PROFESSIONAL PAPER

Levels of nitrite and nitrate content in traditional dry sausage "homemade kulen"

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Abstract

When it comes to sausages production, the meat industry relies on the effectiveness of antimicrobial agents such as nitrite (NO_2^-), nitrate (NO_3^-) and their potassium and sodium salts. These additives are important as curing agents, antioxidants, and they enhance the color, flavor, aroma and inhibit the growth and reproduction of bacteria *Staphylococcus aureus* and *Clostridium botulinum*. However, nitrites and nitrates are known to react in such a way to form N-nitrosamines which are, according to the IARC (International Agency for Research on Cancer), claimed as probably or possibly carcinogen. This stimulated the establishment of The European Regulation (EC) No 1333/2008 which regulates the maximum permitted levels of nitrate and nitrate additives in meat products. Commercially available meat products are designated to 150 $mgkg^{-1}$ and for traditional meat products this limit was set each product type (50 to 180 mg kg^{-1} and from 10 to 300 mg kg^{-1} for nitrite and nitrate). On the other hand, the European Regulation (EC) No 2108/2023 prescribes (from the 9th of October 2025.) the reduction of nitrite and nitrate in dry sausages to 80 and 90 $mgkg^{-1}$. The aim of this investigation was to screen the nitrate and nitrite levels in commercially available dry sausage "Homemade kulen". The investigation was conducted consecutively for four years and 158 samples of "Homemeade kulen" have been analyzed. The results show that mean value for nitrites was 4.42 $mgkg^{-1}$ and for nitrates 16.22 $mgkg^{-1}$ in the first year. In year two, mean values were a bit higher, amounting to 5.68 $mgkg^{-1}$ for nitrites and 17.86 $mgkg^{-1}$ for nitrates. In the third year samples showed a drop in nitrite and nitrate mean values (2.92 and 9.80 $mgkg^{-1}$) while in the fourth year nitrites showed and increase to 4.95 $mgkg^{-1}$ and nitrates to 19.32 $mgkg^{-1}$. Maximal values ranged 7.82–19.67 $mgkg^{-1}$. Minimal values for years three and four were 2.65 $mgkg^{-1}$ and 1.45 $mgkg^{-1}$. Maximal value for nitrates was reached in year four amounting above 90 $mgkg^{-1}$. This shows that this kind of traditional products contain nitrates and nitrites and the amounts of this additive must be monitored.

Keywords: nitrate, nitrite, dry sausage. Homemade kulen

Introduction

In accordance with Annex I of Regulation 1333/2008 of the European Parliament and the Council of December 16, 2008 on food additives (EC2008) of the 26 categories of additives, nitrates and nitrites belong to the group of preservatives, i.e. additives that prevent infections, intoxications and

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spoilage of meat products and increase their durability. Also, nitrates and nitrites affect colour change, smell, taste and texture of meat products and thanks to their antioxidant effect they contribute to the prevention of rancidity (Marco et al., 2006; Sebranek and Bacus, 2007).

In the meat industry, sodium nitrite (E250) and potassium nitrite (E249), or sodium nitrate (E251) and potassium nitrate (E252) are most often used as components of brine (Hui 2012). Nitrates, unlike nitrites, do not have an antimicrobial effect, but are reduced to nitrites by the action of denitrifying bacteria, especially from the genus *Micrococcus*, using the enzyme nitrate-reductase. Nitrates thus serve as a source of nitrites, whose concentration during processing significantly reduces. The reduction of nitrites content is affected by higher pH values, reducing action of ascorbic acid, thermal treatment, long-term ripening or storage (Davidson et al., 2005). Nitrates, if they are not added or come from water and spices, can only be detected in those meat products in which nitrites have been previously added. Research has shown that during accelerated fermentations in industrial production (bacterial starter cultures, sugars and elevated fermentation temperatures), a total of about 50 % of added nitrites turn into nitrates (Pavlinić Prokurica et al., 2010). Nitrates and nitrites are introduced into meat products via salt for curing (NaCl + 3 % $NaNO_3$ or KNO_3), nitrite salt for curing (NaCl + 0.5 - 0.6 % of nitrites expressed as $NaNO_2$) or nitrite salt for brining with 1 % saltpetre (NaCl + 0.5 - 0.6 % nitrite expressed as $NaNO_2$ + 0.9 - 1.2 % saltpeter expressed as $NaNO_3$) (Kovačević, 2001; Kovačević 2014).

