The Annals of the University Dunarea de Jos of Galati
Fascicle VI – Food Technology 38(2):94-103

ORIGINAL RESEARCH PAPER

INFLUENCE OF ANIMAL FAT REPLACEMENT WITH VEGETABLE OILS ON THE SENSORIAL PERCEPTION OF MEAT EMULSIFIED PRODUCTS

CRISTIAN TUDOSE*, GABRIELA IORDACHESCU, FELICIA STAN, FLORICEL CERCEL, PETRU ALEXE
Department of Food Science, Food Engineering and Applied Biotechnology,
Faculty of Food Science and Engineering,
Dunarea de Jos University, 111 Domneasca Street, 800201 Galati, Romania
* Corresponding author: cristian.tudose@ugal.ro

Received on 9th December 2014
Revised on 28th December 2014

For the purpose of the present study, in an emulsified meat product the pork backfat was replaced with a vegetable oil pre-emulsion and its effect on quality attributes were investigated. In order to do so, a classic and a new meat products were manufactured. Extra virgin olive oil and palm oil pre-emulsion were added instead of animal fat in the new product. Texture and physiochemical properties were analyzed by instrumental measurements. It was observed that during storage moisture and pH decreased. Using vegetable oils determined substantial increase of TBA values. Texture was influenced mainly by storage time for both products, while replacement of pork backfat with vegetable oil pre-emulsion had no influence on sample firmness. The sensory properties of meat products were evaluated by a group of trained panelists using an analitycal sensory evaluation technique. Overall the new product presented good acceptability which recommends it like a new healthier meat product.

Keywords: vegetable oils, meat emulsified products, texture, flavor

Introduction

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 nutritional based diseases. Consumers began to realize that a healthy and balanced nutrition is a primordial step in order to maintain in a good health condition. It is known that for a healthy diet essential nutritional components have to be found in a well-defined ratio of 55-60 % for carbohydrates, 15-20 % for proteins, and 20-25 % for fat (Cordain et al., 2005; Wycherley et al., 2012). 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). However, processed meat products contain high levels of saturated fat and salt and high consumption leads to the risk of obesity, diabetes and cancer.

Developing a dietetic meat product would count, however, for just half of the problem. Because fat has a very important role in texture and taste, removing it from meat products is often perceived negatively by consumers and it is expected for new dietetic products to taste like traditional ones (Weiss et al., 2010). Thus, the meat industry should look for solutions in order to be able to provide the market with a dietary product without significant changes in texture or mouth taste. On the other hand, a taste re-education of meat product consumers would be desirable too.

An option for meeting both health and taste issues would be replacing animal fat with vegetable oils. Studies have shown the importance of unsaturated fatty acids, especially linoleic acid (Omega-3) and linolenic acid (Omega-6). The last decade has highlighted the importance for health of conjugated linoleic acid (CLA) (Eulitz et al., 1999). Under these circumstances, the design of a new meat product with a high content of unsaturated fatty acids became a must. Several papers indicate appropriate vegetable source for meat industry, namely olive oil, palm oil, canola, linseed (Jiménez-Colmenero et al., 2001; Fernández - Ginés et al., 2005), soya-seed, cotton seed oil (Ambrosiadis et al., 1996), etc. In the present study two sources of vegetable oils were considered (olive and palm oil) as animal fat replacement in an emulsified meat product.

Extra virgin olive oil contains a high percentage (over 80 %) of unsaturated fatty acids, is rich in antioxidants (carotenoids and polyphenols), contains a complex of vitamins (A, B_1, B_2, C, D, E) and also has lecithins with an important role in emulsification (Matsumoto et al., 1978; Simopoulos, 2002). Palm oil is used especially for thermal treatments because it is resistant to oxidation and does not change the taste of food with which it interacts. Although it contains a ratio of 50 % saturated fatty acids, studies have shown that it does not lead to cardiovascular diseases. Palm oil contains antioxidants, especially beta-carotene, and tocopherols, tocotrienols, and vitamin E (Sundram et al., 2003).

