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THE EFFECT OF REDUCED OR NO NITRITE USE ON PROCESSING, PHYSICOCHEMICAL AND RHEOLOGICAL PROPERTIES OF DRY-FERMENTED SAUSAGES

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I. INTRODUCTION

The addition of nitrites plays a crucial role in dry-fermented meat processing, as they contribute to microbiological safety, oxidative stability, stable color formation and characteristic aroma. Despite these benefits, nitrites have been associated with potential health risks, including toxicity and carcinogenic effects [1]. Consequently, consumer awareness is increasing, leading to industry efforts and even legislative initiatives to reduce nitrite levels in processed meat [2,3]. While certain aspects of nitrite reduction, such as microbiological safety and color stability, have been relatively well studied [1,4], other factors, particularly water loss dynamics and related textural and physicochemical mechanisms, remain insufficiently explored [5]. Given that nitrites influence protein interactions, oxidative processes and development of microbial population, their reduction or omission may significantly affect processing behavior and final product characteristics. To better understand these effects, our study aimed to evaluate how different nitrite concentrations influence the processing, physicochemical properties, and rheological behavior of dry-fermented sausages.

II. MATERIALS AND METHODS

For dry-fermented sausage production, the formulation included pig lean meat and fat tissue (in a 4:1 ratio) ground to a 10 mm particle size, along with pepper (0.2%), garlic (0.4%), dextrose (0.4%) and salt (2.2%). The meat batter was divided into three parts, forming three experimental groups with: 120 ppm sodium nitrite (N120), 60 ppm (N60) and a nitrite-free group (N0). The prepared batter was stuffed into 50 mm diameter collagen casings and the sausages were dried at 12°C until an average weight loss of over 40% was achieved. During processing, weight loss was monitored. After the fermentation and drying process, six samples per experimental group were analyzed for chemical composition (moisture, lipids, salt, proteolysis index and water activity (a_w)), oxidation levels (TBARS), objective color parameters (CIE L*, a*, b*) and instrumental texture using texture profile analysis to determine hardness, gumminess, chewiness, cohesiveness, springiness and adhesiveness. The data were statistically analyzed using SPSS 23.0, applying one-way ANOVA to compare experimental groups.

III. RESULTS AND DISCUSSION

With the exception of the first week, weight loss during processing (Figure 1) was consistently higher in sausages with reduced or no nitrite addition compared to the N120 group. These findings contrast with our previous study [5], which reported lower weight loss following nitrite reduction, attributing it to enhanced surface microbial (mold) growth—an effect not confirmed in the present study. The same trend was reflected in the chemical composition: dry matter and lipid content were lowest in the N120 group, intermediate in N60, and highest in the nitrite-free group. Despite these differences, water activity and salt content remained unaffected across groups. Likewise, nitrite concentration had no significant impact on pH or proteolysis index.

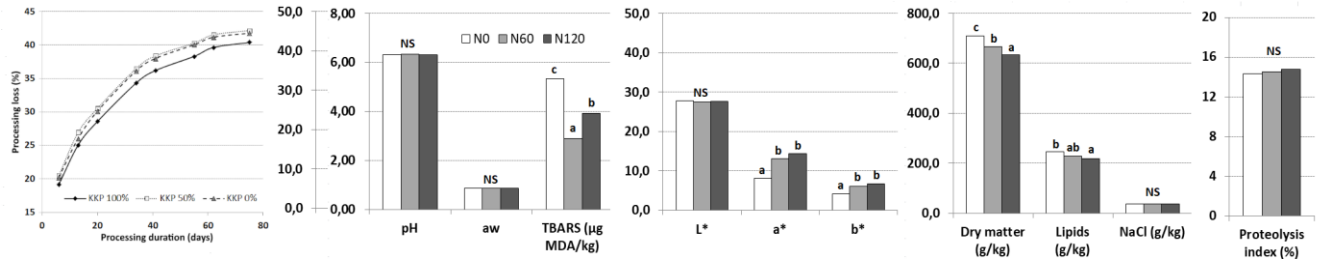


Figure 1: Effect of nitrite concentration on processing losses, pH, water activity (aw), oxidation (TBARS), objective color parameters (L*, a*, b*) and chemical composition of dry-fermented sausages.

Lipid oxidation, assessed via TBARS, was reduced in both nitrite-containing groups, aligning with the known antioxidant role of nitrite [1], but with the lowest oxidation observed in the N60 group. Nitrite addition also significantly affected color parameters (Figure 1): both N60 and N120 sausages exhibited higher a* (redness) and b* (yellowness) values compared to the nitrite-free group, confirming previous findings that even low nitrite concentrations (as little as 25 ppm) are sufficient for color stabilization [6].

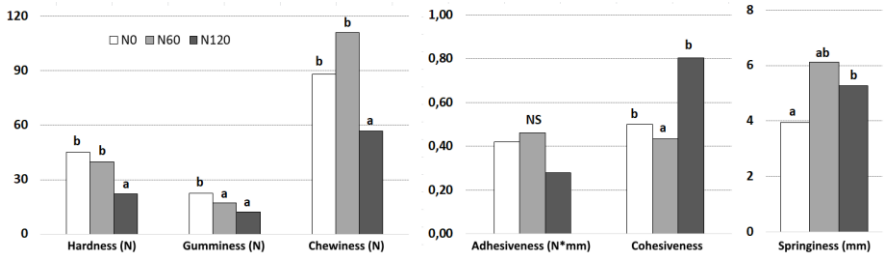


Figure 2: Effect of nitrite concentration on instrumental texture parameters of dry-fermented sausages.

Nitrite concentration also clearly influenced textural properties (Figure 2). Sausages in the N120 group showed lower hardness, gumminess, and chewiness, but higher cohesiveness. The N60 group frequently displayed intermediate or even highest values in traits like chewiness and springiness, indicating that moderate nitrite levels may be optimal for achieving desirable texture. Overall, lower nitrite concentrations (N0 and N60) were associated with firmer and chewier textures, likely reflecting increased moisture loss during processing [7]. However, no effect of nitrite concentration on the proteolysis index was observed. The literature on nitrite's influence on proteolysis remains inconclusive, with some studies reporting inhibitory effects on proteolytic enzymes [8], while others find no such impact [9].

IV. CONCLUSION

In conclusion, higher nitrite levels were associated with lower weight loss, reduced lipid oxidation, softer texture, and more intense color, while reduced or no nitrite addition resulted in a firmer texture, higher dry matter content, and greater oxidation. These findings underscore the functional role of nitrites in processing and product quality, and point to the need for further research including microbiological, sensory, and shelf-life evaluations.

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