

THE EFFECT OF THE ADDITION OF ISOASCORBIC ACID AND SODIUM ASCORBATE ON SENSORY QUALITY OF RAW SAUSAGE

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Abstract. The effect of the addition of isoascorbic acid and sodium ascorbate on storage changes of raw fermented semi-durable sausages quality was investigated in the study. The applied substances improved colour at cross-section, taste and overall acceptability, and had an advantageous effect on the consumer quality of the raw sausage during 30-day storage. It was also observed that the simultaneous application of isoascorbic acid and sodium ascorbate has a more significant effect on sensory quality attributes than the application of only one of them. On the basis of the obtained results it was found that the best products were obtained for the mixture of isoascorbic acid in the amount of 0.1 to 0.4 g/kg batter and 0.5 g sodium ascorbate per 1 kg of batter.

Key words: raw sausage, isoascorbic acid, sodium ascorbate, quality, sensory examination

INTRODUCTION

Quality is generally considered to be one of the most important factors causing market success for a product, especially its long-time success. As it was shown by Baryłko-Pikielna [1995], Baryłko-Pikielna et al. [1996] and Surmacka-Szcześniak [1993] the term quality is difficult to define due to its complexity. For consumers, quality assessment is based mainly on visual sensations, which are the basis for the decision to purchase a given product [Aumaître 1999, Kołczak and Kupiec 2004]. It depends on the person, time, place, circumstances and expectations of the consumer [Moskowitz 1995, Oude Ophius and Trijp 1995].

The aim of technological modification of quality in case of raw sausages is to obtain the highest sensory scoring and long shelf-life. According to the Food Act, the producer gives the date of minimum shelf-life or the expiry date on the basis of required tests conducted on a given product.

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At present the shelf-life of any product is established on the basis of its microbiological analyses. However, these tests are time-consuming and may be used only for sampling inspection of the final product. In many cases it was observed that negative changes of consumer quality of (any sausages) observed earlier by the use of sensory evaluation than microbial analysis investigated sausages.

In the production of raw sausages, apart from curing additives, also carbohydrate substances are applied. It is documented by numerous literature sources [Incze 1992, 1998, Seidler et al. 1995, Pyrcz et al. 1996, Molly et al. 1997, Klettner and Troeger 2000, Pezacki 2000, 2001, Wybrane działy... 1996, Pyrcz 2000 a, b, Danyluk et al. 2003].

In contrast, there are no comprehensive studies on the application of other additives in the production of raw semi-durable sausage.

THE AIM AND SCOPE OF THE STUDY

The aim of the study was to investigate the effect of the addition of isoascorbic acid and sodium ascorbate on changes of consumer quality of raw semi-durable sausages during their storage.

MATERIAL AND METHODS

The experimental Bydgoska type sausage was produced with the addition of isoascorbic acid (KA) and sodium ascorbate (AS) (Table 1) in the Pilot Plant of Institute of Meat Technology at the Agricultural University of Poznań. The reference sample was sausage made with no addition of isoascorbic acid and sodium ascorbate (sample 0).

Model sausages were stored at the temperature of approx. 10°C for 30 days. The experimental sausages were collected at 2, 6, 13, 17, 22, 27 and 30 days after stuffing and analysed for:

Table 1. Amounts of added isoascorbic acid (KA) and sodium ascorbate (AS) in raw sausage
Tabela 1. Ilości dodanego kwasu izoaskorbinowego (KA) i askorbinianu sodu (AS) w kiełbasie surowej

Variant of sausage Wariant wędliny	Isoascorbic acid (KA) g/kg batter Kwas izoaskorbinowy (KA) g/kg farszu	Sodium ascorbate (AS) g/kg batter Askorbinian sodu (AS) g/kg farszu
0	0	0
A	0	0.5
B	0.4	0
C	0.2	0.3
D	0.1	0.4
E	0.3	0.1
F	0.3	0.3

– chemical analysis (protein, total fat, moisture) [PN-74/A-82114, PN-ISO 1444:2000, PN-ISO 1442:2000]

– consumer acceptability using a 5-point scale. The following parameters were evaluated: appearance and external colour, cross-section colour, aroma, taste, consistency, saltiness and overall acceptability [PN-ISO 5492:1997, PN-ISO:1998, PN-ISO 4121:1998, PN-A 82007/A1:1998].