The present study aimed to investigate the physicochemical, textural and sensorial properties of an emulsified meat product influenced by the replacement of the total animal fat with a vegetable oil pre-emulsion. The study evaluated the texture and taste evolution during the estimated shelf-life of the obtained product (15 days).

Materials and methods

Experimental design

The beef (bulk lean cuts) and pork backfat were provided by a local slaughter house and frozen at -18 ^{o}C. For experimental use, cuts were slowly thawed in refrigerated conditions at +4 ^{o}C for 24 hours. Two types of vegetable oils, extra virgin olive oil (Emilio Vallejo, Spain) and palm oil (Indochina) were purchased from a local market.

The considered product for animal fat replacement was an emulsified meat product. Thus, two batches were evaluated, a control one, processed with pork backfat and a batch where backfat was replaced with olive-palm oil pre-emulsion. The ratio of olive/palm oils in the formed pre-emulsion was 70 to 30. The technological process for pre-emulsion obtaining, together with its formulation, was previously published by Tudose et al. (2014a).

Meat product manufacture

The block of thawed beef was chopped in an industrial chopper to 3 mm particle size, then mixed with nitrite containing salting mixture (1.8 %), and cold water at 0°C (18 %), after which the composition was let to age for 24 hours at +5 ^{o}C. A cold emulsion was then obtained. Thus, matured meat was further minced in a bowl chopper (K+G Wetter, CM90T2M-R), the process involving addition of ice flakes (1%) in order to maintain a low temperature (maximum 8 ^{o}C) in the batter. After two minutes the oil pre-emulsion was progressively added (pork backfat for the control batch); the technological process also involved the addition to the mixture of 0.4% sodium tripolyphosphate, and characteristic spices with 1 % of ice. The final proximate composition of the recipe per 100 kg was: 58.33 % beef; 25 % oil pre-emulsion/pork backfat; 16.66 % water.

The meat emulsion was stuffed into cellulosic casings and then thermally processed by water and smoke (VEMAG MICROMAT C7-100) until a core temperature of 71 °C was reached. The thermal treatment involved the following operations: air drying for 10 min at 62 °C followed by smoking for 35 min at 68°C and finished with pasteurization for 40 min at 75°C. The temperature was measured with a thermocouple inserted into the center of the meat product. After the process ended, samples were stored at 10 °C with an air relative humidity of 75%.

Analyses were performed after 1, 8 and 15 days of storage, at the end of the shelf life period. The shelf life period was determined firstly by microbiological analyses, reported by Tudose et al. (2014b). After 15 days of storage, the bacterial load was 36 ufc/g for the control product and 12 ufc/g for the newly obtained product. Considering that thermal treatment involved smoking, thus including the product in the semi-smoked category, the shelf life period could be established for 15 days. The manufacture process was carried out twice.

Physico-chemical analyses

Samples were analyzed according to the AOAC procedures (1997). Ash content was determined by burning the sample at 600 °C to constant weight (SR. ISO 936: 2009), protein content determined with Kjeldhal method, using a Nitrogen conversion factor of 6.25 (STAS 9064/4-8), fat content by Soxhlet method (SR 9065-10:2007), moisture/ Dry matter was determined by oven air drying, at a temperature of 150 °C until constant weight and pH were measured in a homogenate prepared with 1 g of sausage and 10 ml of distilled water, using a METROHM 702 SM-TITRINO (Herisau Switzerland) apparatus. For lipid oxidation analysis the Thiobarbituric acid test was used, after Fernández et al. (1997). The degree of lipid oxidation in the products tested during storage was reported in TBA value expressed as milligrams of malonaldehyde (MA) equivalents per kilogram sample. MA is a minor substance resulted from oxidation of polyunsaturated fatty acids that reacts with the TBA reagent and produces a pink complex with an absorption maximum at 530 nm (Shahidi & Wanasundara, 2002). The TBA test was performed using distillate samples. The determinations were performed in triplicate for each sample and mean values were reported. All reagents were of analytical grade.