Although nitrite is the only known preservative that inhibits the growth of spores of the pathogenic bacterium *Clostridium botulinum* and the creation of botulinum neurotoxin, due to the harmful effects of nitrite on human health, especially the carcinogenic effect of N-nitrosamines (Iammarino et al., 2013; Xie et al., 2023). Maximum permitted amounts of nitrates and nitrites in meat products are limited by regulations, and already in 1995, EFSA's Committee for Food Additives and Nutrient Sources added to Food gave a recommendation for the application of appropriate technological practices in order to reduce the level of nitrates and nitrites to the lowest possible level, at the same time resulting in effective preservation and microbiological food safety. In 1990, the Scientific Committee of Food (SCF) determined the acceptable daily intake (ADI) for nitrates up to 3.7 mg kg^{-1} human body mass (expressed as nitrate ion), and the ADI for nitrites up to 0.07 mg kg^{-1} (expressed as nitrite ion). The additives sodium and potassium nitrite (E250 and E249) are classified as the riskiest 3rd safety group, and it was determined that their estimated daily intake (Eng.: Estimated Daily Intake; EDI) theoretically exceeds the acceptable daily intake (ADI) many times over, which points to the need for continuous monitoring of nitrite intake in the human body.

In this paper, in the samples of homemade kulen (HK), the amounts of nitrates and nitrites were determined and the obtained values were compared with the maximum permissible amounts (LDK) defined by Regulation of the EU Commission no. 1333/2008 and 2108/2023 (EC 2023).

Material and methods

Material

From 2020 to 2023, a total of 158 samples of finished homemade kulen originating from different producers were collected on the Croatian market. Homemade kulen samples were produced according the procedures described by Mastanjević et al. 2021. The samples were prepared for analysis in accordance with the ISO 3100–1:1991 standard. They were homogenized at a speed of 5000-6000 rpm for 15-20 s, using a Grindomix GM 200 homogenizer (Retch, Germany), stored in plastic containers at 4 °C and analyzed for nitrites and nitrates within 24 hours.

Nitrite determination

Determination of nitrite was carried out with FIAstar™ 5000 Analyzer (Foss, Denmark). 10 g of the sample was weighed in Erlenmeyer flask (100 Ml), 80 mL of hot water and 10 mL of Borax solution was added and homogenized for 60 s on T 25 digital ULTRA-TURRAX (Ika, Germany). 30 mL of hot water was added. The contents of the flask were heated in a water bath at 100 °C for 15 min with shaking. Then, the contents were cooled to room temperature and quantitatively transferred into a 100 mL volumetric flask with 2 mL of Carrez solution no. 1 and Carrez no. 2 with stirring after each addition. The contents of the flask were topped up with water up to the mark, and filtered through pleated filter paper (black ribbon). The clear filtrate was used for nitrite determination. The absorbances were read at a

wavelength of 540 nm.

Nitrate determination

Determination of sodium nitrate was carried out using a validated method with FIAstar™ 5000 Analyzer (Foss, Denmark). The preparation of the samples were the same as used for nitrite determination. Before absorbances reads at a wavelength of 540 nm the clean filtrate was subjected to reduction with cadmium colon. The nitrate in samples were reduced to nitrite. Nitrate content was calculated as a difference in absorbances reads at a wavelength of 540 nm before and after reduction.

Results and disscution

In the Table 1 the nitrite and nitrate levels in homemade kulen in year 2020 are presented. Nitrite content ranged from 0.98 to 9.84 mgkg^{-1} and were below the prescribed values. Berardi et al (2021) reported higher values for nitrite content in Italian salami (47.3–71.4 mgkg^{-1}). Lover levels of nitrite in HK are expected since this this sausage in mainly produced on small family farms according to the traditional recipe without the addition of any kind of additives. Nitrate concertation were within the prescribed limits and in the range from 0 to 66.83 mgkg^{-1}.

In the year 2021, 42 samples of HK were analysed (Table 2.). All samples meet the prescribed criteria according to the regulation of EU Commission no. 1333/2008. Sample HK7 showed highest value for nitrate of 86.66 mgkg^{-1}. For nitrite content highest value of 11.8266 mgkg^{-1} was recorded for the sample HK38.