The obtained results (means from two series) were analysed statistically using Microsoft Excel 2000 and STATISTICA 6.0 software.

In the interpretation of the results the analyses of variance and regression were applied. All the results were interpreted at the level of significance $\alpha = 0.05$.

DISCUSSION AND RESULTS

The basic composition of experimental sausages was formulated in compliance with the respective standard PN-A-82007/A1:1998. Produced sausages directly after production contained on average 16.12% protein, 32.12% fat and 49.7% water. The conducted analyses showed no significant differences in the contents of these components between the produced variants and the experimental series.

The performed analysis of variance of the obtained results showed a statistically significant effect of storage time on all analysed quality parameters. In turn, the amount and type of applied additives had a significant effect only on external colour, the acceptability and intensity of cross-section colour and overall acceptability. Table 2 presents indexes of significance for all the analysed parameters.

Table 2. A list of indexes of significance F ($\alpha \leq 0.05$)
Tabela 2. Zestawienie wskaźników istotności F ($\alpha \leq 0,05$)

Analysed quality attributes Badane cechy jakościowe	Value $F_{obl.}$ for: Wartość $F_{obl.}$ dla:	
	storage time czasu przechowywania $F_{tab.} = 2.36$	variant of model sausage (Table 1) wariant wędliny modelowej (tab. 1) $F_{tab.} = 2.36$
External appearance Wygląd zewnętrzny	276.54	0.98
External colour Barwa zewnętrzna	334.12	2.91
Acceptability of cross-section colour Pożądalność barwy przekroju	56.35	12.19
Intensity of cross-section colour Intensywność barwy na przekroju	79.20	7.55
Aroma – Zapach	59.27	0.89
Consistency – Konsystencja	76.38	1.25
Taste – Smak	13.16	1.54
Overall acceptability Ogólna pożądalność	43.46	4.50

In accordance with the aim of the study, the analyses were focused on primary attributes of sensory properties, i.e. intensity and acceptability of cross-section colour, taste and overall acceptability of experimental sausages.

The determination of consumer quality of model sausages was started with the analysis of changes in colour intensity. It was observed that the most changes were recorded in the sample with no addition of isoascorbic acid and sodium ascorbate (sample 0). In sample A (only sodium ascorbate added) up to day 13 of storage no significant changes were observed in colour intensity. Only longer storage resulted in a significant deterioration of this attribute. In the other (5) samples colour intensity increased until day 13 of storage. Storage of samples for the successive 17 days significantly deteriorated colour intensity.

Figure 1 present the effect of storage time on changes in colour intensity of experimental sausages. The course of changes in colour is described by equations presented below:

sample 0	$y = -0.0008x^2 + 0.0057x + 4.2529$	$R^2 = 0.827$
sample A	$y = -0.0008x^2 + 0.0111x + 4.2498$	$R^2 = 0.6563$
sample B	$y = -0.0018x^2 + 0.0379x + 4.2899$	$R^2 = 0.8994$
sample C	$y = -0.0016x^2 + 0.0344x + 4.2384$	$R^2 = 0.907$
sample D	$y = -0.0023x^2 + 0.0540x + 4.1346$	$R^2 = 0.8666$
sample E	$y = -0.0017x^2 + 0.0410x + 4.1675$	$R^2 = 0.9106$
sample F	$y = -0.0016x^2 + 0.0352x + 4.2406$	$R^2 = 0.6924$

