INVESTIGATION OF THE EFFECTIVENESS OF THE NANOTECHNOLOGICAL FORM OF ASCORBIC ACID FOR COOKED SAUSAGES

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Abstract – The results of the study showed that the mycelized form of ascorbic acid (E300) obtained using nanotechnologies had a number of technological advantages compared to the traditional form. It can be used in smaller doses of incorporation without loss of effectiveness; it can generate better conditions of color formation for sodium nitrite (E250), provide less residual content of sodium nitrite in a finished product, ensure better color stability of sausages, allow to reduce the dose of sodium nitrite addition without loss of consumer properties and reduction of sausage storability; it has the antioxidative and bacteriostatic activity and a fat-soluble form.

Key Words – Mycelized ascorbic acid, Cooked Sausages, Color stability

I. INTRODUCTION

Ascorbic acid (E 300) is traditionally used in meat industry because of the favorable effect on the processes of color formation due to the increase in the reduction potential of a meat system and prevention of nitrosopigments from oxidation. An amount of the reacted sodium nitrite (E250) significantly increases and its residual amount reduces in the presence of ascorbic acid [1].

Mycelized ascorbic acid obtained with the use of nanotechnologies consists of nanoparticles (food-grade micelles), which are the carriers of active substances. The nucleus of micelles is formed from an active ingredient, the envelope from the system of surfactants that are soluble in water and fat, and are stable to the exposure to temperatures and changes in the environmental pH. The unique mycelized form of ascorbic acid contains in each micelle with 30 nm diameter strictly the same quantity of the active substance molecules. A small concentration of an active substance due to the multifold increase in the potential area of interaction ensures the high effectiveness of the mycelized food additives use [2].

II. MATERIALS AND METHODS

The samples of cooked sausages produced under the traditional technological scheme were studied. In their production, ascorbic acid in the traditional and mycelized form was used (Table 1). Water- and fat-soluble mycelized ascorbic acid was dissolved beforehand in a small amount of warm water (40-50^{o}C).

All sausage samples contained 40% trimmed beef with fat and connective tissue content not more than 6%; 60% trimmed pork with fat and connective tissue content 30 to 50%; 35% water (above the formulation), ground black pepper and allspice, garlic and were produced in an artificial protein casing without use of vacuum packaging and modified atmosphere.

Table 1. Sausage samples formulation

Name of food additives	Norm for cooked sausages samples			
	1	2	3	4
g/100 kg unsalted raw material				
nitrite curing mixture	2300	2300	2300	2300
Sodium nitrite (in the composition of the nitrite curing mixture)	10	-	5	5
Traditional form of ascorbic acid	50	-	-	-
Mycelized form of ascorbic acid	-	50	50	27

After production, the samples were stored for 7 days (with a norm 5 days) at a temperature of 0-6^{o}C and the relative humidity not higher than 75%. Organoleptic indices, color characteristics using the Spectroton colorimeter, color stability, the indicators of oxidative and microbial spoilage, the

residual content of sodium nitrite and ascorbic acid, the content of nitrosopigments were studied; the multisensory evaluation of odor was conducted.

III. RESULTS AND DISCUSSION

Samples No 1, No 3 and No 4 corresponded in their organoleptic indices to the traditional characteristics of cooked sausages (Table 2).

Table 2. Organoleptic evaluation of cooked sausages samples

No samples	Organoleptic indices				
	appearance	cross section surface color	odor (aroma)	taste	overall score
1	5	5	5	5	4.96
2	4	2.8	3.8	4	3.84
3	5	4.8	4.8	4.5	4.78
4	5	4.5	4.9	4.4	4.72

In organoleptic characteristics, experimental samples No 3 and No 4 corresponded to control sample No 1. Sample No 2 (without sodium nitrite) had grey color unacceptable for traditional cooked sausages and also had less distinct taste and aroma compared to control sample No 1 and experimental samples No 3 and No 4.

In main color characteristics, experimental samples No 3 and No 4 corresponded to control sample No 1 (Table 3). Sample No 2 had the lowest values of redness and the highest values of yellowness, which was considered as a deviation from the traditional values of cooked sausages color characteristics.

Table 3. The instrumental evaluation of the color of the cooked sausages samples during storage

No	Color characteristics			Color stability, %
	L*	a*	b*	
1 day				
1	66.46	8.99	10.92	-
2	64.75	5.34	14.18	-
3	65.72	8.71	10.89	-
4	65.76	8.59	10.91	-
7 days				
1	66.99	8.54	11.84	95.26
2	66.61	4.42	15.04	91.28
3	66.41	8.45	11.48	96.85
4	66.64	7.91	11.38	95.48

On the 7th day of storage, the experimental samples were characterized by better color stability (No 3 – 96.85% and No 4 – 96.58%) compared to control sample No 1 (95.26%) and sample No 2 without nitrite (91.28%).