In the year 2022 nitrite content ranged from 0.98 to 7.82 mgkg^{-1} and the nitrate concentration were in range from 2.65 to 58.40 mgkg^{-1}. From all analysed years the samples of HK in 2022. showed lowest content of both nitrite and nitrate.

Highest number of samples (46) were investigated in the year 2023 (Table 4.). The content of nitrate in sample HK34 (91.56 mgkg–1) exceeded the concentration prescribed by the Regulation of the EU Commission no. 2108/2023 (this regulation is in force from 9th October of 2025) of 90 mgkg^{-1}. Nitrite levels (ranged from 0 to 19.67 mgkg–1) were in ordinance with the both EU Commission Regulation.

The highest values of nitrite were determined in the sample HK35 (19.67 mgkg^{-1}) from the year 2023, while the lowest amounts were found in the samples of HK42 also from the year 2023 (0 mgkg^{-1}).

Table 1 Nitrite and nitrate content of homemade kulen (HK) in year 2020

Sample	Nitrite content (mgkg^{-1})	Nitrate content (mgkg^{-1})
HK 1	9.84	16.83
HK2	3.93	25.11
HK3	3.92	21.44
HK4	4.89	51.7
HK5	4.89	39.7
HK6	5.89	23.12
HK7	4.89	0
HK8	5.89	0.15
HK9	5.9	0.16
HK10	4.9	0
HK11	1.97	16.2
HK12	2.94	0
HK13	2.94	0
HK14	2.95	5.54
HK15	4.91	9.61
HK16	3.93	4.53
HK17	2.95	7.94
HK18	4.89	38.45
HK19	5.91	66.83
HK20	6.86	12.46
HK21	2.94	4.29
HK22	0.98	12.3
HK23	0.98	1.44
HK24	5.91	8.65
HK25	4.93	7.21
HK26	3.93	48.13

Also, the results of nitrate and nitrite for each year, showed high differences, which indicates large differences in the manufacturer's recipes (mass fraction of added Na-nitrate and Na-nitrite, addition of sugar and starter culture) and technological parameters of production. This is why nitrates are used in the meat industry for the production of slow-fermented sausages (they are firstly converted into nitrites), and nitrites are used for the production of fast-fermented sausages (the action starts immediately) (Honikel, 2008).

Kovačević et al. (2016) reported nitrate values from 4 to 315 mgkg^{-1} for dry sausages from Croatian market. Similar as in this study the nitrate and nitrite values for kulen samples were within prescribed levels and lowest of all examined dry sasuasges.

Spanish dry sausages chorizo style showed levels of nitrite between 7 and 25 mgkg^{-1} (Hospital

Table 2 Nitrite and nitrate content of homemade kulen (HK) in year 2021

Sample	Nitrite content ($mgkg^{-1}$)	Nitrate content ($mgkg^{-1}$)
HK 1	3.94	61.53
HK2	1.97	0
HK3	0.98	0
HK4	0.98	0
HK5	0.98	0
HK6	8.86	6.9
HK7	8.83	86.66
HK8	1.97	1.67
HK9	4.93	7.21
HK10	3.94	43.34
HK11	4.92	47.21
HK12	6.89	22.21
HK13	7.84	12.69
HK14	3.94	25.16
HK15	1.96	1.67
HK16	2.94	0
HK17	4.9	1.14
HK18	5.89	19.49
HK19	4.92	1.14
HK20	7.43	5.91
HK21	4.92	12.05
HK22	3.93	25.11
HK23	6.88	11.29
HK24	6.87	39.06
HK25	6.88	2.8
HK26	6.88	6.44
HK27	2.94	10.34
HK28	4.91	4.77
HK29	4.91	13.22
HK30	7.88	9.11
HK31	8.86	3.26
HK32	7.84	16.31
HK33	6.89	1.6
HK34	8.82	55.18
HK35	4.91	0
HK36	7.83	13.88
HK37	5.9	77.67
HK38	11.82	52.5
HK39	6.89	36.76
HK40	7.87	3.05
HK41	7.86	6.66
HK42	6.9	5.24

et al., 2015) which is higher than the nitrite levels for HK reported in this study.