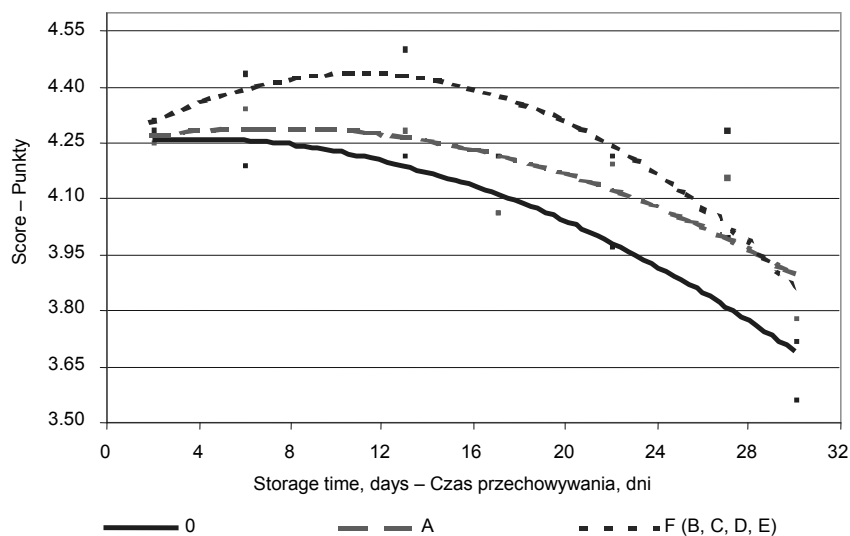


Fig. 1. The effect of storage time on colour intensity of experimental sausages
Rys. 1. Wpływ czasu przechowywania na intensywność barwy kielbas doświadczalnych

These equations show that the course of changes in colour intensity in samples B, C, D, E and F was very similar. For this reason the figure presents only samples 0, A and F. The course of respective graphs for samples F, B, C, D and E is almost identical. For example: after 13 days of storage the control sample (no additives) received the score of

approx. 4.20 points, while sample F 4.50 points, whereas for the other samples it was B = 4.50, C = 4.44, D = 4.47 and E = 4.44 points, respectively.

Similar dependencies were found when assessing changes in the other attributes, i.e. acceptability of cross-section colour, taste and overall acceptability of the tested sausages.

The obtained results were used to determine the more general dependencies between the level and type of the applied additive and storage time, and the performance in sensory examination. This requires the determination of a function with three independent variables, where: t – storage time, KA – amount of isoascorbic acid, AS – amount of sodium ascorbate.

The effect of the amounts of added isoascorbic acid, sodium ascorbate and storage time on the intensity of cross-section colour was investigated in the first stage of the study. The obtained function with the coefficient of determination $R^2 = 0.811$ and significance $p = 1.55 \cdot 10^{-11}$ is described by equation (1):

$$y_{\text{inten}} = 4.135 + 2.212 \cdot (KA) - 1.945 \cdot (AS) + 0.028 \cdot t - 4.457 \cdot (KA)^2 + 4.000 \cdot (AS)^2 - 0.001 \cdot t^2 + 0.932 \cdot (KA) \cdot (AS) - 0.005 \cdot (KA) \cdot t + 0.010 \cdot (AS) \cdot t \quad (1)$$

While analysing partial coefficients of this regression the significant effect of storage time (t and t^2) on the colour intensity was observed.

This equation may not be presented in the graphic form on a plane, and for this reason it was rearranged. At the assumption of no sodium ascorbate added ($AS = 0$) the above equation takes the following form:

$$y_{\text{inten}} = 4.135 + 2.212 \cdot (KA) + 0.028 \cdot t - 4.457 \cdot (KA)^2 - 0.001 \cdot t^2 - 0.005 \cdot (KA) \cdot t \quad (2)$$

It may be presented in the graphic form (Fig. 2).

There may be seen that the highest notes for this parameter were given to sausages produced with the addition of isoascorbic acid in the amount ranging from 0.18 to 0.5 g per 1 kg batter and between day 5 and 15 day after their production. In turn, at storage time from 15 to 30 days colour intensity will depend rather on storage time than the amount of added isoascorbic acid.

However, by rearranging equation 1, at the assumption of no addition of isoascorbic acid ($KA = 0$) a dependency was obtained described by equation 3 and graphically in the following form (Fig. 3):

$$y_{\text{inten}} = 4.135 - 1.945 \cdot (AS) + 0.028 \cdot t + 4.000 \cdot (AS)^2 - 0.001 \cdot t^2 + 0.010 \cdot (AS) \cdot t \quad (3)$$

The application of only sodium ascorbate also has a positive effect on colour intensity of produced sausages (Fig. 3). The highest notes were given to products with the addition of sodium ascorbate in the amounts ranging from 0.08 to 0.38 g per 1 kg batter, at storage time from 5 to 15 days after production. In turn, at longer storage, similarly as in case of the addition of only isoascorbic acid, first of all storage time had an effect on colour intensity.

