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

REDUCING NaCl IN BEEF BURGERS USING HIGH-POWER ULTRASOUND AND MICRONIZED SALT: SENSORY DYNAMICS, TECHNOLOGICAL, AND TEXTURAL CHARACTERISTICS

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I. INTRODUCTION

Excessive sodium intake is a major public health concern, with processed meat products like burgers contributing significantly to this issue. Reducing NaCl in these products is challenging due to its essential roles in flavor, texture, and microbial stability. Isolated strategies, such as using salt substitutes or applying emerging technologies, often compromise sensory quality or raise safety concerns [1]. Micronized salt (MS) enhances the perception of saltiness at lower sodium levels but may negatively affect texture. Ultrasound (US) has shown potential to mitigate such effects [2]. yet the combined use of MS and US in burgers remains underexplored. Furthermore, dynamic sensory methods like Temporal Dominance of Sensations (TDS) offer detailedinsights into how perceptions evolve during consumption, complementing traditional approaches such as Descriptive Analysis (DA). This study aimed to evaluate the effects of combining MS and US on sodium reduction in beef burgers, focusing on physicochemical, technological, and sensory impacts.

II. MATERIALS AND METHODS

Beef burgers were prepared using seven treatments combining three MS levels (0.75%, 1.0%, and 1.5%) with or without ultrasound application (10 min at 25 kHz). A randomized block design was adopted (n = 20 per treatment), with processing day as the blocking factor. After molding, samples were stored at −18 °C. Analyses included pH, color, moisture, ash, sodium content [3], cooking loss, diameter reduction [4], and texture profile analysis (TPA). Volatile compounds were evaluated using SPME-GC-MS. Microbiological tests ensured product safety prior to sensory analysis. DA was conducted by a trained panel (n = 18) following ISO standards, and samples were presented using a balanced Latin square design. Consumer sensory evaluation included TDS and overall liking. Statistical analyses were performed using R (v4.2.3) and XLSTAT.

III. RESULTS AND DISCUSSION

Sodium reduction did not affect burger color or microbiological safety, ensuring compliance with food quality and hygiene standards. Ultrasound treatment led to a slight but statistically significant increase in pH, possibly due to protein unfolding and ion mobility, however it did not impair water-holding capacity or increase cooking loss. Textural properties, assessed via TPA, were largely preserved across treatments, with a moderate rise in cohesiveness at lower salt concentrations. Notably, the combination of MS and US contributed to the retention of key volatile compounds—such as hexanal, benzaldehyde, and sabinene—critical for the perception of freshness and beef flavor. These compounds were positively correlated with overall liking and key sensory attributes. Descriptive Analysis (DA) indicated that juiciness and tenderness were maintained in treatments with reduced sodium, particularly those with US. Temporal Dominance of Sensations (TDS) revealed a stable perception of desirable attributes, such as meaty and juicy during mastication, even in formulations with up to 50% less NaCl. The combined MS+US approach enabled significant sodium reduction without compromising sensory quality, In some cases, it even enhanced flavor perception and texture, demonstrating a synergistic effect. This highlights the potential of this dual strategy to meet nutritional targets while maintaining consumer satisfaction.

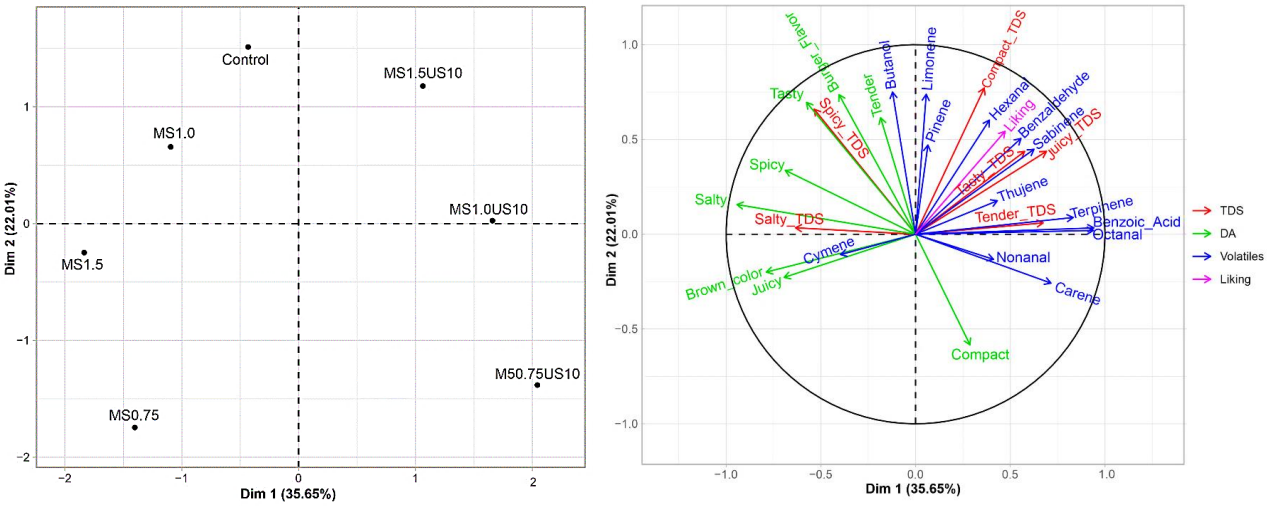


Figure 1. Multiple Factor Analysis (MFA) of burgers illustrating the relationship between volatile compounds and the results of TDS attribute durations, DA attribute intensities and overall liking. MS1.5 = 1.5% micronized salt, MS1.0 = 1.0% micronized salt, MS0.75 = 0.75% micronized salt, MS1.5US10 = 1.5% micronized salt + 10 min of ultrasound, MS1.0US10 = 1.0% micronized salt + 10 min of ultrasound, MS0.75US10 = 0.75% micronized salt + 10 min of ultrasound, Control = Control formulation.

IV. CONCLUSION

The combination of micronized salt and ultrasound enabled a 50% reduction in sodium in beef burgers without compromising physicochemical, technological, or sensory quality. Key volatile compounds were preserved, and consumer-perceived tastiness and tenderness were improved. These findings highlight the potential of MS and US as a synergistic strategy for developing healthier meat products without compromising consumer acceptance.

ACKNOWLEDGEMENTS

Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES), which granted the doctoral scholarship (grant number 88887.637004/2021-00).

REFERENCES

[1] H. Xiao, Y. Yan, Y. Gu, and Y. Zhang, “Strategy for sodium-salt substitution: On the relationship between hypertension and dietary intake of cations,” Food Research International, vol. 156, p. 110822, Jun. 2022, doi: 10.1016/j.foodres.2021.110822.

[2] J. D. Rios-Mera et al., “Impact of the content and size of NaCl on dynamic sensory profile and instrumental texture of beef burgers,” Meat Sci, vol. 161, p. 107992, Mar. 2020, doi: 10.1016/j.meatsci.2019.107992.

[3] V. Paez et al., “AOAC SMPR® 2016.002,” J AOAC Int, vol. 99, no. 4, pp. 1122–1124, Jul. 2016, doi: 10.5740/jaoacint.SMPR2016.002.

[4] M. M. Selani et al., “Effects of pineapple byproduct and canola oil as fat replacers on physicochemical and sensory qualities of low-fat beef burger,” Meat Sci, vol. 112, pp. 69–76, Feb. 2016, doi: 10.1016/j.meatsci.2015.10.020.