71st ICoMST
GIRONA - CATALONIA - SPAIN
3rd-8th August - 2025

EFFECTS OF INULIN USAGE ON PHYSICOCHEMICAL, MICROBIOLOGICAL AND TEXTURAL PROPERTIES OF FERMENTED SAUSAGE (SUCUK) THROUGHOUT THE RIPENING PERIOD

Necmiye Korkmaz Ulusoy[1], Sibel Çetin[1], Melis Yıldız[1], Azim Şimşek[2], Birol Kılıç[1*]

[1]Suleyman Demirel University, Faculty of Engineering and Natural Sciences, Department of Food Engineering, 32260, Isparta, Türkiye

[2]Isparta University of Applied Sciences, Egirdir Vocational School, Department of Food Processing, 32500, Isparta, Türkiye

*Corresponding author email: birolkilic@sdu.edu.tr

I. INTRODUCTION

Sucuk, a traditional Turkish-style dry-fermented sausage, is one of the most popular and widely consumed meat products in Türkiye. However, their traditional formulations are often high in saturated fats, which have been linked to various health risks, including cardiovascular diseases and obesity. As consumer demand shifts toward healthier food options, the meat industry has increasingly focused on developing reformulated products with reduced fat content without compromising sensory quality. Fat plays a crucial role in the sensory attributes of sucuks, influencing texture, flavor, mouthfeel, and juiciness. Therefore, reducing fat in sausages poses significant technological and sensory challenges [1]. To address this, various fat substitutes have been investigated and applied, including carbohydrate-based (e.g., inulin, starch), protein-based (e.g., soy protein, whey protein), and fat-based substitutes (e.g., vegetable oils, oleogels). These approaches have the potential to successfully reduce fat levels while maintaining the overall quality of the products [2]. In this context, inulin, a naturally occurring polysaccharide found in different plants like chicory root, has emerged as a promising fat replacer in food applications. Inulin has been effectively used to replace animal fat in items such as sausages, pâtés, and meat emulsions. Studies have shown that incorporating inulin can maintain or even improve technological properties such as water-holding capacity, emulsion stability, and texture, while also enhancing fiber content [3]. However, the concentration of inulin must be carefully optimized to avoid undesirable effects on taste or texture. This study aimed to investigate the changes in the physicochemical, microbiological, and textural characteristics of sucuks in which beef back fat was partially replaced with inulin (at levels of 0%, 7.5%, and 15%) throughout the fermentation process.

II. MATERIALS AND METHODS

Twenty-four hours post-mortem fresh beef (*Longissimus thoracis et lumborum*, LL) and beef back fat were supplied from a local butcher (Isparta, Türkiye). Spices, inulin (FOS) and starter culture mix (BAKTOGARD®SW-10) were purchased by Arifoglu Spices and Food Industry (Istanbul, Türkiye), Fibrelle (İstanbul, Türkiye) and Inovative Biotechnology Chemistry and Health Ltd. (İstanbul, Türkiye), respectively. The natural casings (derived from beef small intestines) utilized in the production of sucuk were procured from Mahirbey Sucukları, a commercial enterprise based in Isparta, Türkiye. Sucuk production was conducted following the methodology outlined by Kılıç and Özer [4]. The process was repeated three times on separate production days. Fresh, boneless lean beef was minced using a PKM-22 meat grinder (Arı Machine, İstanbul, Türkiye) equipped with a 25 mm plate. Spice mix (3%), salt (2%), cold water (6%), garlic (1.5%), sucrose (0.6%), sodium nitrite (0.015%), and starter culture (0.025%) were incorporated into the minced beef, and the mixture was held at 4°C for 12 hours. Subsequently, the mixture was ground together with chilled beef back fat using a 3 mm plate to achieve a homogeneous blend. Inulin (FOS) was incorporated into the mixture during the kneading stage. Three different formulations of sucuk were prepared in three replicate batches: (1) 80% beef + 20% beef back fat (control); (2) 80% beef + 12.5% beef back fat + 7.5% inulin (T1); (3) 80% beef + 5% beef back fat + 15% inulin (T2). Prior to filling, natural casings were immersed in a 5% lactic acid solution at 20°C for a short period. The stuffed sucuks were held at ambient temperature for 3 hours to allow for equilibration. The sucuks were ripened over 7 days under controlled conditions, with relative humidity (RH) gradually reduced from 95% to 70% and temperatures adjusted from 22°C to 16°C. Specifically, the ripening schedule was as follows: 22 ± 0.5°C at 95% RH for 24 hours; 21 ± 0.5°C at 90% RH for 24 hours; 20 ± 0.5°C at 85% RH for 12 hours; 20 ± 0.5°C at 80% RH for 12 hours; 18 ± 0.5°C at 75% RH for 48 hours; and 16 ± 0.5°C at 70% RH for the final 48 hours. Lactic acid bacteria (LAB) counts, pH [5], color [6], and water activity (a_w) [7] were measured at 0, 8, 16, 24, 32, 40, 48, 56, 64, 72, 120, and 168 hours during ripening. In addition, the analyses of proximate composition, thiobarbituric acid reactive substances (TBARS) [6], texture profile, total mesophilic aerobic bacteria (TMAB), total coliform and yeast-mold [7] were determined on days 0 (production day) and 7 (at the end of the ripening period).

