ASSESSING THE EFFECTS OF COLD ATMOSPHERIC PLASMA TREATMENT ON SPOILAGE MICROBIOTA AND QUALITY OF PORK

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I. INTRODUCTION

The consumption of meat is progressively increasing worldwide, and it is expected to rise by 15% by 2031 [1]. However, growing meat consumption has created major global challenges in the food supply chain, resulting in 20% of meat waste [2]. This is ethically, environmentally, and economically unacceptable. Although the limited shelf-life of meat has the highest impact on the amount of waste, an extension of meat storage would be the most effective solution to reduce it [3]. Cold atmospheric plasma (CAP) is a promising antimicrobial method for prolonging meat shelf-life since it is an efficient, cost-effective, and residue-free technology [4]. However, difficulties arise in implementing CAP technology in meat processing as there is a knowledge gap in CAP's impact on the quality and antibacterial efficiency in meat.

II. MATERIALS AND METHODS

Pork loin samples were treated with CAP (input voltage: 15 V, frequency: 50 kHz, gas: air) at different application times (0, 1, 3, 6 and 9 min). *Enterobacteriaceae spp, Pseudomonas spp, Lactic acid bacteria spp* (LAB) and total viable counts (TVC) were determined using specific growth media and incubation conditions. Meat quality traits, thiobarbituric acid reactive substances (TBARS) levels and colour parameters were determined. The significance of differences between the average values was performed by two-way ANOVA (with Tukey HSD post hoc test) at a significance level of $P<0.05$.

III. RESULTS AND DISCUSSION

According to EU guidelines on microbiological criteria for foodstuffs [5], pork bacterial shelf-life is determined by TVC (>5 log CFU/g) and *Enterobacteriaceae spp* (>3 log CFU/g) levels. Whilst *Pseudomonas spp* are the dominant microbiota in aerobically stored meat [6]. Thus, the current study focused on estimating the reduction of main spoilage microbiota in pork after CAP treatment (Fig. 1). Immediately after 1, 3, 6 and 9 min CAP application, the mean populations of *Pseudomonas spp* were significantly reduced by 0.5-1.7 log CFU/ g (Fig. 1.). However, only 3, 6 and 9 min CAP treatments led to a significant reduction of TVC and *Enterobacteriaceae spp* populations by 0.7-0.8 log CFU/g and 1-1.1 log CFU/g respectively. Thus, at least 3 min CAP treatment was found to be effective and allowed to decrease the levels of the studied spoilage microbiota in pork.

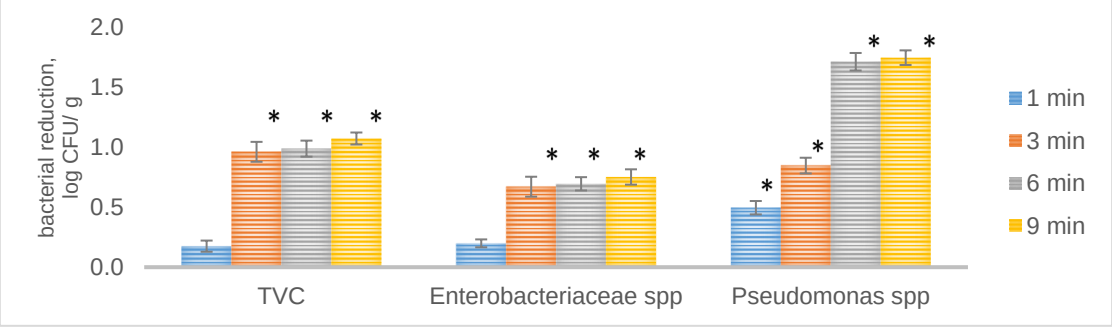

Figure 1. Bacterial reduction of *Pseudomonas spp, Enterobacteriaceae spp* and TVC in pork samples with different times of CAP treatments (1 min, 3 min, 6 min, 9 min) when compared to untreated samples

* denotes a significant difference compared to the control, significance level <0.05

The change in meat quality traits, TBARS levels and colour parameters in CAP-treated and untreated pork is shown in Table 1. CAP application did not lead to any significant changes in TBARS levels, pH and tenderness. The changes for three colour parameters (*L**, *a**, and *b**) in CAP-treated samples were not consistent; *L** value did not change, a* value significantly decreased (by 39.4%) and *b** value significantly increased (by 15.5%). Cooking loss in 3, 6 and 9 min CAP-treated samples significantly decreased by 15.6–17.2%. However, according to consumer perceptions of meat quality, increased juiciness (i.e., because of reduced cooking loss) is considered desirable [7]. Also, results on a* and b* values showed that they are within the acceptable ranges [8]. Thus, the changes in meat quality traits, TBARS levels and colour parameters in pork loin samples after CAP application can be considered negligible.

Table 1. Meat quality parameters in pork samples after CAP treatments at different exposure times (1 min, 3 min, 6 min, 9 min) and CAP untreated samples (0 min)

parameter		CAP treatment time				
		0 min	1 min	3 min	6 min	9 min
pH		5.44±0.03 ^{a}	5.39±0.02 ^{a}	5.38±0.02 ^{a}	5.38±0.02 ^{a}	5.38±0.02 ^{a}
cooking loss, %		18.48±0.38 ^{a}	17.27±0.44 ^{ab}	15.63±0.34 ^{b}	15.58±0.51 ^{b}	15.27±0.35 ^{b}
Tenderness, kg		2081±158.5 ^{a}	1849±148.7 ^{a}	1761±130.0 ^{a}	1989±106.9 ^{a}	1953±194.5 ^{a}
TBARS, µmol/mg		0.55±0.03 ^{a}	0.48±0.03 ^{a}	0.66±0.01 ^{a}	0.69±0.02 ^{a}	0.62±0.03 ^{a}
colour	*L** (paleness)	55.13±0.71 ^{a}	55.98±0.49 ^{a}	52.99±1.11 ^{a}	53.18±0.40 ^{a}	52.77±0.98 ^{a}
	*a** (redness)	4.27±0.09 ^{a}	3.48±0.21 ^{ab}	2.68±0.08 ^{b}	2.31±0.14 ^{b}	2.83±0.14 ^{b}
	*b** (yellowness)	7.24±0.16 ^{a}	8.31±0.16 ^{b}	7.90±0.13 ^{b}	8.63±0.12 ^{b}	9.44±0.14 ^{b}

different uppercase letters within the same parameter denote a statistically significant difference ($P < 0.05$)

IV. CONCLUSION

Cold atmospheric plasma treatment caused a significant reduction of *Pseudomonas spp, Enterobacteriaceae spp* and TVC populations in pork. The differences in the quality parameters concerning plasma-treated and untreated pork samples were minor and negligible. The above showed that cold plasma is a promising technology to extend the microbiological shelf-life of pork without compromising quality.

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