EFFECT OF NEW PEPPER AND CUMMIN FREON EXTRACTS ON THE PROXIMATE COMPOSITION AND SENSORY PROPERTIES OF BULGARIAN TYPE FERMENTED SAUSAGE (SUDJUK)

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Abstract—**The effect of pepper (*Piper nigrum*) and cummin (*Cumminum cyminum*) extracts obtained by Freon 134a on the proximate composition and sensory properties of Bulgarian type dry fermented sausage (sudjuk) during the production (14 days) and during 30 days storage at 0 - 4°C of the vacuum packed sausage was studied. Besides the control sample C and the experimental sample with spice extracts E, a comparative control sample B with addition of 0.2 g.kg^{-1} butylated hydroxytoluene (BHT) was examined. It was estimated that the replacement of ground pepper and cummin with aliquot parts of their Freon extracts contributed to expressive improvement of the sensory properties, increased water and protein content and decreased lipid and ash content both for the final product and the vacuum packed sausage after 30 days refrigerated storage at 0 – 4°C. The addition of 0.02 % BHT was not so effective to preservation of the sudjuk sensory properties and did not effect on the proximate composition of the meat product.**

Index Terms—**Freon 134a spice extracts, proximate composition, sensory properties, dry fermented sudjuk**

I. INTRODUCTION

Sudjuk is a distinctive traditional dry-fermented meat product for Bulgaria. The major raw material for its production is beef. The tipycal taste and flavour of sudjuk are due to the lactic fermentation occurring during the drying process (Demeyer, Verplaetse & Gistelinck, 1986), autolytic processes (Verplaetse, 1994), used microbial starter cultures (Bozkurt & Erkmen, 2002), spices (Mateo & Zumalacarregue, 1996) or their extracts (Akarpat, Turhan & Ustun, 2008). The production and accumulation of free amino acids and short-chain peptides is considered as an important factor for the dry-fermented sausages taste improvement (Mateo & Zumalacarregue, 1996). Their role in flavour formation is limited compared to the lipids hydrolysis and oxidation (Johanson, Berdague, Larsson, Tran & Borch, 1994).

Experiments for the replacement of ground natural spices from sudjuk with their water extracts have been carried out (Akarpat, et al., 2008). It is estimated that pepper ethanol extract shows anti-oxidative activity close to the synthetic antioxidants activity (BHA and BHT), and the pepper water extract has higher anti-oxidative activity compared to BHA и BHT (Gülcin, 2005; Singh, Marimuthu, Murali & Bawa, 2005). The black pepper contributes to the fresh pork grilled sausages colour stabilization (Martínez, Cilla, Beltrán & Roncalés, 2007).

The cummin extract exhibits anti-oxidative activity close to the synthetic antioxidants BHT and BHA activity (Singh, Marimuthu, Catalan & de Lampasona, 2004) and is better than the ascorbic acid (Satyanarayana, Sushruta, Sarma, Srinivas & Subbva Raju, 2004). The spices extracts show bacteriostatic properties, also (Martínez et al., 2007). They inhibit the various pathogens, toxic and spore-forming bacteria growth (Baratta, Dorman, Deans, Figueiredo, Barroso & Ruberto, 1998) and some moulds (Baratta et al., 1998; Singh et al., 2004). According Milič and Milič (1998) the phenol compounds contained in the spices also exhibit anti-mutagen and anti-carcinogen properties.

In the literature available no studies for the replacement of the natural ground spices with their extracts in dry-fermented sausages have been found.

The objective of this study is to determine the effect of new Freon134a extracts from pepper (*piper nigrum*) and cummin (*cumminum cyminum*) on the proximate composition and sensory properties of Bulgarian type fermented sausage (sudjuk).

II. MATERIALS AND METHODS

A. Materials

In the experiment sudjuk "Sadovski" was used, produced in "Meat processing plant – Sadovo" Ltd (Sadovo municipality, district of Plovdiv, Bulgaria) from 0.9 kg/kg chilled beef and 0.1 kg/kg pork dorsal fat.

The meat and fat for the sudjuk production were supplied by "Unitemp" Ltd (Vojvodinovo village, Maritsa municipality, district of Plovdiv, Bulgaria). The nitrite (E 250) salt used in the sudjuk production was purchased from the company "BBT" Ltd (Sofia, Bulgaria).

The bacterial starter culture „Bactoferm" P I inoculated in the sudjuk filling mass was supplied by the „Christian Hansen"A/S. (Horsholm, 10-12 Boge Alle, Denmark).

The ground pepper (*Piper nigrum*) and cummin (*Cumminum cyminum*) were produced by "Kresona" Ltd (Buzovgrad village, Kazanlak municipality, district of Stara Zagora, Bulgaria). The spices were ground at -80°C, and afterwards were packed in hermetic sealed packages made from barrier aluminium foil under modified atmosphere.