The obtained results indicated the necessity to verify the advisability of a simultaneous application of isoascorbic acid and sodium ascorbate at the accepted storage time.

Equation 1 was appropriately rearranged, at the assumption that accepted storage time is $t = 25$ days. The following form of the equation was obtained:

$$y_{\text{inten}} = 4.044 + 2.296 \cdot (KA) - 1.775 \cdot (AS) - 4.457 \cdot (KA)^2 + 4.000 \cdot (AS)^2 + 0.932 \cdot (KA) \cdot (AS) \quad (4)$$

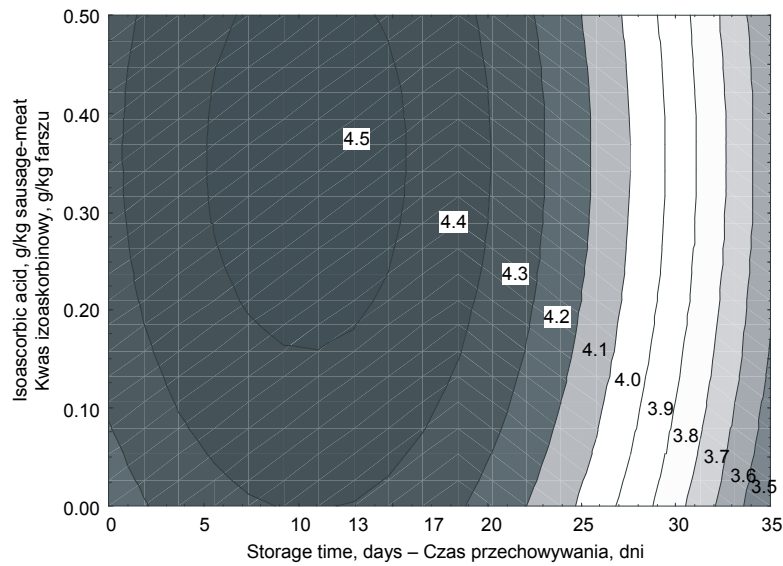


Fig. 2. The effect of storage time and the addition of isoascorbic acid on intensity of cross-section colour of experimental sausages
 Rys. 2. Wpływ czasu przechowywania i dodatku kwasu izoaskorbinowego na intensywność barwy przekroju kiełbas doświadczalnych

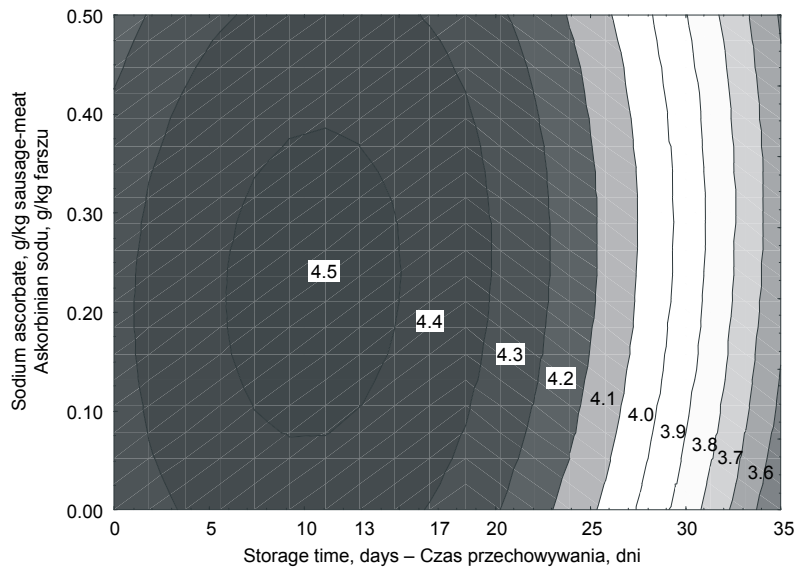


Fig. 3. The effect of storage time and the addition of sodium ascorbate on intensity of cross-section colour of experimental sausages
 Rys. 3. Wpływ czasu przechowywania i dodatku askorbinianu sodu na intensywność barwy przekroju kiełbas doświadczalnych