Texture analysis

Texture measurements were determined for individual samples using a Metrohm 702 SMTexture Analyser. All tests were performed at room temperature. Two individual (20 mm×20 mm) cylindrical slices of each meat products were taken from each sample. Every slice was compressed with a penetration depth of 10 mm and a crosshead speed of 5 mm/s. The resulted firmness was expressed in *N* of force per *mm* of depth. Texture analysis was performed in triplicate and mean values were reported.

Sensory evaluation

The sensorial evaluation of the analyzed dietetic meat product was performed by a panel of 13 trained male and female panelists, aged between 20 and 24 years. A week before the testing day, the panelists were familiarized with the tested product in two preliminary sessions. The analyses were conducted in specially equipped booths at an ambient temperature of 21 °C and a relative humidity of 48 %. A period of 10 minutes was allowed between every batch analysis, while serving non salted bread and water. The sessions were repeated three times, immediately after the end of the technological process, on the 8^{th} day of storage and at the end of the shelf life period, on the 15^{th} day, respectively. A total of 12 sensorial attributes were analyzed in order to observe the effect of fat replacement on the sensorial perception of the obtained meat functional product. For every attribute a score of 15 points was applied, from 0 – meaning insignificant intensity of the attribute or no perception to 15 – corresponded to a very intense perception.

Data analysis

Statistical analyses were performed using Microsoft Excel Software with application of Anova Single Factor. Each experiment was carried out in triplicate and the results were reported as mean values.

Results and discussions

Physico-chemical analyses

The values obtained for proximate composition were reported in Table 1. During storage time the moisture of the meat products under study significantly decreased ($p<0.05$), influencing thus the values for the other parameters determined, with no statistical differences ($p>0.05$) between control and newly obtained product since both products followed the same recipe. No differences ($p>0.05$) were observed in terms of pH, during storage time, between the two formulation types. pH values are appropriate for the type of the obtained product, specified by researches (López-López et al., 2009). A slight variation for pH values ($p>0.05$) during shelf life period was however noticed for both products. The only observed differences were referred to TBA values, as shown in Figure 1.

Table 1. Proximate composition of studied emulsified meat products during shelf life period

Storage time	Sample type	Moisture*, %	Protein*, %	Fat*, %	Ash*, %	NaCl*, %	pH
first day	control	66.59±0.27	14.62±0.92	13.70±0.22	3.38±0.02	1.80±0.02	6.49
	oil	66.15±0.45	15.08±1.25	13.77±0.27	3.78±0.11	2.04±0.11	6.42
8th day	control	54.79±0.61	17.82±2.11	19.76±0.37	4.94±0.01	2.36±0.09	6.38
	oil	51.85±0.53	18.20±1.43	21.78±0.42	5.11±0.03	2.61±0.08	6.41
15th day	control	44.10±0.38	18.05±0.87	29.71±0.25	5.34±0.02	3.08±0.03	6.51
	oil	43.57±0.24	19.85±1.59	27.23±0.33	5.86±0.02	2.96±0.05	6.47