Samples of dry sausages from Italy also showed relatively higher nitrite content (from 17.3 to 25.82 $mgkg^{-1}$) (Berardi et al., 2021) the nitrite levels for HK.

Bozkurt and Erkmen, 2004 reported residual nitrite levels for sucuk (Turkish style beef dry sausage) from 5.14 to 12.01 $mgkg^{-1}$ after the storage of 45 days. This result agrees with the nitrite levels in HK presented in this study. On the other hand, another study (Uren and Babayiğit, 1997) observed a residual nitrite level of 40 $mgkg^{-1}$ for this kind of dry sausage.

Greek traditional dry sausage (produced without the additive) showed similar residual nitrite levels (from 0.00 to 36.85 $mgkg^{-1}$) (Konstandinidis et al., 2013) as nitrite levels determined in this study.

Conclusions

Nitrite (NO_2^-) and nitrate (NO_3^-) subsequently after reduction to the nitrite and their potassium and sodium salts are only additives which can assure the microbiological safety of cured meat product. The usage of this kind of additives in traditional production of dry sausages such as homemade kulen is not appropriate. Results of this study indicated that the most producers still used traditional recipe without usage of additives such as nitrite and nitrate. Only few samples showed increased concentrations of nitrate and nitrite which can be related to the possible usage of these additives in production of homemade kulen. Because of the prescribed reduction of concentrations of nitrite and nitrate from 9th October of 2025 (according to the Regulation of the EU Commission no. 2108/2023) in dry sausages the constant monitoring of these additives in homemade kulen are required.

Table 3 Nitrite and nitrate content of homemade kulen (HK) in year 2022

Sample	Nitrite content ($mgkg^{-1}$)	Nitrate content ($mgkg^{-1}$)
HK 1	3.94	6.97
HK2	4.93	5.99
HK3	2.95	4.31
HK4	0.98	6.29
HK5	4.89	8.35
HK6	3.92	19
HK7	1.96	10.13
HK8	0.98	3.86
HK9	0.98	3.86
HK10	0.98	3.84
HK11	3.94	20.33
HK12	2.94	38.2
HK13	0.98	2.65
HK14	0.98	3.86
HK15	0.98	3.86
HK16	2.94	3.09
HK17	0.98	3.86
HK18	2.95	5.53
HK19	4.89	10.79
HK20	1.96	2.87
HK21	0.98	19.59
HK22	3.93	4.55
HK23	4.91	38.6
HK24	2.95	23.72
HK25	0.98	3.86
HK26	3.92	6.94
HK27	3.92	4.53
HK28	0.98	13.55
HK29	2.96	11.6
HK30	3.93	8.18
HK31	2.95	15.2
HK32	3.93	4.53
HK33	1.96	2.87
HK34	2.94	3.09
HK35	1.96	10.09
HK36	3.92	4.53
HK37	2.94	4.3
HK38	2.94	3.1
HK39	5.91	6.23
HK40	4.92	4.78
HK41	0.98	3.87
HK42	2.94	4.31
HK43	7.82	58.40

Table 4 Nitrite and nitrate content of homemade kulen (HK) in year 2023

Sample	Nitrite content ($mgkg^{-1}$)	Nitrate content ($mgkg^{-1}$)
HK 1	6.88	38.54
HK2	0.98	2.65
HK3	3.94	5.77
HK4	0.98	2.64
HK5	3.94	3.34
HK6	4.91	5.98
HK7	4.9	15.63
HK8	6.89	7.66
HK9	7.86	50.25
HK10	4.92	5.26
HK11	4.92	4.78
HK12	5.88	11.03
HK13	4.9	28.88
HK14	5.88	6.19
HK15	1.97	57.44
HK16	6.87	88.17
HK17	1.97	2.87
HK18	1.96	1.67
HK19	0.98	1.45
HK20	1.96	4.09
HK21	2.96	3.11
HK22	6.89	28.88
HK23	7.87	10.32
HK24	1.96	5.3
HK25	11.78	16.03
HK26	9.79	10.72
HK27	2.95	12.8
HK28	3.94	34.86
HK29	3.94	13.05
HK30	5.89	6.2
HK31	2.96	5.54
HK32	7.84	17.52
HK33	6.87	12.46
HK34	5.89	91.56
HK35	19.67	11.22
HK36	9.8	10.73
HK37	4.93	17.94
HK38	4.91	42.26
HK39	3.94	8.19
HK40	1.97	51.38
HK41	1.96	13.76
HK42	0	3.63
HK43	4.92	91.37
HK44	1.96	17.42
HK45	4.91	3.55
HK46	3.91	4.58