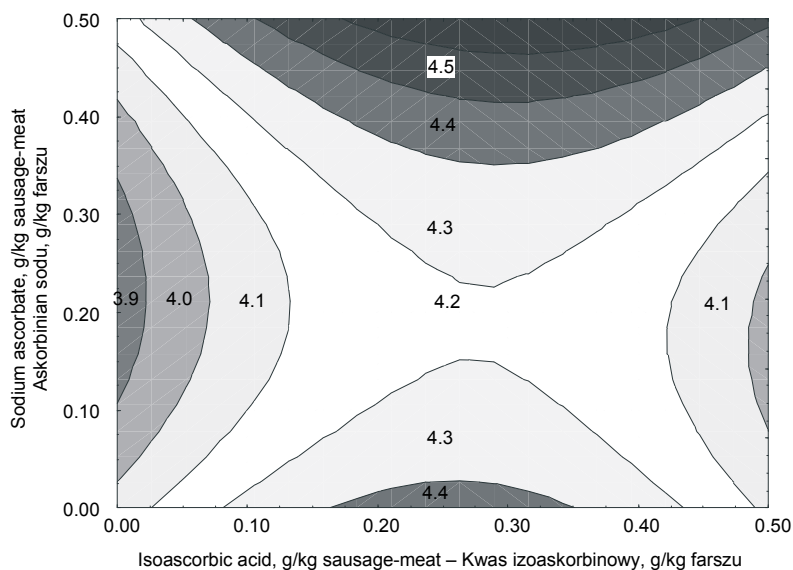


Fig. 4. The effect of the addition of isoascorbic acid and sodium ascorbate on intensity of cross-section colour of experimental sausages on day 25 of storage
Rys. 4. Wpływ dodatku kwasu izoaskorbinowego i askorbinianu sodu na intensywność barwy przekroju kiełbas doświadczalnych w 25 dniu przechowywania

This equation is presented in Figure 4.

The simultaneous addition of isoascorbic acid in the amount from 0.12 to 0.50 g and sodium ascorbate in the amount exceeding 0.41 g per 1 kg batter has a positive effect on colour intensity of products. They received the score of 4.5 points on this day. It can be also seen that this amount of isoascorbic acid ensures the highest notes for the analysed attribute (from 4.1 to 5.0 points), irrespective of the amount of added sodium ascorbate. Similar effects, i.e. scores from 4.2 to 5.0 points, are obtained by the addition of sodium ascorbate below 0.12 g/kg batter and over 0.22 g/kg. In contrast, if isoascorbic acid is added in the amount 0.02 g and sodium ascorbate 0.10 to 0.33 g per 1 kg batter, after identical storage time, sausages received only 3.9 points.

Analyzing the results of colour acceptability determination the dependence was obtained with very high significance $p = 4.612 \cdot 10^{-14}$ and coefficient of determination $R^2 = 0.861$ (equation 5).

$$y_{\text{colour}} = 4.151 + 6.518 \cdot (\text{KA}) - 6.051 \cdot (\text{AS}) + 0.009 \cdot t - 14.514 \cdot (\text{KA})^2 + 12.930 \cdot (\text{AS})^2 - 0.001 \cdot t^2 + 2.305 \cdot (\text{KA}) \cdot (\text{AS}) - 0.014 \cdot (\text{KA}) \cdot t + 0.010 \cdot (\text{AS}) \cdot t \quad (5)$$

Obtained partial correlation coefficients for this function similarly as in the determination of colour intensity, showed a significant effect of storage time and levels of applied additives.

In turn, the simultaneous effect of added isoascorbic acid and sodium ascorbate on acceptability of cross-section colour on day 25 after production ($t = 25$), may be presented in the form of equation 6 and in the graphic form (Fig. 5).