The *Piper nigrum L.* and *Cumminum cyminum* extracts were obtained at pilot installation (Nenov, 2006) in the Department of Industrial Termotechnics of the University of Food Technologies (Plovdiv, Bulgaria) from the half of the ground spices described above. The extraction was carried out with Freon 134a at 20°C. Freon 134a ($C_2H_2F_4$, nomenclature name: 1,1,1,2-tetrafluorethane) is chemically inert, harmless to the human body, fire and explosion safe and is permitted by EU as a solvent for food flavourings extraction. The Freon 134a was produced by Solvay Fluor GmbH (Milano, Italy) under the trade mark Solkane 134a, with CAS number 811-97-2. Full absence of the solvent in the extracts was estimated.

B. Experimental design

The sorted boneless beef and pork dorsal fat were dosed in ratio 90:10. The filling mass was prepared by cutting. During the processing nitrite salt, bacterial starter culture and spices were added. The filling mass obtained was separated into three equal samples: control (C), containing 3 $g.kg^{-1}$ ground pepper and 3 $g.kg^{-1}$ ground cummin; experimental (E), containing aliquot parts Freon 134a extracts to 3 $g.kg^{-1}$ pepper and 3 $g.kg^{-1}$ cummin, respectively, and comparative (B), containing 3 $g.kg^{-1}$ ground pepper, 3 $g.kg^{-1}$ ground cumin and 0.2 $g.kg^{-1}$ BHT. Each of the samples was filled into pork natural casings ∅ 28 – 30 mm and the sudjuk was formed by bandaging in "horseshoes".

Samples for analysis were taken on the 1 d of the experiment (filling mass), on the 7 d of the experiment (after sudjuk's first pressing), on the 14 d of the experiment (final product), and on the 44 d of the experiment (after 30 d storage at 0 - 4°C of vacuum packed product).

C. Methods

The water content as well as total protein content; total lipids and ash were estimated by known standard methods (Yilmaz & Zorba, 2010).

The sensory properties of the samples were determined by nine member panel with proven tasting capabilities (Meilgaard et al., 2007). For the purpose a nine score scale (9 – excellent, 8 – very good, 7 – good, 6 acceptable, 5 – satisfactory, 4 – slightly unsatisfactory, 3 – very unsatisfactory, 2 – bad, and 1 - unacceptable) was used. The appearance and colour, cutting surface colour, flavour, taste, texture, and total evaluation of the final product (14 d of experiment) and after 30 days of storage at 0-4C of vacuum packed product were estimated.

The analytical results obtained were processed by known statistical methods. For the purpose program product Excel 5.0 from Microsoft Office 6.0 package was used. The calculations were carried out at value of statistical significance $\alpha = 0.05$. By ANOVA (Zuur & Ieno, 2005) variances and experiment dispersion was determined.

III. RESULTS AND DISCUSSION

Proximate composition

It was determined that during the production the water content of all samples significantly ($p^* < 0.05$) decreased (Table 1). Compared to the values reported for the final product, after 30 d storage of vacuum packed sudjuk for all three samples no significant ($p^* > 0.05$) differences were determined (Table 1). These results confirmed the results of other researchers (Akarpat, et al., 2008; Yilmaz & Zorba, 2010), that during the sudjuk ripening moisture evaporated, which reflected on its dry content.

The water content of control samples C and B was statistically insignificant and was lower than this of the experimental sample E approximately with 5.5 % (Table 1). These results hardly were due only to the addition of liquid spice extracts in sample E (Akarpat, et al., 2008).

During the drying process with 6 – 10 % significantly ($p^* < 0.05$) increase of the protein content of the sudjuk was estimated. The highest increase was for the experimental sample E (Table 2), and the lowest – for the sample B. During the following storage no changes in the protein content of the vacuum packed sudjuk was estimated.

A significant ($p^* < 0.05$) increase with 4.5 – 12.4 % of the total lipids content of the sudjuk during the drying process, was determined (Table 3). The most considerable was the increase in the control samples C and B - with 12.4 and 10.2 %. The content of total lipids in the experimental sample E increased only with 4.5 % (Table 3). After 30 d of storage the total lipids content did not change significantly ($p^* < 0.05$) (Table 3).

Significantly ($p^* < 0.05$) increase of the ash content with 3.8 – 4.3 % of the samples during the drying process was estimated (Table 4). The highest increase was for the samples B and C - 4.2 - 4.3 %. In the experimental sample E the ash content increased with 3.8 % only (Table 4). The mineral salts content (expressed as ash content) in the final product samples C and after 30 d storage did not differ significantly ($p^* > 0.05$).

In conclusion, irrespectively of the spices type and BHT addition into sudjuk, typical processes of drying and ripening occurred, which described the trend found by us to water content decrease and relative share of proteins and lipids increase, respectively.