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Sadržaj nitrita i nitrata u tradicionalnoj trajnoj kobasici "domaćem kulenu"

Sažetak

Kada je riječ o proizvodnji trajnih kobasica, mesna industrija se oslanja na učinkovitost antimikrobnih tvari kao što su nitriti (NO_2^-), nitrati (NO_3^-) te njihove natrijeve i kalijeve soli. Ovi aditivi važni su kao pojačivači boje, okusa, mirisa te inhibiraju rast i razmnožavanje bakterija *Staphylococcus aureus* i *Clostridium botulinum*. Međutim, poznato je da nitriti i nitrati u mesnim proizvodima mogu stvarati N-nitrozamine za koje Međunarodna agencija za istraživanje raka, tvrdi da su vjerojatno ili moguće kancerogeni. To je pota-

knulo donošenje uredbe Europskog parlamenta i vijeća (EZ) br. 1333/2008 koja regulira maksimalno dopuštene količine nitrata i nitratnih aditiva u mesnim proizvodima. Za komercijalno dostupne mesne proizvode dozvoljeno je 150 mgkg^{-1}, a za tradicionalne mesne proizvode ovo je ograničenje postavljeno za svaku vrstu proizvoda (50 do 180 mg kg^{-1} i od 10 do 300 mg kg^{-1} za nitrite i nitrate). 2023. godine Europski parlament donosi uredbu (EZ) br. 2108/2023 kojom se propisuje smanjenje (od 9. listopada 2025.) koncetracija nitrita i nitrata u trajnim kobasicama na 80 i 90 mgkg^{-1}. Cilj ovog istraživanja bio je odrediti sadržaj nitrata i nitrita u komercijalno dostupnim trajnim kobasicama "domaći kulen". Istraživanje se provodilo uzastopno četiri godine, a analizirano je 158 uzoraka "domaćeg kulena". Rezultati pokazuju da je srednja vrijednost za nitrite bila 4,42 mgkg^{-1}, a za nitrate 16,22 mgkg^{-1} u prvoj godini. U drugoj godini srednje vrijednosti bile su nešto više i iznosile su 5,68 mgkg^{-1} za nitrite i 17,86 mgkg^{-1} za nitrate. U trećoj godini uzorci su pokazali pad srednjih vrijednosti nitrita i nitrata (2,92 i 9,80 mgkg^{-1}), dok su u četvrtoj godini nitriti pokazali porast na 4,95 mgkg^{-1}, a nitrati na 19,32 mgkg^{-1}. Maksimalne vrijednosti bile su u rasponu 7,82–19,67 mgkg^{-1}. Minimalne vrijednosti za treću i četvrtu godinu bile su 2,65 mgkg^{-1} i 1,45 mgkg^{-1}. Maksimalna vrijednost za nitrate dosegnuta je u četvrtoj godini i iznosila je iznad 90 mgkg^{-1}. To pokazuje da ovakvi tradicionalni proizvodi sadrže nitrate i nitrite te se njihove razine u trajnim kobasicama moraju konstantno pratiti.

Ključne riječi: nitrati, nitriti, trajne kobasice, domaći kulen

Nitrit- und Nitratgehalte in traditioneller Rohwurst „Hausgemachter Kulen"

