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INFLUENCE OF FERMENTATION AND CURING ON RESIDUAL NITRITE, AROMA PROFILE, QUALITY AND SAFETY FEATURES OF READY-TO-EAT SUCUK DÖNER KEBAB

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I. INTRODUCTION

Consumer demand for ready-to eat (RTE) meat products is increasing and one of the most popular RTE meat product is döner kebab [1]. Nowadays, RTE döner kebab is widely produced and consumed. Döner kebab is a traditional Turkish meat product typically made from beef, lamb, or poultry meat, arranged in a cylinder form on a skewer and cooked by turning horizontally or vertically [2]. In addition, sucuk is a traditional Turkish fermented sausage that is also frequently preferred by consumers [3]. Consumer demands and the meat industry's efforts to create new meat products have resulted in the production of a new type of döner kebab called sucuk döner kebab, which includes some of the features of both sucuk and döner kebab. Although sucuk is fermented and cured product, sucuk döner kebab is not subjected to fermentation or curing processes. The studies conducted focus on innovative approaches and researching different techniques to increase the shelf life of RTE döner kebabs and increase food safety and quality [2]. There is limited information in the literature on sucuk döner kebab. Thus, more studies are needed on sucuk döner kebab to provide a valuable insight for improving the safety and quality characteristics of this highly demanded meat product. In this respect, this research was aimed to evaluate influences of fermentation, fermentation duration and sodium nitrite incorporation on residual nitrite, aroma profile, physico-chemical, and microbiological properties of RTE sucuk döner kebab during refrigerated and frozen storage.

II. MATERIALS AND METHODS

Post mortem (24 h) *M. longissimus thoracis et lumborum* muscles from Simmental cattles and frozen beef back fat were obtained from a local supplier (Isparta, Türkiye). The formulation and preparation of sucuk döner kebab dough was performed as decribed by Özer and Kılıç [4]. The basic sucuk döner kebab dough was prepared without incorporation of starter culture and sodium nitrite, and contained ground lean beef (75%) and beef back fat (25%). Sodium cloride, distilled water and sucuk spice mix were also used in the production of all sucuk döner kebab dough. All ingredients were incorporated according to meat weight basis. After the kneading process, sucuk döner kebab dough was divided randomly into 5 treatments with equal weights. The present study involved the production of five different types of RTE sucuk döner kebabs, including unfermented sucuk döner kebab (control), semi-fermented sucuk döner kebab (24 h fermentation), semi-fermented sucuk döner kebab (24 h fermentation) with added sodium nitrite (100 ppm), fermented sucuk döner kebab (72 h fermentation), and fermented sucuk döner kebab (72 h fermentation) with added sodium nitrite (100 ppm). Then, the mixture of starter cultures (*Lactobacillus plantarum* and *Lactobacillus sakei*; 10^8 CFU/g) and saccarose (0.6%; meat weight basis) were incorporated into the sucuk döner kebab dough. The treatments with starter culture addition were fermented at 20 ℃ and 95% relative humidity for 24 or 72 h. After the fermentation, sucuk döner kebabs were subjected to heat treatment, slicing and vacuum packaging as described by Şimşek and Kılıç [1]. Then, RTE sucuk döner kebab samples were stored at either +4°C or -18°C for 30 d. Sucuk döner kebab slices were separated randomly for analysis. Physico-chemical, textural, and microbiological properties were assessed, including cooking loss, water activity, moisture, protein, fat, ash, color, texture, pH, thiobarbituric acid reactive substances (TBARS), residual nitrite, total aerobic mesophilic bacteria, lactic acid bacteria, coliform group bacteria, and total mold and yeast count. Entire study was repeated as three replications and analysis carried out for each replication were also performed in triplicate. To determine the effect of fermentation, fermentation duration and curing process on the dependent variables, the experimental design was completely randomized design with five treatments Generalized linear model (GLM) was assessed on the collected data to determine significant difference for each dependent variable. Significant differences among the means were evaluated using the Tukey multiple comparison test.

III. RESULTS AND DISCUSSION

Results revealed that fermented samples exhibited the lowest pH ($p<0.05$). These results indicated that the fermentation process plays a significant role for reducing pH in fermented samples which is typically attributed to the production of organic acids, such as lactic acid, which are by-products of bacterial fermentation [5]. The nitrite

addition did not alter pH in fermented treatments but resulted in higher ($p<0.05$) pH in semi-fermented ones. Results demonstrated a clear relationship between cooking loss (CL) and pH. The highest CL was observed in uncured fermented treatments, exhibited the lowest pH ($p<0.05$). Conversely, cured semi-fermented treatments had the lowest CL, likely due to their higher pH ($p<0.05$). Fermented treatments, particularly uncured ones, exhibited the lowest water activity ($p<0.05$). L* values were similar among treatments, whereas, nitrite-containing treatments generally had higher a* and lower b*values than others ($p<0.05$). Results demonstrated that fermentation, regardless of fermentation duration or nitrite use, had a significant effect on reducing thiobarbituric acid reactive substances ($p<0.05$). It has been stated that lactic acid bacteria (LAB) degrade the meat proteins into bioactive peptides during the fermentation and these peptides exhibit antioxidant activity [6]. The enzymes derived from LAB such as superoxide dismutase has also been reported to also play a role for reducing the development of lipid oxidation [7]. The highest residual nitrite levels were found in nitrite-containing treatments ($p<0.05$). Several aroma compounds, including 2-methyl-1-butanol, allyl mercaptan, acetic acid, and methyl allyl disulfide, were dominant across all treatments ($p<0.05$). Fermented treatments, particularly those without nitrite, had higher acetaldehyde and ethanol levels. Our findings indicated that terpenes were the dominated compounds identified in sucuk döner kebab treatments. Terpenes have generally been reported as the most abundant aroma compounds in fermented muscle foods and they are originated from added spices and sulfur- and nitrogen-containing compounds derived from Maillard reactions [8]. The highest total mesophyll aerobic bacteria count was obtained in semi-fermented treatments with nitrite ($p<0.05$). All sucuk döner kebab samples had similar total coliform bacteria count. Regarding LAB count, as expected, control sucuk döner kebab samples had < 1.00 LAB count. Fermented treatments with nitrite had higher LAB compared to semi-fermented treatments without nitrite and fermented treatments without nitrite, whereas LAB counts of semi-fermented treatments with nitrite were similar to fermented treatments without nitrite and fermented treatments with nitrite but higher ($p<0.05$) than semi-fermented treatments without nitrite. All treatments had similar *Lactococcus-Streptococcus* spp. count. Yeast and mold were not detected any of sucuk döner kebab treatments.

IV. CONCLUSION

Present study highlighted the critical influence of fermentation and curing on physico-chemical, aroma, sensory, and microbiological properties of RTE sucuk döner kebab. The findings demonstrated that fermentation significantly affected key parameters, such as pH, water activity (aw), color, aroma profile, and lipid oxidation, with fermented products generally exhibiting lower pH, reduced a_w, and greater protection against lipid oxidation. Sensory evaluations revealed that semi-fermented sucuk döner kebab treatments without nitrite were most preferred by panelists for flavor and overall acceptability. It can be concluded that fermentation may be utilized in the processing of RTE sucuk döner kebab as a processing tool to improve its shelf-life, quality and safety.

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