.45±0.11 and 5.97±0.01 respectively, but, results in this study were lower than reports of many authors like **(Zaki, 2017)** who reported that camel sausage pH was 5.81±0.02 and 5.81 respectively. The results in this study were also lower than those reported by **(Marapana *et al.*, 2018; Kwoan-Sik *et al.*, 2012; Huda *et al.*, 2010)** who reported that chicken sausage pH were 6.56±0.03, 6.02±0.0 and 6.99±0.02 respectively.

Table (2): Physical composition values of beef, camel and chicken sausage.

Factor A (Sausage Type)	Water holding Capacity	Cooking Lose	Shrinkage	pH
Beef	2.38	31.70	4.54	5.14
Camel	2.32	30.91	4.64	5.24
Chicken	2.10	29.32	4.56	5.12
S.E	0.10	0.89	0.27	0.08
Sig	NS	NS	NS	NS
Factor B (Fat levels)				
5%	2.23^{b}	30.59	4.38	4.93
7%	3.23^{a}	31.56	4.26	5.18
10%	1.34^{c}	29.81	4.20	5.07
S.E	0.24	0.89	0.27	0.08
Sig	***	N. S	N.S	N.S

***** Means in the same column with different superscripts are highly significant differences.**
N.S: No-significance differences.

CONCLUSIONS

Hump fat used in percentages of 5%, 7% and 10% can be incorporated in sausage formulation and the best level of fat in sausage formulation was 7%. It is substantially recommended to use hump fat right amount for sausage processing.

REFERENCES

1. Alamin, S. A. (2015). Chemical composition of different types of sausage. *American International Journal of Research in Humanities, Arts and Social Sciences*, 4, 151-154.
2. Ali, E. A. (2018). *Effect of Using Different Levels of Camel Hump and Mutton Fat on Quality of Sausage from Beef, Camel and Chicken*. M.Sc. Thesis. University of Gezira, Sudan.
3. AOAC, (1990). *Official Methods of Analysis of the Association of Official Analytical Chemists*.
4. Biesalski, H. K. (2005). Meat as a component of a healthy diet. *Meat Science*, 70(3), 509-524.
5. Carvalho, C. B., Madrona, G. S., Corradine, S. S., Reche, P. M., Pozza, M. S. S. & Prado, I. N. (2013). Evaluation of quality factors of bovine and chicken meat marinated with reduced sodium content. *Food Science and Technology (Campinas)*, 33(4), 776-783.
6. Elhashmi, Y. H., Falih, S. Y. & Abdalmageed, M. E. I. (2021). Characteristics of ostrich meat in manufacturing sausage in comparison with beef. *Online Journal of Animal and Feed Research*, 11(1), 23-27.
7. Elkreeny, M. F. (2000). *Effect of Refrigeration Storage on the Shelf-life of Processed Meat*. M.Sc. Thesis, Faculty of Animal Production, University of Khartoum. Sudan.
8. FAO. (1992). *Manual of Food Quality Control 4.Rev. 1. Microbiological Analysis*. Rome, Italy.
9. Hidayat, B. T., Wea, A. & Andriati, N. (2018). Physicochemical, sensory attributes and protein profile by SDS-PAGE of beef sausage substituted with texturized vegetable protein. *Food Research*, 2(1), 20-31.
10. Huda, N., Lin, O. J., Ping ,Y. C. & Nurkhoeriyati, T. (2010). Effect of chicken and duck meat ratio on the properties of sausage. *International Journal of Poultry Science*, 9(6), 550-555.

11. Karmlich, W. E., Pearson, A. M. & Tauber, I. W. (1975). *Processed Eats West Port Connecticut*. The Avi. Publishing Company. INC, USA.
12. Kwoan-Sik, P., Yun-Sang, C. L., Hack-Youn, K., Hyun-Wook, K., Dong-Heon, S., Ko-Eun, H., Seul-Gi, C. & Cheon-Jei, K. (2012). Quality characteristics of chicken emulsion sausages with different levels of makgeolli lees fiber. *Korean Journal for Food Science of Animal Resources*, 32(1), 54-61.
13. Marapana, R. A. U. J., Nayanarasi, H. A. D., Senanayaka, S. Perera, P. R. D. & Kodagoda, K. H. G. K. (2018). Effect of processing conditions on quality of chicken sausages stuffed in different casings. *Journal of Pharmacognosy and Phytochemistry*, 7(5), 56-64.
14. Nafiseh, S., Mahdi, K., Javad, K., Hooshang, B. & Fatemeh, P. (2010). Camel cocktail sausage and its physicochemical and sensory quality. *International Journal of Food Sciences and Nutrition*, 61(2), 226-243.
15. Savadkoohi, S., Hoogenkamp, H., Shams, I. K. & Farahnaky, A. (2014). Color, sensory and textural attributes of beef frankfurter, beef ham and meat-free sausage containing tomato pomace. *Meat Science*. 97(4), 410-418.
16. Souza, K., Araujo, R. B., Santos, A. D., Rodrigues, C. E. C., Faria, D. E. D. & Trindade, M. A. (2011). Adding value to the meat of spent laying hens manufacturing sausages with a healthy appeal. *Brazilian Journal of Poultry Science*, 13(1), 57-63.
17. Steel, R. G. & Torrie, J. H. (1980). *Principle and Procedures of Statistics*. MC Grow Hill, New York, USA.
18. Williams, P. (2007). Nutritional composition of red meat. *Nutrition and Dietetics*, 64(4), s99-s195.
19. Wycherley, T. P., Moran, L., Clifton, P. M., Noakes, M. & Brinkworth, G. D. (2012). Effects of energy-restricted high-protein, low-fat compared with standard-protein, low fat diets: a meta-analysis of randomized controlled trials. *American Journal of Clinical Nutrition*, 96(6), 1281-1298.
20. Zaki, E. F. (2017). The quality characteristics of camel sausage formulated with different levels of whey protein powder. *International Journal of Environment, Agriculture and Biotechnology*, 2(5), 2456-1878.