Zusammenfassung

Bei der Herstellung von Wurstwaren ist die Fleischindustrie auf die Wirksamkeit von antimikrobiellen Mitteln wie Nitrit (NO_2^-) und Nitrat (NO_3^-) und deren Kalium- und Natriumsalze angewiesen. Diese Zusatzstoffe sind wichtig als Pökelstoffe, Antioxidantien, Farb-, Geschmacks- und Aromastoffe und hemmen das Wachstum und die Vermehrung der Bakterien *Staphylococcus aureus* und *Clostridium botulinum*. Es ist jedoch bekannt, dass Nitrite und Nitrate so reagieren, dass sie N-Nitrosamine bilden, die laut IARC (International Agency for Research on Cancer) als wahrscheinlich oder möglicherweise krebserregend eingestuft werden. Dies war der Auslöser für die Einführung der europäischen Verordnung (EG) Nr. 1333/2008, die die zulässigen Höchstwerte für Nitrat und Nitratzusatzstoffe in Fleischerzeugnissen regelt. Für handelsübliche Fleischerzeugnisse gilt ein Grenzwert von 150 mg/kg^{-1} und für traditionelle Fleischerzeugnisse wurde dieser Grenzwert für jede Produktart festgelegt (50 bis 180 mg/kg^{-1} und 10 bis 300 mg/kg^{-1} für Nitrit und Nitrat). Andererseits schreibt die Europäische Verordnung (EG) Nr. 2108/2023 (ab dem 9. Oktober 2025) die Reduzierung von Nitrit und Nitrat in Trockenwurst auf 80 und 90 mg- kg^{-1} vor. Ziel dieser Untersuchung war es, den Nitrat- und Nitritgehalt in handelsüblicher Rohwurst „Hausgemachter Kulen" zu überprüfen. Die Untersuchung wurde vier Jahre lang fortlaufend durchgeführt und 158 Proben von „Hausgemachtem Kulen" wurden analysiert. Die Ergebnisse zeigen, dass der Mittelwert für Nitrite 4,42 mgkg^{-1} und für Nitrate 16,22 mgkg^{-1} im ersten Jahr betrug. Im zweiten Jahr lagen die Mittelwerte etwas höher und betrugen 5,68 mgkg–1 für Nitrite und 17,86 mgkg–1 für Nitrate. Im dritten Jahr zeigten die Proben einen Rückgang der Mittelwerte für Nitrit und Nitrat (2,92 und 9,80 mgkg^{-1}), während im vierten Jahr ein Anstieg der Nitrite auf 4,95 mgkg^{-1} und der Nitrate auf 19,32 mgkg^{-1} zu verzeichnen war. Die Maximalwerte lagen zwischen 7,82 und 19,67 mgkg^{-1}. Die Minimalwerte für das dritte und vierte Jahr lagen bei 2,65 mgkg^{-1} und 1,45 mgkg^{-1}. Der Höchstwert für Nitrate wurde im vierten Jahr erreicht und lag bei über 90 mgkg^{-1}. Dies zeigt, dass diese Art von traditionellen Produkten Nitrate und Nitrite enthält und die Mengen dieses Zusatzstoffs überwacht werden müssen.

Schlüsselwörter: Nitrat, Nitrit, Trockenwurst, hausgemachter Kulen

Niveles de contenido de nitritos y nitratos en el embutido tradicional kulen casero

Resumen

En la producción de embutidos, la industria cárnica se basa en la eficacia de agentes antimicrobianos como el nitrito (NO_2^-), el nitrato (NO_3^-) y sus sales de potasio y sodio. Estos aditivos son fundamentales como agentes de curado, antioxidantes, y mejoran el color, sabor, aroma, además de inhibir el crecimiento y la reproducción de las bacterias *Staphylococcus aureus* y *Clostridium botulinum*. Sin embargo, se sabe que los nitritos y nitratos pueden reaccionar formando N-nitrosaminas, las cuales, según la IARC (Agencia Internacional para la Investigación del Cáncer), son clasificadas como probablemente o posiblemente carcinógenas. Esto ha impulsado la creación del Reglamento Europeo (CE) No 1333/2008, que regula los niveles máximos permitidos de aditivos de nitrato y nitrito en productos cárnicos. Los productos cárnicos disponibles comercialmente están limitados a 150 mg/kg, mientras que para los productos cárnicos tradicionales este límite se establece para cada tipo de producto (de 50 a 180 mg/kg para nitrito y de 10 a 300 mg/kg para nitrato). Por otro lado, el Reglamento Europeo (CE) No 2108/2023 establece, a partir del 9 de octubre de 2025, la reducción de nitritos y nitratos en embutidos secos a 80 y 90 mg/kg, respectivamente. El objetivo de esta investigación fue evaluar los niveles de nitrato y nitrito en el embutido seco kulen casero disponible comercialmente. La investigación se realizó de manera consecutiva durante cuatro años, y se analizaron 158 muestras de kulen casero. Los resultados muestran que el valor medio de nitritos fue de 4,42 mg/kg y el de nitratos de 16,22 mg/kg en el primer año. En el segundo año, los valores medios fueron ligeramente superiores, ascendiendo a 5,68 mg/kg para nitritos y 17,86 mg/kg para nitratos. En el tercer año, las muestras mostraron una disminución en los valores medios de nitritos y nitratos (2,92 y 9,80 mg/kg), mientras que en el cuarto año los nitritos aumentaron a 4,95 mg/kg y los nitratos a 19,32 mg/kg. Los valores máximos variaron entre 7,82 y 19,67 mg/kg. Los valores mínimos en los años tres y cuatro fueron 2,65 mg/kg y 1,45 mg/kg, respectivamente. El valor máximo de nitratos se alcanzó en el cuarto año, superando los 90 mg/kg. Estos resultados indican que este tipo de productos tradicionales contienen nitratos y nitritos, y la cantidad de estos aditivos debe ser monitoreada.

