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Effect of processing temperature (70°c) and high pressure treatment (300 and 600 Mpa) on the partition coefficient of sodium (P_{Na+}) in salted pork loins as a new strategy to influence saltiness perception (#33)

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Introduction

High sodium (Na^+) intake is associated with high blood pressure and other cardiovascular diseases [1]. Na^+ intake comes primarily from the consumption of salt (NaCl) and about 20 % comes from processed meats [2]. Therefore, in recent years, there have been plenty of studies addressing this issue. Particularly, reformulating strategies such as the use of salt replacers, flavors enhancers and water binders, and different processing conditions have been tested [3]. However, there are still practical limitations, and probably the most important constrain is a weaker sensory perception of saltiness and overall flavor in the salt-reduced products. In this sense, there exists a relationship between [Na^+] in the saliva and perceived saltiness. [Na^+] in the mouth depends on the binding strength of Na^+ to the meat matrix and its release to the water phase. This basic interaction can be estimated by calculating the partition coefficient (P), which is the ratio of concentrations of a compound in a mixture of two immiscible phases at equilibrium. The determination of P for Na^+ (P_{Na+}) allows for a physico-chemical estimation of the affinity of Na^+ to the meat matrix. Modification of P_{Na+} by using different processing conditions could be a powerful strategy to increase saltiness perception in an industry convenient manner. The application of high pressure processing (HPP) has already been suggested as a tool to increase saltiness perception [4, 5]. The aim of this paper was to investigate the effect of processing temperature (70 °C) and HPP treatment (300 and 600 MPa) on the P_{Na+} in salted pork loins.

Methods

Pork loins (n=6) were collected from a local processing plant. All loins were within a pH range of 5.4-5.6. Loins were salted by immersion into an appropriate brine for 2 weeks at 4°C in order to reach a concentration of 2 % of NaCl and 180 ppm of $NaNO_2$. After salting, loins rested for 1 day before each loin was cut into 6 equivalent blocks, vacuum packaged, and randomly assigned to the following treatment. For each loin, 3 blocks were kept raw (R) and the other 3 were cooked (C) in a water bath at 74 °C to an internal temperature of 70 °C. After resting overnight, HPP treatment (5 min at 300 or 600 MPa) was applied to R and C loins. All meat products were tested for water content, water activity (a_w) and P_{Na+}. [Na^+] was determined using inductively coupled plasma - mass spectrometry (ICP-MS). A one-way-analysis of variance (ANOVA) with a Turkey's pairwise test was used to analyze the statistical differences (software Past version 3.24).

Results

All cooked products had approx. 4-5 % less water content than their raw counterparts (*P*-value < 0.05) and a_w values were within a tight range of 0.974-0.980 (*P*-value < 0.05) (Table 1).

Comparing raw to cooked products, it can be observed that cooked products had a tendency for the P_{Na+} to be higher than for their raw counterparts (Table 2). Indeed, P_{Na+} of cooked control sample for r value equal to 3.4 was significantly higher (*P*-value < 0.05) than of the raw control sample (Table 2). In addition, the averaged P_{Na+} were also significantly higher for two product cases, the cooked control sample and the cooked sample treated by HPP at 300 MPa in comparison to the respective raw samples, confirming a higher P_{Na+} in this type of meat products when cooked.

If we look at the effect of HPP treatment, it can be observed a trend for the P_{Na+} to be higher for the raw products that were treated with HPP, though this trend was not statistically significant (Table 2). In contrast, this trend was not observed for cooked products, which had already a higher P_{Na+} than raw products (Table 2). This fact would be coherent with a higher interaction of ions to the meat matrix in raw products in comparison to cooked products. Cooked products will have a greater degree of protein denaturation and disruption of the muscle structure, which possibly lead to less electrostatic interactions and restrictions to the mobility of ions in the meat product. In fact, this will be favoring their transfer to the water phase.

Overall, this work could not conclude the existence of a larger P_{Na+} after HPP treatment, though a tendency could be observed, but did showed a higher P_{Na+} for some cooked meat products.

Conclusion

This preliminary data showed that some cooked meat products had a higher P_{Na+} than their equivalent raw counterparts. The higher is the P_{Na+}, the lower will be the affinity for the ion to stay in the product. This fact could have important implications for the meat industry, as raw meat products submitted to a heat treatment could result in a product with an enhanced saltiness. This could allow for the use of lower salt concentrations during manufacturing while keeping saltiness and flavour intensity.

References

Notes

1.
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2.
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3.
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r[#]	Raw			Cooked		
	Control	HPP		Control	HPP	
		300 MPa	600 MPa		300 MPa	600 MPa
2.3	$1.2^{A} \pm 0.2$	$1.2^{A} \pm 0.2$	$1.6^{A} \pm 0.5$	$1.8^{A} \pm 0.2$	$1.7^{A} \pm 0.4$	$1.3^{A} \pm 0.2$
3.4	$1.2^{A} \pm 0.2$	$1.2^{A} \pm 0.3$	$1.6^{AB} \pm 1.5$	$2.4^{B} \pm 0.5$	$1.8^{AB} \pm 0.5$	$2.0^{AB} \pm 0.3$
4.6	$1.9^{A} \pm 0.5$	$1.4^{A} \pm 0.2$	$2.3^{A} \pm 0.8$	$1.8^{A} \pm 0.4$	$1.7^{A} \pm 0.5$	$2.0^{A} \pm 0.7$
5.7	$1.3^{A} \pm 0.3$	$1.4^{A} \pm 0.2$	$1.4^{A} \pm 0.9$	$3.0^{A} \pm 1.6$	$2.8^{A} \pm 1.4$	$2.1^{A} \pm 1.0$
Average	$1.4^{AB} \pm 0.5$	$1.3^{A} \pm 0.2$	$1.7^{AC} \pm 0.7$	$2.2^{C} \pm 0.8$	$2.1^{BC} \pm 1.0$	$1.8^{ABC} \pm 0.7$

Different superscripts within the same row mean a significant difference at *P*-value < 0.05.

[#]: r = mass (liquid phase) / mass (solid phase)

Table 2. Effect of processing temperature (70 °C) and high pressure treatment (300 and 600 MPa for 5 min) on the partition coefficient of sodium (P_{Na+}) in salted pork loins (mean ± standard deviation) (n=2).

Notes