Values are reported as means ± Standard Deviation

Regarding the oxidation process during storage time, significant differences ($p<0.05$) were obtained when comparing the two types of meat products. TBA values were higher for samples obtained with vegetable oil pre-emulsion, almost double with respect to control samples. Similar results were communicated by other researches too (Bloukas et al., 1997; Choi et al., 2010), which only confirms the higher vulnerability to oxidation of unsaturated fatty acids in vegetable oils. TBA values slightly increased during storage time for control samples, but with no statistical differences ($p>0.05$). On the other hand, samples with olive oil in composition presented a significant decrease in TBA values during storage time ($p<0.5$). Figure 1 shows that TBA values arrived at in our research were above 2 mg MA/kg dry matter. When referring to the emulsified meat products, most of the existent researches reported TBA values lower than 1 mg MA/kg sample (Ansorena & Astiasaran, 2004; Yıldız-Turp & Serdaroğlu, 2008; Choi et al., 2010). For low fat frankfurters, Choi et al. (2010) reported TBA values significantly higher for all samples with vegetable oil in comparison to control samples with no added vegetable oils. However, we appreciate that the smoking process could be a factor that affected lipid oxidation. Scientific literature provides data that recall an 8.4 TBA value for vacuum packaged meat steaks after 7 days of storage (Resurreccion, 2004). Salgado et al. (2006) reported TBA values reaching 2.42 mg MA/kg for homemade *Chorizo de cebolla* were pork fat was used in composition. Another study where high values of TBA were reported is the one of Soriano et al. (2007), which analyzes the lipid stability of commercial ostrich *salchichon*. The lipid source was pork and values from 8 to 25 mg MA/kg were found. Taking this into account we can appreciate that a higher value for TBA may necessarily relate to an unsafe product.

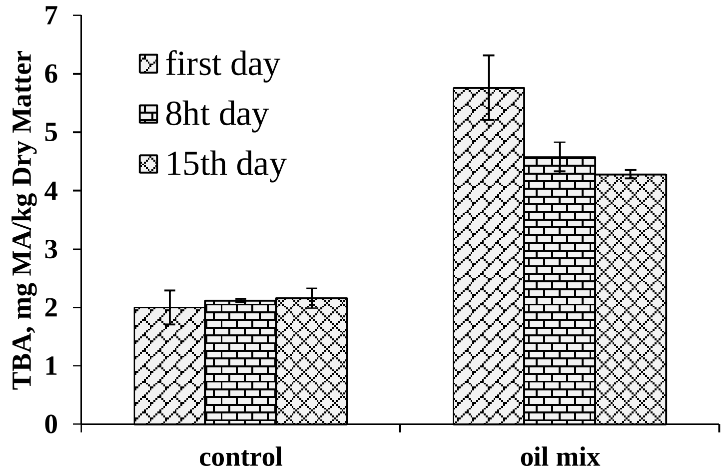

Figure 1. TBA values determined during shelf life period for studied emulsified meat products

Our results showed an increase in firmness values for the emulsified meat product formulated with olive-palm oil pre-emulsion. However, statistical analysis showed no significant differences between firmness values of the two batches ($p>0.05$). When analyzing the effect of the storage time on sample texture, data showed significant differences ($p<0.05$) between values for both batches.

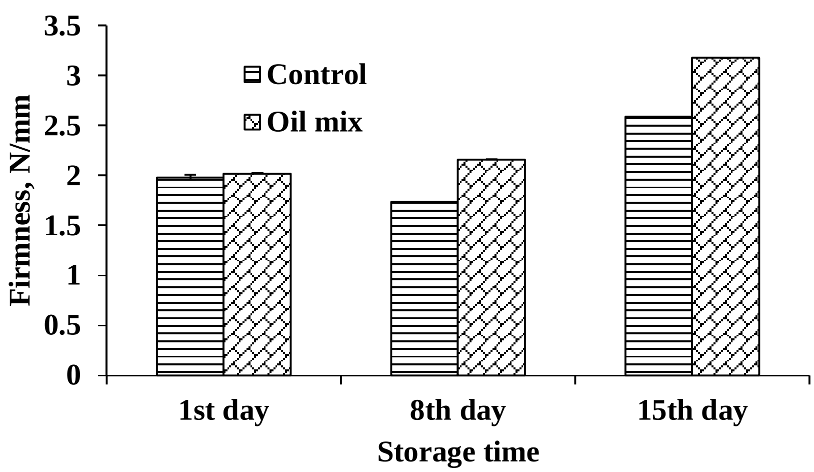

Figure 2. Firmness evolution of studied emulsified meat products during shelf life period