Palabras claves: nitrato, nitrito, embutido seco, kulen casero

Contenuto di nitriti e nitrati nel "kulen nostrano", insaccato stagionato tradizionale

Riassunto

Nella produzione di insaccati stagionati, l'industria della carne fa affidamento sull'efficacia di sostanze antimicrobiche come i nitriti (NO_2^-), i nitrati (NO_3^-) e i relativi sali di sodio e potassio. Questi additivi sono importanti come esaltatori di colore, gusto e odore e inibiscono la crescita e la riproduzione dei batteri *Staphylococcus aureus* e *Clostridium botulinum*. Tuttavia, è noto che i nitriti e i nitrati presenti nei prodotti a base di carne possono creare N-nitrosammine che, secondo l'Agenzia internazionale per la ricerca sul cancro, sono probabilmente cancerogene. Ciò ha portato alla promulgazione del regolamento del Parlamento Europeo e del Consiglio (CE) n. 1333/2008, che disciplina la quantità massima consentita di nitrati e di additivi nitrati nei prodotti a base di carne. Per i prodotti a base di carne disponibili in commercio sono consentiti 150 $mgkg^{-1}$ di nitriti e nitrati mentre, per i prodotti a base di carne tradizionali, questo limite è stato fissato per ciascun tipo di prodotto (da 50 a 180 mg kg^{-1} e da 10 a 300 mg kg^{-1} per nitriti e nitrati). Nel 2023 il Parlamento Europeo ha approvato il Regolamento (CE) n. 2108/2023, che prescrive la riduzione (dal 9 ottobre 2025) delle concentrazioni di nitriti e nitrati negli insaccati stagionati a 80 e 90 $mgkg^{-1}$. Questa ricerca è stata condotta con l'obiettivo di determinare il contenuto di nitrati e nitriti nel "kulen nostrano", insaccato stagionato disponibile in commercio. La ricerca è stata condotta consecutivamente per quattro anni e sono stati analizzati 158 campioni di "kulen nostrano". I risultati del primo anno hanno evidenziato un valore medio per i nitriti di 4,42 $mgkg^{-1}$ e per i nitrati di 16,22 $mgkg^{-1}$. Nel secondo anno, i valori medi erano leggermente più alti e ammontavano a 5,68 $mgkg^{-1}$ per i nitriti e 17,86 $mgkg^{-1}$ per i nitrati. Nel terzo

anno i campioni analizzati hanno evidenziato una diminuzione dei valori medi di nitriti e nitrati (2,92 e 9,80 $mgkg^{-1}$), mentre nel quarto anno i nitriti sono aumentati a 4,95 $mgkg^{-1}$ e i nitrati a 19,32 $mgkg^{-1}$. I valori massimi erano compresi tra 7,82 e 19,67 $mgkg^{-1}$. I valori minimi registrati per il terzo e quarto anno erano di 2,65 $mgkg^{-1}$ e 1,45 $mgkg^{-1}$. Il valore massimo per i nitrati è stato raggiunto nel quarto anno ed era superiore a 90 $mgkg^{-1}$. Ciò dimostra che tali prodotti tradizionali contengono nitrati e nitriti e che il loro contenuto negli insaccati stagionati deve essere costantemente monitorato.

Parole chiave: nitrati, nitriti, insaccati stagionati, kulen nostrano