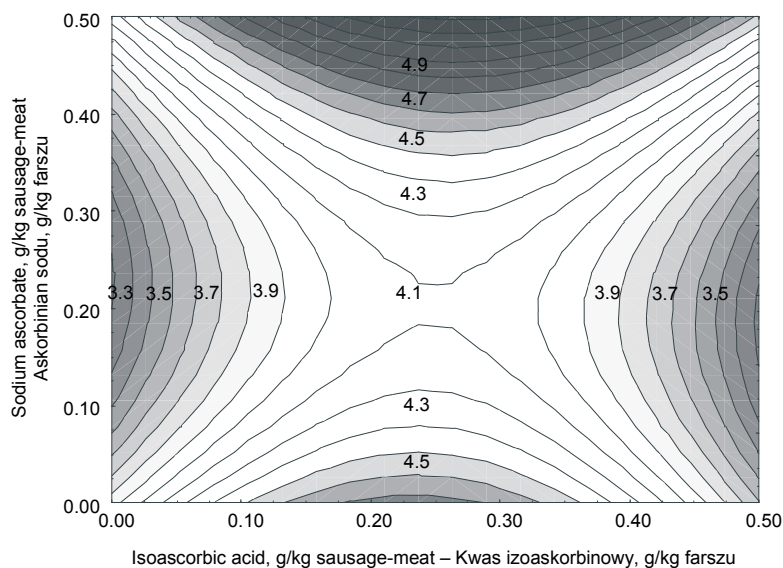


Fig. 5. The effect of the addition of isoascorbic acid and sodium ascorbate on acceptability of cross-section colour of experimental sausages on day 25 of storage

Rys. 5. Wpływ dodatku kwasu izoaskorbinowego i askorbinianu sodu na pożądalność barwy przekroju kielbas doświadczalnych w 25 dniu przechowywania

$$y_{\text{colour}} = 3.856 + 6.758 \cdot (\text{KA}) - 5.880 \cdot (\text{AS}) - 14.514 \cdot (\text{KA})^2 + 12.930 \cdot (\text{AS})^2 + 2.305 \cdot (\text{AS}) \cdot (\text{KA}) \quad (6)$$

The graphic form of this equation is similar to the one obtained for the determination of colour intensity. The best acceptability of cross-section colour (4.51-5.0 points) on day 25 of storage may be obtained when adding to sausages:

– Isoascorbic acid in the amounts from 0.10 to 0.35 g and 0.01 g sodium ascorbate per 1 kg batter

or

– Isoascorbic acid in the amount from 0.10 to 0.45 g and 0.45 to 0.50 g sodium ascorbate per 1 kg batter.

In case of the evaluation of taste acceptability the obtained dependency is presented by the equation 7.

$$y_{\text{taste}} = 4.091 + 3.933 \cdot (\text{KA}) - 4.493 \cdot (\text{AS}) + 0.017 \cdot t - 8.832 \cdot (\text{KA})^2 + 9.316 \cdot (\text{AS})^2 - 0.0009 \cdot t^2 + 2.575 \cdot (\text{AS}) \cdot (\text{KA}) - 0.001 \cdot (\text{KA}) \cdot t + 0.006 \cdot (\text{AS}) \cdot t \quad (7)$$

$$R^2 = 0.657 \text{ and } p = 8.957 \cdot 10^{-7}.$$

Rearranging the above equation it was found that the application of only isoascorbic acid or only sodium ascorbate did not have a significant effect on taste acceptability of analyzed sausages. In turn, a statistically significant effect on the analysed parameter was found for storage time.

The most important attribute of consumer quality of sausage is the determination of its overall acceptability. Changes of overall acceptability of analysed sausages are described by equation (8):

$$y_{og} = 4.045 + 1.613 \cdot (KA) - 1.591 \cdot (AS) + 0.031 \cdot t - 2.881 \cdot (KA)^2 + 3.518 \cdot (AS)^2 - 0.001 \cdot t^2 + 1.198 \cdot (AS) \cdot (KA) - 0.003 \cdot (KA) \cdot t + 0.007 \cdot (AS) \cdot t \quad (8)$$

$$R^2 = 0.815 \text{ and } p = 1.103 \cdot 10^{-11}.$$

While analysing partial regression coefficients a significant effect of storage time was observed (t and t^2) on overall acceptability of tested sausages.