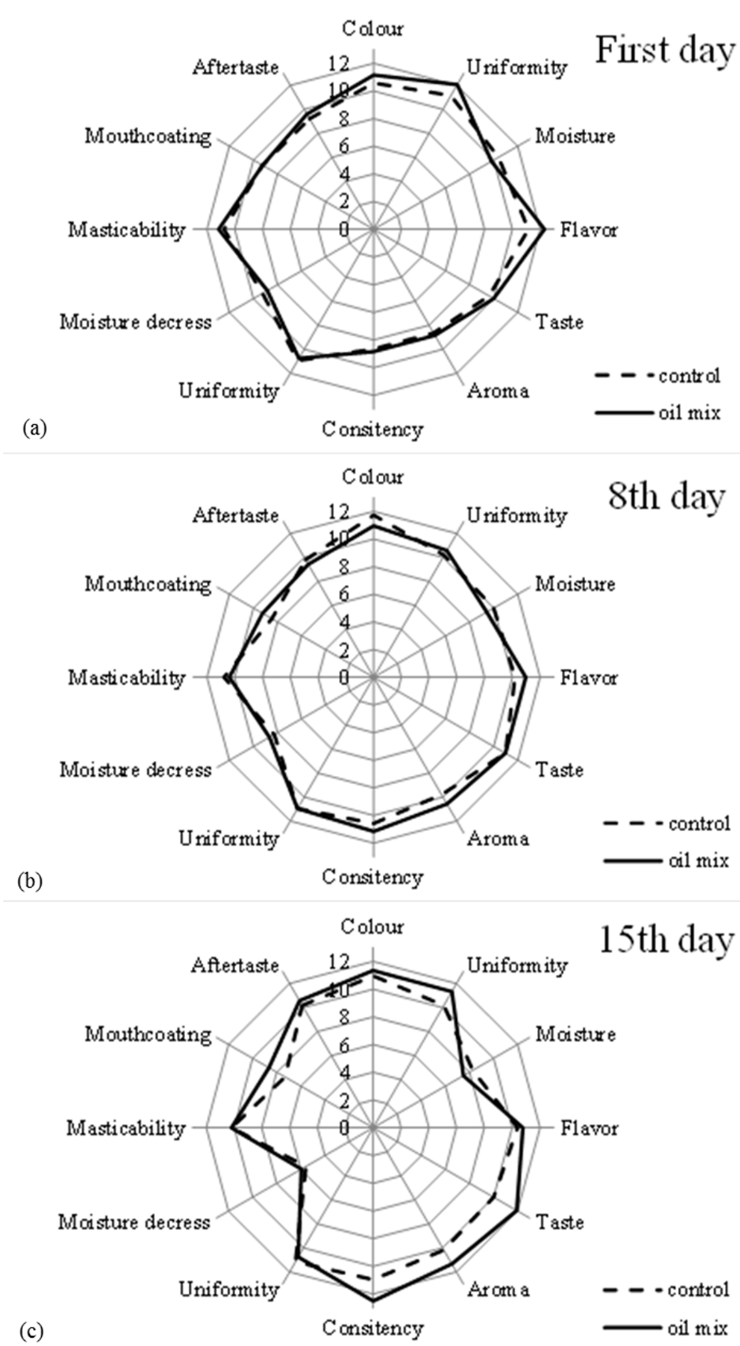

Figure 3. Sensorial evolution of studied emulsified meat products during storage time – the influence of pork backfat replacement with an olive-palm oil pre-emulsion