III. RESULTS AND DISCUSSION

The results showed that there were no significant differences in the moisture, ash, protein, and TBARS values among all treatment groups at the beginning of the ripening period. Moreover, there were no differences in moisture and ash contents among treatment groups at the end of the ripening period. On the other hand, the treatment groups containing inulin had lower fat contents and TBARS values at the end of the ripening period ($P < 0.05$), whereas the carbohydrate and protein contents of the inulin-containing groups were higher than those of the control group ($P<0.05$). Glisic et al. [8] noted that dry fermented sausages containing inulin gel had a higher carbohydrate content compared to those without inulin. The TBARS values, as well as the fat, protein, ash, and carbohydrate (except in the control group) contents, increased in all treatment groups during the ripening period ($P<0.05$). There were no significant differences in TMAB, total coliform, and yeast-mold counts among the treatment groups at any stage of the ripening period. There was a gradual increase ($P<0.05$) in LAB counts for each treatment group during the first 32 hours of ripening, whereas no changes were generally determined in other ripening hours. The T2 group exhibited a significantly higher LAB count compared to the control group at the end of the ripening period ($P<0.05$). Results showed a gradual decrease in pH and a_w values in all treatment groups during the ripening period ($P<0.05$). Hardness, adhesiveness, springiness, gumminess, and chewiness values of all treatment groups generally increased at the end of the ripening period ($P<0.05$), whereas resilience and cohesiveness values remained relatively stable. The inulin-containing groups had lower hardness values at the end of the ripening period ($P<0.05$), whereas there were generally no differences in other texture profile parameters among the treatment groups. L^* values (except in the T2 group) and a^* values of the treatment groups increased at the end of the ripening period compared to the production day (P<0.05), whereas b^* values of the treatment groups decreased. Moreover, there were generally no significant differences in L^*, a^* and b^* values among all treatment groups during the ripening period.

IV. CONCLUSION

The study results demonstrated that the addition of inulin as a fat replacer in sucuk formulation resulted in improved oxidation inhibition. Furthermore, the results indicated that TBARS values decreased with increasing amounts of added inulin. The addition of inulin caused a decrease in hardness values. Inulin generally had no significant impact on microbial growth. It was concluded that inulin has the potential to serve as a fat replacer, improving quality attributes and retarding oxidative changes in sucuks.

ACKNOWLEDGEMENTS

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

REFERENCES

1. 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.
2. Asyrul-Izhar, A. B.; Bakar, J.; Sazili, A. Q.; Meng, G. Y.; Ismail-Fitry, M. R. (2023) Incorporation of different physical forms of fat replacers in the production of low-fat/reduced-fat meat products: which is more practical?. Food Reviews International *39*(9), 6387-6419.
3. Illippangama, A. U.; Jayasena, D. D.; Jo, C.; Mudannayake, D. C. (2022) Inulin as a functional ingredient and their applications in meat products. Carbohydrate Polymers 275, 118706.
4. Kılıç, B.; Özer, C. O. (2017) Effects of replacement of beef fat with interesterified palm kernel oil on the quality characteristics of Turkish dry-fermented sausage. Meat Science 131, 18-24.
5. Bozkurt, H., Erkmen, O. (2007) Effects of some commercial additives on the quality of sucuk (Turkish dry-fermented sausage). Food chemistry 101(4), 1465-1473.
6. Kılıç, B.; Şimşek, A.; Claus, J. R.; Atılgan, E. (2014) Encapsulated phosphates reduce lipid oxidation in both ground chicken and ground beef during raw and cooked meat storage with some influence on color, pH, and cooking loss. Meat science 97(1), 93-103.
7. Köker, Ö.; Kılıç, B.; Şimşek, A. (2024) Effects of Çemen pastes prepared in different formulations on physicochemical, microbiological, and textural properties of beef hamburger patties during refrigerated storage. Food Science & Nutrition 12(6), 4330-4341.
8. Glisic, M.; Baltic, M.; Glisic, M.; Trbovic, D.; Jokanovic, M.; Parunovic, N.; Vasilev, D. (2019) Inulin-based emulsion-filled gel as a fat replacer in prebiotic-and PUFA-enriched dry fermented sausages. International Journal of Food Science and Technology 54(3), 787-797.