Sensory properties

The sensory analysis data of the sudjuk "Sadovski" on the 14 d of the experiment showed that the total evaluation of the final product for all samples sudjuk varied between the scores of 7.50 - 8.67. The highest total evaluation got the experimental sample E, which average score was maximal and differed significantly from the control samples ($p^* < 0.05$) (Table 5). The results obtained gave us the reason to conclude that the replacement of the natural ground spices pepper and cummin with Freon 134a extracts contributed for appearance, cutting surface colour, texture, taste and general perception of sudjuk "Sadovski". The addition of the 0.2 $g.kg^{-1}$ BHT exhibited less expressed ability to stabilize the sensory indicators of the sudjuk "Sadovski".

The highest total evaluation for the 30 d stored vacuum packed sudjuk got the sample E - 7.42. Significantly lower was the score of sample B, and the lowest was assessed the control sample C - 5.83 (Table 6).

From the data obtained a conclusion could be made that the replacement of natural ground pepper and cummin with their Freon 134a extracts improved with 27 – 28 % the general sensory perception of vacuum packed sudjuk "Sadovski", stored for 30 d at 0-4°C. For comparison, the addition of the 0.2 $g.kg^{-1}$ BHT improved the general sensory perception with 17.1 %.

IV. CONCLUSION

The replacement of ground pepper and cummin with aliquot parts of their Freon 134a extracts could be one opportunity for increased consumer demand for sudjuk and improvement of its satisfaction.

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Table 1. Water content of sudjuk "Sadovski" during processing and storage

Sample	1 d	7 d	14 d	44 d
		Water content, % of total mass		
C	57.97 ± 0.15	43.74 ± 0.19	29.56 ± 0.22	29.67 ± 0.19
E	57.97 ± 0.15	46.81 ± 0.18	35.22 ± 0.20	35.51 ± 0.22
B	57.97 ± 0.15	43.35 ± 0.23	29.85 ± 0.13	29.99 ± 0.27

Table 2. Total protein of sudjuk "Sadovski" during processing and storage

Sample	1 d	7 d	14 d	44 d
		Total protein, % of total mass		
C	16.18 ± 0.17	20.19 ± 0.19	24.27 ± 0.21	24.38 ± 0.30
E	16.18 ± 0.17	20.98 ± 0.21	25.53 ± 0.24	25.66 ± 0.31
B	16.18 ± 0.17	19.95 ± 0.27	22.11 ± 0.23	22.34 ± 0.28

Table 3. Total lipids of sudjuk "Sadovski" during processing and storage

Sample	1 d	7 d	14 d	44 d
		Total lipids extracted in Soxhlet apparatus, % of total mass		
C	25.94 ± 0.59	31.10 ± 0.54	38.56 ± 0.61	38.67 ± 0.73
E	25.94 ± 0.59	28.06 ± 0.58	30.30 ± 0.55	30.95 ± 0.66
B	25.94 ± 0.59	31.31 ± 0.63	36.78 ± 0.70	36.91 ± 0.75

Table 4. Ash content of sudjuk "Sadovski" during processing and storage

Sample	1 d	7 d	14 d	44 d
		Ash content, % of total mass		
C	1.62 ± 0.11	3.91 ± 0.14	5.80 ± 0.17	5.83 ± 0.18
E	1.62 ± 0.11	3.43 ± 0.18	5.24 ± 0.15	5.28 ± 0.16
B	1.62 ± 0.11	3.78 ± 0.16	5.94 ± 0.21	5.96 ± 0.22

Table 5. Sensory evaluated scores of sudjuk "Sadovski" in the final product

Sample	Appearance	Colour	Texture	Flavour	Taste	Total evaluation
C	7.78 ± 0.34	7.65 ± 0.29	7.44 ± 0.37	7.98 ± 0.33	6.84 ± 0.57	7.50 ± 0.38
E	8.93 ± 0.45	9.00 ± 0.00	9.00 ± 0.00	8.58 ± 0.22	7.99 ± 0.55	8.67 ± 0.46
B	8.06 ± 0.41	7.70 ± 0.22	8.40 ± 0.23	8.40 ± 0.28	8.14 ± 0.45	8.11 ± 0.21

Table 6. Sensory evaluated scores of vacuum-packed sudjuk "Sadovski" stored 30 d at 0 - 4°C

Sample	Appearance	Colour	Texture	Flavour	Taste	Total evaluation
C	7.00 ± 0.47	6.50 ± 0.38	6.08 ± 0.28	6.16 ± 0.33	6.67 ± 0.42	5.83 ± 0.55
E	7.33 ± 0.39	8.17 ± 0.47	7.33 ± 0.37	7.42 ± 0.49	7.42 ± 0.49	7.42 ± 0.49
B	7.42 ± 0.46	7.42 ± 0.49	6.50 ± 0.38	7.50 ± 0.51	7.50 ± 0.51	6.83 ± 0.52