THE USE OF ORGANIC ACID WHEY DURING COOKED SAUSAGE PRODUCTION WITH REDUCED ADDED NITRITES

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I. INTRODUCTION

In recent years, consumers are increasingly looking for foods with fewer food additives, because it is perceived to be healthier [1]. Nitrite is a key ingredient in meat curing, creating the desired sensory properties and safety of meat products but its use raises social concern. [2]. European Union legislative solutions are aimed at limiting this ingredient in meat products. A significant reduction in the amount of nitrites in the meat curing process may adversely affect the quality and durability of meats produced using traditional methods by small processors, where no other chemical additives are used to support the curing process as in the large conventional meat industry. Acid whey is a natural by-product of the production of cottage cheese that contains lactic acid, whey proteins, vitamins and compounds with antioxidant activity, i.e., glutathione and lactoferrin. Previous research showed the positive effect of acid whey on the colour, taste and shelf life length of uncured meat products [3]. Nevertheless, the properties of organic acid whey, especially the content of organic acids and antioxidant ingredients, has potential for the use in the production of meat products with reduced added nitrite that can influence the formation of desired quality features and durability of products. Therefore, this research aimed to assess the impact of using organic acid whey in the meat curing process with a reduced amount of sodium nitrite on the physicochemical properties and microbiological quality of cooked sausages.

II. MATERIALS AND METHODS

In this experiment 4 meat batter treatments were prepared for sausage production: (C1) treatment with a 2.0% nitrite curing mixture (99.5% NaCl, 0.5% $NaNO_2$), (C2) treatment with a 1.0% nitrite curing mixture and 1.0% of salt, (S) treatment with 2.0% of salt and (CW) with a 1.0% nitrite curing mixture, 1.0% of salt and 5.0% of organic acid whey (Bydgoszcz, Poland). The glucose (0.5%) was added to all treatments and water to replenish the mass of sausages. The pork trimmings meat were minced (8 mm), mixed with ingredients and left for 48 h at 4-6 °C (curing time). Next, the meat batter was stuffed into casings and the sausages were smoked (55–65 °C, 1 h) and cooked up to 70 °C in the centre. The products were chilled, vacuum-packed and cold-stored. In the samples the following values were defined: pH and redox potential using Delta 350 pH meter, thiobarbituric acid-reactive substance (TBARS) by Pikul method, colour parameters in the system CIE L*a*b* using Minolta CR-300, total viable counts (ISO 4833-2:2013), the presence of *Salmonella* spp. (ISO 6579-1:2017), *Listeria monocytogenes* (ISO 11290-2:2017) and *Clostridium* spp. (PN-A-82055–12). The experiment was performed at 3 replications (n=3) in industrial conditions. The two-way ANOVA included the main effects (treatments), and the storage period (0, 14 days) as well as their interactions were used. The Fisher's LSD test was used to determine the significance of the mean values for a multiple comparison at $P < 0.05$. The Statistica program, version 13 was used.

III. RESULTS AND DISCUSSION

The research results are presented in Table 1. The addition of acid whey did not significantly affect the pH of the sausages after production. The dynamics of pH changes during sausage storage depended on the treatment used. After production, the lowest redox potential value was found in CW treatment ($P < 0.05$), which was probably related to the antioxidant effect of acid whey components. It was also observed that in the CW treatment, the TBARS value was lower than in the C2 treatment

($P < 0.05$) and similar to that of cured sausage with normal nitrite content (C1). After storage, the significantly highest TBARS value was found in the uncured sample (S), which indicates that the amount of secondary fat oxidation products in these samples was the highest. After production and storage, the CW sausages were characterized by a higher value of a* parameter than C2 sausages ($P < 0.05$) and were similar to the C1 treatment. High redness may be related to the reductivity of the meat system with acid whey and the amount of nitrosyl pigments [3,4]. Treatments C1 and CW generally had similar brightness (L*). The S sample had the highest yellowness (b*) after production and storage. All of the tested products were free of pathogenic bacteria. After storage, the total number of bacteria in all experimental samples remained at a similar level and ranged from 10^3 to 10^4 cfu/g.

Table 1 - The pH, ORP, TBARS and colour parameters (L, a*, b*) of the experimental sausages.

Parameter	Sampling time (days)	Treatment (n=3)				S x T
		C1	C2	S	CW	P
pH	0	5.90 ± 0.03^{Aa}	5.85 ± 0.03^{Aa}	6.03 ± 0.11^{Ab}	5.86 ± 0.07^{Aa}	***
	14	6.02 ± 0.02^{Bbc}	6.11 ± 0.02^{Bc}	5.85 ± 0.11^{Aa}	5.94 ± 0.08^{Aab}	
ORP (mv)	0	428.83 ± 2.11^{Bc}	423.17 ± 2.27^{Bb}	433.33 ± 5.82^{Ac}	410.17 ± 1.77^{Aa}	***
	14	397.17 ± 0.90^{Aa}	404.17 ± 4.30^{Aa}	428.83 ± 3.72^{Ab}	433.83 ± 6.89^{Ba}	
TBARS (mg MDA/kg)	0	0.58 ± 0.01^{Aa}	0.66 ± 0.06^{Ab}	0.93 ± 0.06^{Ac}	0.55 ± 0.02^{Aa}	***
	14	0.64 ± 0.06^{Aa}	0.68 ± 0.04^{Aa}	0.85 ± 0.06^{Ab}	0.69 ± 0.05^{Ba}	
L*	0	63.52 ± 3.27^{Aab}	63.70 ± 4.34^{Aab}	65.58 ± 0.91^{Ab}	61.55 ± 3.18^{Aa}	NS
	14	62.75 ± 3.28^{Aab}	64.18 ± 2.93^{Ab}	66.87 ± 2.94^{Ac}	61.52 ± 2.88^{Aa}	
a*	0	8.56 ± 1.50^{Ac}	6.94 ± 1.80^{Ab}	3.96 ± 0.53^{Aa}	8.80 ± 1.59^{Ac}	NS
	14	8.68 ± 1.81^{Ac}	7.35 ± 2.02^{Ab}	3.71 ± 1.15^{Aa}	9.30 ± 1.69^{Ac}	
b*	0	9.02 ± 0.28^{Aa}	8.90 ± 0.38^{Aa}	10.21 ± 0.43^{Ab}	9.01 ± 0.43^{Aa}	NS
	14	8.97 ± 0.32^{Aa}	9.13 ± 0.27^{Aa}	10.38 ± 0.42^{Ab}	8.95 ± 0.49^{Aa}	

Means followed by the different lowercase letters (a-c) between the treatments at the same storage time and capital letters (A-B) between the same treatment at different storage times are significantly different ($P < 0.05$). SD: standard deviation. P: significance of effects treatment-time interaction; NS – not significant; ***$P < 0.001$.

IV. CONCLUSION

Implementing organic acid whey to the meat curing process with a reduced amount of sodium nitrite enabled a higher redness (a*) in the meat product than in the case of the product cured without acid whey. The pork sausages with acid whey were characterized by the storage-stable pink colour, oxidative and storage stability. This research shows that the suggested technology may be a promising solution to produce good quality meat products with reduced addition of sodium nitrite.

ACKNOWLEDGEMENTS

This research was funded by the Ministry of Agriculture and Rural Development Republic of Poland. Decision No. DRE.prz.070.2.2024

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