The addition of only isoascorbic acid or only sodium ascorbate did not have a significant effect on changes in overall acceptability of model sausages (Figs 6 and 7). However, a positive interaction was observed for the effect of isoascorbic acid and sodium ascorbate addition. Equation 9 and Figure 8 present this interaction on day 25 of storage of tested sausages:

$$y_{og} = 4.033 + 1.570 \cdot (KA) - 1.472 \cdot (AS) - 2.881 \cdot (KA)^2 + 3.518 \cdot (AS)^2 + 1.198 \cdot (AS) \cdot (KA) \quad (9)$$

As it can be seen, the range of this effect is similar to those observed previously. Sausages produced with isoascorbic acid added in the amount from 0.20 to 0.50 g and sodium ascorbate in the amount from 0.45 to 0.50 g/kg batter receive very good notes (over 4.51 points) on day 25 after production. In contrast, the lowest notes for overall product acceptability (3.90 points), on day 25 of storage, were found when 0.12 to 0.28 g sodium ascorbate and not more than 0.02 g isoascorbic acid were added per 1 kg batter.

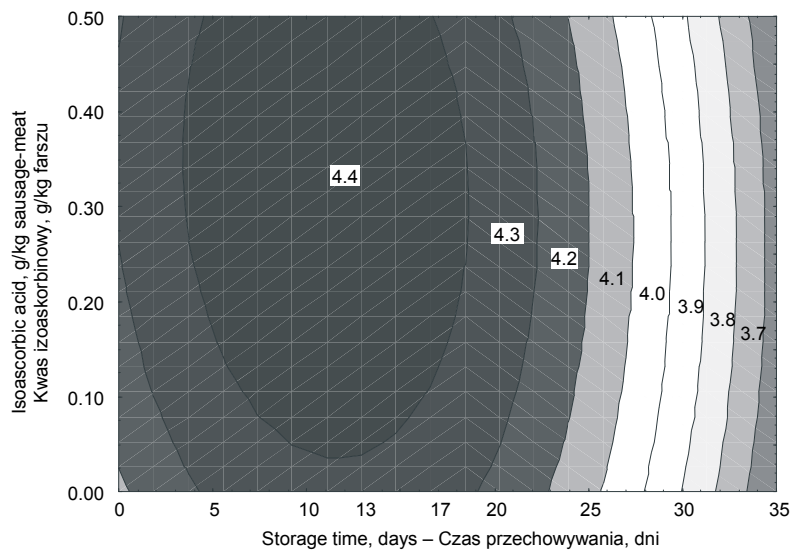


Fig. 6. The effect of storage time and the addition of isoascorbic acid on overall acceptability of experimental sausages

Rys. 6. Wpływ czasu przechowywania i dodatku kwasu izoaskorbinowego na ogólną pożądalność kielbas doświadczalnych

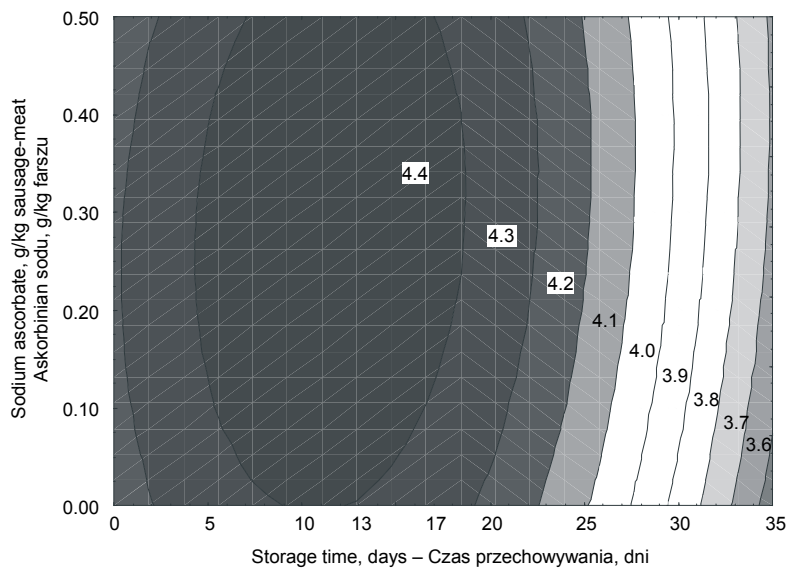


Fig. 7. The effect of storage time and the addition of sodium ascorbate on overall acceptability of experimental sausages
 Rys. 7. Wpływ czasu przechowywania i dodatku askorbinianu sodu na ogólną pożądalność kiełbas doświadczalnych

