PROTEIN OXIDATION OF FERMENTED SAUSAGE (SUCUK) PRODUCED WITH OLIVE OIL DURING STORAGE

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Abstract – The aim of our work was to investigate the changes in oxidative quality parameters of sucuk (Turkish dried fermented sausage) due to fat replacement with olive oil during storage at 4°C under refrigerator conditions. Our results showed that α-Aminoadipic (AAS) and γ-glutamic semialdehydes (GGS) content were increased with using of olive oil. Total amount of semialdehydes which represent the sum of AAS and GGS, was increased during storage period.

Key Words – protein oxidation, sucuk, α-Aminoadipic semialdehydes-AAS, γ-glutamic semialdehydes-GGS

I. INTRODUCTION

Protein oxidation, in meat and meat products is one of the most innovative study topics in the food chemistry field. The oxidation of proteins cause the changes in water holding capacity, colour and texture of meat, also involves the loss of essential amino acid and decreases protein digestibility which affects its nutritional value during processing and storage [1,2]. The studies conducted so far, have focused on occurrence and effect of protein oxidation, do not provide specific information about particular protein oxidation products and oxidation mechanism. Recently, an advanced technique is used for detection of specific protein oxidation products in order to understand the basic chemistry and the complex mechanism of protein oxidation in meat and meat products. α-Aminoadipic (AAS) and γ-glutamic semialdehydes (GGS) are considered the main carbonyl products of oxidized proteins and play up as protein oxidation biomarkers in biological systems [3]. AAS is the main oxidation product from lysine, whereas GGS derives from the oxidative degradation of arginine and proline [4]. Both compounds have been found remarkably high levels in different meat products during storage.

II. MATERIALS AND METHODS

Fresh boneless lean beef, beef fat, olive oil and other additives were supplied from local market of İzmir. Three different formulations of sucuk, containing 4 kg meat each, were prepared. Each treatment was formulated to contain 20% total fat. Control (C) group was consisted of 100 % beef fat. Olive oil was replaced with beef fat at levels of 15% (O15) or 30 % (O30). After mixing all ingredients, sucuk doughs were stuffed into natural casings with a diameter of 36 mm by a hydraulic filling machine (Alpina, Switzerland). Sucuk samples were allowed to stand at 22.5°C and 60% relative humidity (RH) for 3 h before fermentation in a fermentation chamber (Wisd, Germany), and then, sucuks were pre-fermented at 23°C and 88% RH until the pH reached 5.4. After pre-fermentation, sucuks were fermented for 3 days at 21°C and 83% RH. Sucuk samples were then allowed to stand at 19°C and 73% RH for 2 days to drop the moisture to 40%. After production, sucuk samples were packaged under vacuum and stored at 4°C for 4 months. Samples were taken for analysis at the end of the production (final product) and every month. Differences among the means were compared using Duncan's Multiple Range Test. A significance level of $p<0.05$ was used for evaluations.

α-Aminoadipic (AAS) and γ-glutamic semialdehydes (GGS) were analysed using the method described by Utrera and Estévez [4] upon derivatization with p-amino benzoic acid and analysis by HPLC. Standard AAS and GGS were synthesized in vitro from N acetyl-Llysine and N-acetyl-L-ornithine using lysyl oxidase activity from egg shell membrane, as described by Akagawa *et al.* [5].

III. RESULTS AND DISCUSSION

Changing in AAS and GGS values of sucuk samples during storage at 4C were given in Table 1 and 2, respectively. Storage period had a remarkable impact on the oxidative stability of proteins as reflected in the significant increases of AAS and GGS at the end of the storage. During storage period, lysine is degraded to AAS, while the oxidative deamination of arginine and proline residues leads to the formation

of GGS [6].

Table 1 AAS content of sucuk treatments during storage

Groups	Initial	1st Month	2nd Month	3rd Month	4th Month
C	0,207±0,01a,Z	0,203±0,01a,Z	0,00a,W	0,00a,W	0,260±0,01a,V
O15	0,222±0,06b,Z	0,196±0,02ab,Y	0,00a,X	0,00a,X	0,268±0,01a,W
O30	0,212±0,01ab,X	0,165±0,09b,Y	0,00a,Z	0,00a,Z	0,251±0,01b,W

Data are presented as the mean values of 3 replications ± SD. Means within same column with different letters (a,b,c) are significantly different ($p < 0.05$). Means within same row with different letters (X,Y,Z) are significantly different ($p < 0.05$).

Table 2 GGS content of sucuk treatments during storage

Groups	Initial	1st Month	2nd Month	3rd Month	4th Month
C	0,00a,X	0,252±0,07a,Y	0,410±0,01b,Z	0,418±0,01a,Z	0,890±0,04a,W
O15	0,00a,X	0,254±0,01a,Y	0,245±0,01a,Y	0,418±0,01a,Z	0,480±0,01b,W
O30	0,00a,X	0,216±0,00b,Y	0,257±0,11a,Y	0,375±0,01b,Z	0,407±0,04c,W

Data are presented as the mean values of 3 replications ± SD. Means within same column with different letters (a,b,c) are significantly different ($p < 0.05$). Means within same row with different letters (X,Y,Z) are significantly different ($p < 0.05$).

Although it was initially AAS, GSS was never found at the end of the production. However, the formation of GGS was faster than that of AAS in sucuk sample during 4-month storage. This situation coherent with the study of Esteves [6] which was about protein oxidation during frozen storage of different beef muscles. While GGS conctent of sucuk samples was increased, some fluctuations were observed for AAS content during storage. this situation might be observed due to conversion of semialdehyde to each other. If the total amount of semialdehyde formation during storage is to be taken into consideration, semialdehyde content of sucuk samples was increased during storage under refrigerator conditions. On the other hand, using olive oil as a fat replacer decreased the AAS and GGS contents of samples. This situation can be explained with the presence of antioxidants in olive oil.

IV. CONCLUSION

The results of our study showed that, lipid acid composition has an effect on the formation of specific protein oxidation marker in terms of AAS and GGS.

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REFERENCES

1. Xiong, Y.L. (2000). Protein oxidation and implications for muscle foods quality. In E.A. Decker, C. Faustman, & C.J. Lopez-Bote, Antioxidants in muscle foods (pp 85-111), Wiley, New York.
2. Estévez, M., Ventanas, S. & Cava, R. (2005). Protein oxidation in frankfurters with increasing levels of added rosemary essential oil: Effect on colour and texture deterioration. Journal of Food Science, 70 : 427−432
3. Estévez, M., Ollilainen, E. & Heinonen, M. (2008). α-Aminoadipic and γ-glutamic semialdehydes as indicators of protein oxidation in myofibrillar proteins. Proceedings of the 54th international congress on meat science and technology (ICoMST), Cape Town, South Africa
4. Utrera, M. & Estevez, M. (2013). Oxidative Damage to Poultry, Pork, and Beef during Frozen Storage through the Analysis of Novel Protein Oxidation Markers. Journal of Agricultural and Food Chemistry, 7987-7993.
5. Akagawa, M., Sasaki, D., Ishii, Y., Kurota, Y., Yotsu-Yamashita, M. & Uchida, K. (2006). New methods for the quantitative determination of mayor protein carbonyls, a-aminoadipic and c-glutamic semialdehydes: Investigation of the formation mechanism and chemical nature in vitro and in vivo. Chemical Research in Toxicology, 19, 1059–1065.
6. Utrera, M., Parra, V. & Estévez, M. (2014). Protein oxidation during frozen storage and subsequent processing of different beef muscles. Meat science, 96(2), 812-820.