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STABILITY OF S-NITROSOGLUTATHIONE IN MEAT PRODUCTS AS A NATURAL NITRITE SUBSTITUTE

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I. INTRODUCTION

The current trend of reducing nitrite content in meat products has led to the search for new and safe additives that can provide similar preservative, antioxidant, and color-enhancing functions. Nitrite plays a crucial role in preventing spoilage and ensuring the sensory quality of meat. A promising alternative group of compounds is nitrosothiols (RSNOs), which are naturally found in living organisms and serve as nitric oxide (NO) donors. These compounds form in vivo through reactions involving NO signaling pathways. RSNOs, such as S-nitrosoglutathione (GSNO), are created when reactive nitrogen species interact with thiol (-SH) groups in tissues (Al-Temimi et al., 2023). They function as NO carriers and donors, providing a controlled release mechanism compared to unstable free NO. In this study, GSNO was used as a nitrosating agent, and its stability in meat products during storage was evaluated. The aim of the study was to determine whether GSNO added to meat remains stable during 21 days of storage. Since glutathione (GSH) and its nitrosylated form, GSNO, are known for their health-promoting properties, it is particularly important that significant amounts of GSNO remain intact throughout storage. Glutathione plays a key role in cellular defense mechanisms, acting as an antioxidant and supporting detoxification processes in the body. Therefore, preserving GSNO levels in meat products may not only contribute to their safety and quality but also enhance their potential health benefits.

II. MATERIALS AND METHODS

Pork *m. quadriceps femoris* muscle was ground (plate Ø 3 mm, Mado, Germany), mixed, and divided into portions. GSNO was added as a freshly prepared aqueous solution with an average pH of 2.4. All samples contained the same amount of water to ensure uniform RSNO distribution. Two control samples were prepared: one with water only (H_2O control) and one with sodium nitrite at 80 mg/kg (1.16 mmol/kg) (NO_2 control). Experimental samples contained GSNO at different molar equivalents relative to sodium nitrite: 1.16 mmol/kg (equivalent to NO_2), 0.60 mmol/kg (50% of NO_2 equivalent), 0.39 mmol/kg (33% of NO_2 equivalent), and 1.74 mmol/kg (150% of NO_2 equivalent).
Each sample was homogenized (Robot Coupe, France) for three minutes, portioned (60 g), and placed in glass containers. The meat was cooked in a convection oven at 99°C for 30 minutes under 100% steam, then vacuum-packed and stored at 4°C for 21 days. The glutathione content was measured on the first and twenty-first day of storage using the Glutathione Assay Kit (Sigma-Aldrich, CS0260). The extraction method involved homogenization with 5% sulfosalicylic acid (SSA) followed by spectrophotometric analysis at 412 nm absorbance. The results allowed the assessment of the initial glutathione level and its stability over the storage period.
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III. RESULTS AND DISCUSSION

The results of glutathione content in meat samples on the first and twenty-first day of storage are presented in Figure 1. On day one, the H_2O and NO_2 control samples exhibited low natural glutathione content (0.067 nmol/ml and 0.022 nmol/ml, respectively). As the GSNO concentration increased, the initial glutathione levels significantly rose, ranging from 0.21 to 1.02 nmol/ml.

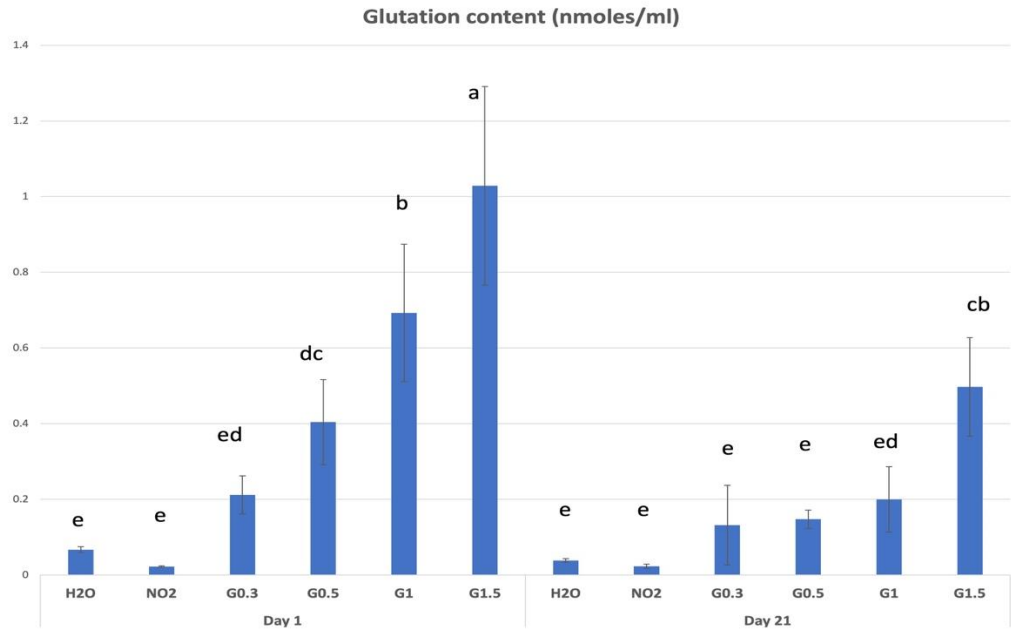


Figure 1. Glutathione content in meat samples on the first and twenty-first day of storage ($p < 0.05$). Results are presented as mean values, with standard deviation bars shown. H_2O – Control sample with water only, NO_2 – Sample with sodium nitrite at 80 mg/kg (1.16 mmol/kg), G0.3 – Sample with GSNO at 0.39 mmol/kg (33% of NO_2 equivalent), G0.5 – Sample with GSNO at 0.60 mmol/kg (50% of NO_2 equivalent), G1 – Sample with GSNO at 1.16 mmol/kg (100 %equivalent to NO_2), G1.5 – Sample with GSNO at 1.74 mmol/kg (150% of NO_2 equivalent).

After 21 days of storage, all GSNO-treated samples exhibited a decrease in glutathione content, suggesting that glutathione participated in oxidative reactions, helping to protect the meat from oxidation. Higher initial GSNO levels correlated with greater glutathione retention, indicating prolonged antioxidant protection. Glutathione, as a potent antioxidant, likely reacted with free radicals and pro-oxidants in the meat, slowing oxidative processes. The potential functional food benefits of glutathione-rich meat products should be further explored, as dietary glutathione has been linked to reduced oxidative stress in humans (Schmitt et al., 2015).

IV. CONCLUSION

GSNO effectively increased glutathione levels in meat, with higher concentrations offering prolonged antioxidant protection during storage. These findings suggest that GSNO could serve as a promising nitrite alternative while enhancing meat stability and potential health benefits. Further studies are needed to optimize GSNO application in processed meats.

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