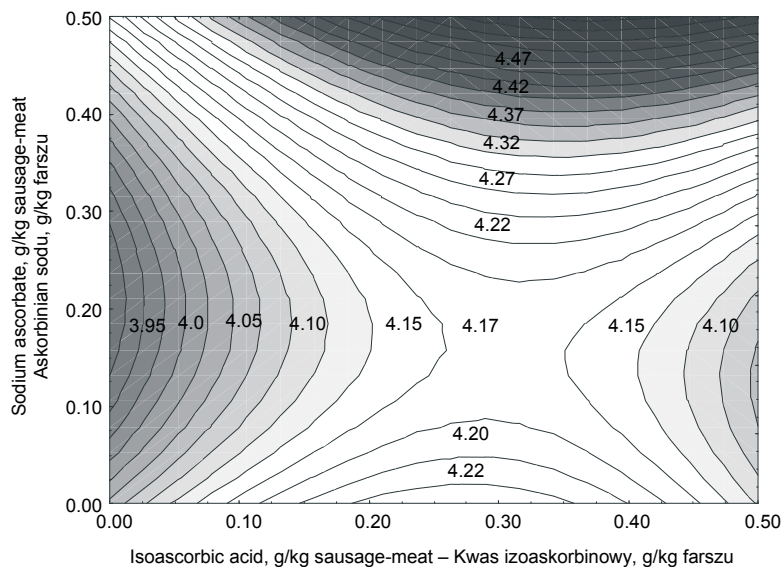


Fig. 8. The effect of the addition of isoascorbic acid and sodium ascorbate on overall acceptability of experimental sausages on day 25 of storage
 Rys. 8. Wpływ dodatku kwasu izoaskorbinowego i askorbinianu sodu na ogólną pożądalność kiełbas doświadczalnych w 25 dniu przechowywania

CONCLUSIONS

1. The applied additives had a positive effect on consumer quality of Bydgoska type sausage. During 4 weeks of storage sausages received scores not lower than 3.60 points, while for the control sample it was 3.34 points.

2. The determination of sensory quality of analysed sausages was statistically significantly affected also by storage time.

3. Simultaneous addition of isoascorbic acid and sodium ascorbate had a more advantageous effect on the analysed parameters of sensory quality than the application of only one of them at a time.

The proportions of the amounts of these additives are significant.

4. The highest scores for sensory quality are obtained using at the same time from 0.1 to 0.4 g isoascorbic acid and 0.5 g sodium ascorbate per 1 kg batter. The highest sensory acceptability was found for the sample with the addition of isoascorbic acid and sodium ascorbate in the amounts of respectively 0.1 g and 0.4 g per 1 kg batter.

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WPLYW DODATKU KWASU IZOASKORBINOWEGO I ASKORBINIANU SODU NA JAKOŚĆ SENSORYCZNĄ KIELBASY SUROWEJ

Streszczenie. Badano wpływ dodatku kwasu izoaskorbinowego i askorbinianu sodu na przechowalnicze zmiany jakości konsumenckiej kielbas surowych półtrwałych. Zastosowane substancje podniosły ocenę barwy przekroju, smaku i ogólnej pożądaności oraz korzystnie wpłynęły na zachowanie jakości kielbasy surowej typu bydgoska w czasie 30 dni przechowywania. Zauważono także, że równoczesne stosowanie dodatku kwasu izoaskorbinowego i askorbinianu sodu ma bardziej istotny wpływ na wyróżniki oceny sensorycznej badanych kielbas niż pojedyncze stosowanie dodatków. Na podstawie uzyskanych wyników stwierdzono, że najwyższe oceny uzyskamy, stosując mieszaninę o składzie: kwas izoaskorbinowy w ilości 0,1-0,4 g/kg farszu i 0,5 g/kg askorbinianu sodu.

Słowa kluczowe: kielbasa surowa, kwas izoaskorbinowy, askorbinian sodu, jakość, ocena sensoryczna

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