Sensory evaluation

All panelists perceived the newly obtained products as tasty (characteristic to products` range) and there were no significant differences (p>0.05) between batches during the first and the second tasting sessions (1^{st} and 8^{th} days). At the end of the shelf life period considered, the scores received varied, differentiating thus the sensorial perception of the two studied meat products. As can be seen, the aroma and taste were better appreciated in the case of the newly obtained product where pork backfat was replaced with an olive-palm oil pre-emulsion with significant differences between score values (p<0.05). In this respect, Kayaardi & Gok (2003) and Yildiz-Turp & Serdaroglu (2008) demonstrated that replacing beef fat with olive oil and hazelnut oil improved the quality characteristics of fermented sausages. In what regards consistency, the newly obtained product was perceived as firmer, the results being similar to those obtained experimentaly (Figure 2). The moisture attribute was perceived as similar for both batches, with no statistical differences (p>0.05) between them. However, both products recorded water evaporation during storage, the phenomenon being perceived by panelists, and moisture data reported during storage time were significantly different (p>0.05). Because people basically rely on the visual aspect of food products, this is usually decisive for the buying decision making. In this respect it was observed that product color was stable during storage.

Conclusions

The present study aimed to investigate the influence of pork backfat replacement with vegetable oils on the sensorial quality of an emulsified meat product. Since consumers often choose foodstuff based on its appearance and taste, it is very important for any new manufacture technology to ensure product quality. Results showed that the newly obtained meat product was perceived well by tasters. It seems that during storage aroma and taste positively evolved and intensified for the product which had vegetable oil pre-emulsion in composition. However, the recorded decrease in moisture led to an increase in firmness especially for the new product, a phenomenon that was quantified by laboratory equipment as well as by the tasters.

References

Ambrosiadis, J., Vareltzis, K. P., & Georgakis, S. A. (1996). Physical, chemical and sensory characteristics of cooked meat emulsion style products containing vegetable oils. *International journal of food science & technology*,*31*(2), 189-194.

Ansorena, D., & Astiasaran, I. (2004). The use of linseed oil improves nutritional quality of the lipid fraction of dry-fermented sausages. *Food Chemistry*, *87*(1), 69-74.

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.

Bloukas, J. G., Paneras, E. D., & Fournitzis, G. C. (1997). Effect of replacing pork backfat with olive oil on processing and quality characteristics of fermented sausages. *Meat Science*, *45*(2), 133-144.

Choi, Y. S., Choi, J. H., Han, D. J., Kim, H. Y., Lee, M. A., Kim, H. W., ... & Kim, C. J. (2009). Characteristics of low-fat meat emulsion systems with pork fat replaced by vegetable oils and rice bran fiber. *Meat Science*, *82*(2), 266-271.

Choi, Y. S., Choi, J. H., Han, D. J., Kim, H. Y., Lee, M. A., Jeong, J. Y., ... & Kim, C. J. (2010). Effects of replacing pork back fat with vegetable oils and rice bran fiber on the quality of reduced-fat frankfurters. *Meat Science*, *84*(3), 557-563.

Eulitz, K., Yurawecz, M. P., Sehat, N., Fritsche, J., Roach, J. A., Mossoba, M. M., ... & Ku, Y. (1999). Preparation, separation, and confirmation of the eight geometrical cis/trans conjugated linoleic acid isomers 8, 10-through 11, 13–18∶2. Lipids, 34(8), 873-877.

Cordain, L., Eaton, S. B., Sebastian, A., Mann, N., Lindeberg, S., Watkins, B. A., ... & Brand-Miller, J. (2005). Origins and evolution of the Western diet: health implications for the 21st century. The American journal of clinical nutrition, 81(2), 341-354.

Fernández, J., Pérez-Álvarez, J. A., & Fernández-López, J. A. (1997). Thiobarbituric acid test for monitoring lipid oxidation in meat. Food Chemistry,59(3), 345-353.

Fernández‐Ginés, J. M., Fernández‐López, J., Sayas‐Barberá, E., & Pérez‐Alvarez, J. (2005). Meat products as functional foods: A review. *Journal of Food Science*, *70*(2), R37-R43.