None of the studied samples exceeded the regulated in Russia norm for sodium nitrite content 0.005% (Table 4). It is necessary to note that this norm is 5 times lower in Russia than in the other European countries.

Table 4. Analysis of the mass fraction of sodium nitrite, ascorbic acid and nitrosopigments content in the cooked sausages samples during storage

No	Mass fraction of sodium nitrite, %	ascorbic acid content, mg/kg	nitrosopigments content, % to total pigment
1 day			
1	0.0043	3.21	73.68
2	0.0004	4.53	-
3	0.0015	2.76	72.12
4	0.0028	2.54	48.12
7 days			
1	0.0035	1.96	72.72
2	0.0001	2.57	-
3	0.0006	1.78	71.39
4	0.0012	1.67	46.92

Sample No 4 made with halved amount of mycelized ascorbic acid contained twice as much sodium nitrite as sample No 3 produced with the traditional dose of mycelized ascorbic acid, which provided more complete involvement of sodium nitrite in the processes of color formation in cooked sausages (Table 4).

The ascorbic acid content in experimental samples No 3 and No 4 was lower than in the control one after the manufacture and during storage (Table 4). The highest amount of ascorbic acid was in sample No 2 made without use of sodium nitrite.

During storage, slight reduction in nitrosopigments was observed (Table 4) along with the reduction in color stability, which was determined by their oxidation to metmyoglobin and methemoglobin as a consequence of the air oxygen influence.

On the 7th day of storage, cooked sausages samples No 2 and No 3 made with mycelized ascorbic acid had the acid value 1.24 (12.7% lower than the control) and 1.38 (2.8% lower) mgKOH/g, respectively, control sample No 1 had the acid value 1.42 mgKOH/g (Table 5). The highest value (1.49 mgKOH/g) was found in sample No 4, made with the reduced dose of mycelized ascorbic acid.

In control sample No 1 the peroxide value was not detected during 7 days of storage. In sample No 4, the peroxide value was detected on the 5th day of storage, in samples No 2 and 3 on the 7th day.
The thiobarbituric values were approximately at the same level during storage.

Table 5. Analysis of the oxidative spoilage indices of the cooked sausages samples during storage

No	acid value, mgKOH/g	peroxide value, mmol O_2/kg	Thiobarbituric value, mg /kg
1 day			
1	0.62	n/d	0.039
2	0.59	n/d	0.036
3	0.64	n/d	0.039
4	0.47	n/d	0.039
7 days			
1	1.42	n/d	0.062
2	1.24	1.46	0.064
3	1.38	1.22	0.055
4	1.49	2.08	0.057

The results of the microbiological investigations of the cooked sausages samples showed that the number of mesophyll aerobic and optional-anaerobic microorganisms (QMA&OAMO) did not exceed $1x10^3$ CFU/g product. Escherichia coli group bacteria (coli-forms), sulfite-reducing clostridia and pathogens (including salmonella) were not detected in all samples during storage for 7 days. On the 7th day, the lowest QMA&OAMO levels were in control sample No 1 ($5x10^2$) and experimental sample No 3 with the reduced dose of sodium nitrite ($6x10^2$). QMA&OAMO in sample No 2 without sodium nitrite and sample No 4 were at the level of $8x10^2$ CFU/g.

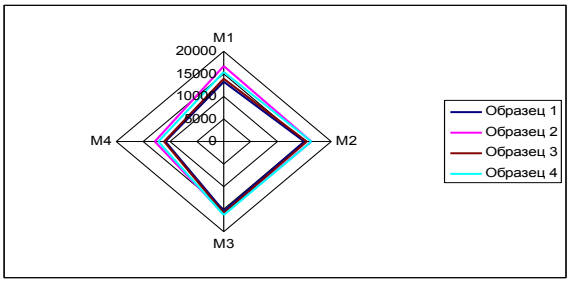

Figure 1. The odor multisensory profiles of the cooked sausages samples

The results of the examination of the odor multisensory profiles of the cooked sausages samples (Fig. 1) showed that the aromatic gamut was identical. The M1-M4 sensor values characterizing the content of volatile aroma-forming substances in the gas phase of the samples had insignificant differences between each other.

IV. CONCLUSION

Based on the results of the research, it was established that the use of mycelized ascorbic acid in cooked sausages production (27-50 g/100 kg of unsalted raw material) with the reduced dose of sodium nitrite (5 g) provided the high consumer properties and low indices of oxidative and microbiological spoilage during storage at the level of the finished product samples made with the use of 50 g of the traditional form of ascorbic acid and the full dose of sodium nitrite (10 g).
However, it is necessary to note that the complete elimination of sodium nitrite can lead to an alteration of the organoleptic characteristics of the produce which is traditionally manufactured with its use. And both complete and partial elimination of sodium nitrite can result in microbiological instability of produce in the process of storage in serial meat products production.

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