Jiménez-Colmenero, F., Carballo, J., & Cofrades, S. (2001). Healthier meat and meat products: their role as functional foods. *Meat science*, *59*(1), 5-13.

Kayaardı, S., & Gök, V. (2004). Effect of replacing beef fat with olive oil on quality characteristics of Turkish soudjouk (sucuk). *Meat Science*, *66*(1), 249-257.

López-López, I., Cofrades, S., & Jiménez-Colmenero, F. (2009). Low-fat frankfurters enriched with n−3 PUFA and edible seaweed: Effects of olive oil and chilled storage on physicochemical, sensory and microbial characteristics.*Meat Science*, *83*(1), 148-154.

Luruena-Martınez, M. A., Vivar-Quintana, A. M., & Revilla, I. (2004). Effect of locust bean/xanthan gum addition and replacement of pork fat with olive oil on the quality characteristics of low-fat frankfurters. *Meat science*, *68*(3), 383-389.

Matsumoto, S., Ueda, Y., Kita, Y., & Yonezawa, D. (1978). Preparation of water-in-olive oil-in-water multiple-phase emulsions in an eatable form.*Agricultural and Biological Chemistry*, *42*(4), 739-743.

Muguerza, E., Gimeno, O., Ansorena, D., Bloukas, J. G., & Astiasarán, I. (2001). Effect of replacing pork backfat with pre-emulsified olive oil on lipid fraction and sensory quality of Chorizo de Pamplona—a traditional Spanish fermented sausage. *Meat Science*, *59*(3), 251-258.

Resurreccion, A. V. A. (2004). Sensory aspects of consumer choices for meat and meat products. *Meat Science*, *66*(1), 11-20.

Salgado, A., Fontán, M. C. G., Franco, I., López, M., & Carballo, J. (2006). Effect of the type of manufacture (homemade or industrial) on the biochemical characteristics of Chorizo de cebolla (a Spanish traditional sausage). *Food control*, *17*(3), 213-221.

Tudose, C., Patrascu, L., & Alexe, P. (2014a). Rheological characteristics of beef filling mixture with vegetable oils.*Studia Universitatis Babes-Bolyai, Chemia*, *59*(2).

Tudose, C., Patrascu, L., & Alexe, P. (2014b). A study regarding preservation period of a dietetic meat product. 8th International Conference on Water in Food - Timisoara, May 25-27, 20014. Book of abstracts, p.72. ISSN: 978-606-569-796-6

Shahidi, F., & Wanasundara, U. N. (2002). Methods for measuring oxidative rancidity in fats and oils. *Food lipids: chemistry, nutrition and biotechnology*, 387-403.

Soriano, A., Garcı, A., Gómez, E., Pardo, R., Galán, F. A., & Vinas, M. G. (2007). Lipolysis, proteolysis, physicochemical and sensory characteristics of different types of Spanish ostrich salchichon. *Meat science*, *75*(4), 661-668.

Simopoulos, A. P. (2002). The importance of the ratio of omega-6/omega-3 essential fatty acids. *Biomedicine & pharmacotherapy*, *56*(8), 365-379.

Sundram, K., Sambanthamurthi, R., & Tan, Y. A. (2003). Palm fruit chemistry and nutrition. *Asia Pacific journal of clinical nutrition*, *12*(3), 355-362.

Weiss, J., Gibis, M., Schuh, V., & Salminen, H. (2010). Advances in ingredient and processing systems for meat and meat products. *Meat Science*, *86*(1), 196-213.

Wycherley, T. P., Moran, L. J., 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.*The American journal of clinical nutrition*, ajcn-044321.

Yıldız-Turp, G., & Serdaroğlu, M. (2008). Effect of replacing beef fat with hazelnut oil on quality characteristics of sucuk–A Turkish fermented sausage.*Meat science*, *78*(4), 447-454.