Effect of biopolymer coating on texture characteristics of dry fermented sausage during storage

M Jokanovic1, N Hromis1, V Tomovic1, V Lazic1, S Skaljac1, B Sojic1, P Ikonic2, T Peulic2 and M Ivic1

1 University of Novi Sad, Faculty of Technology Novi Sad, Bulevar cara Lazara 1, 21000 Novi Sad, Serbia
2 University of Novi Sad, Institute of Food Technology in Novi Sad, Bulevar cara Lazara 1, 21000 Novi Sad, Serbia

E-mail: marijaj@tf.uns.ac.rs

Abstract. In this paper, the changes of texture characteristics of Petrovská klobása, a traditional dry-cured sausage, were analysed during 150 days of storage. Sausages were produced in the traditional manner, but underwent drying and ripening processes in industrial conditions. Chitosan was used to coat experimental sausages after the drying process was considered finished. Changes in moisture content were measured during the storage period, but the differences between control and chitosan coated sausages were not significant (P>0.05). Changes in moisture content influenced progressive increases in hardness and chewiness of both groups of sausages. The differences in texture characteristics between the different sausage groups were not significant for the entire storage period. Chitosan coating had no positive influence on preventing texture changes in Petrovská klobása during storage.

1. Introduction

Petrovská klobása is a traditional dry-cured sausage made in Vojvodina (the province in Northern Serbia). It is produced in the traditional way, according to original recipes without the use of nitrate/nitrite, gluconodelta-lactone (GDL) or microbial starters, in village households at the end of November and during December, when atmospheric temperatures are around 0°C or lower. Petrovská klobása is prepared by mixing ground pork meat (the most valuable meat cuts from mature pigs, containing less water, and having more intensive red colour and firmer consistency than pork from younger animals), lard, red hot paprika powder, salt, crushed garlic, caraway and sugar. Sausages undergo a smoking process using specific kinds of wood, and drying and ripening processes for up to 4 months. At the end of ripening, Petrovská klobása is characterised by a specific savoury taste, aromatic and spicy-hot flavour, dark red colour and hard consistency [1–3].

The quality of dry-cured sausages and other meat products is strongly affected by their texture characteristics. Many factors affect the final texture of fermented sausages, including ingredients used, processing parameters, acidification method, drying/ripening conditions, as well as interactions among these factors over an extended period of time [4–6].

In order to meet higher market demands for this type of sausage and provide market supply for a longer period during the year, it is necessary, on one hand, to displace production from small household enterprises to industrial plants, on the other hand, to prolong the sausages’ shelf life.
Chitosan, as a semi-natural biopolymer, has been extensively researched for edible film application. Chitosan is approved as an additive in the food industry in many countries, has the ability to form films with good barrier properties for gases, demonstrates antimicrobial and antioxidant properties, tends to exhibit fat and oil resistance, but lacks resistance to water transmission [7]. This could be a drawback for use of chitosan films in direct contact with foods and/or for direct handling. In order to improve hydrophilic biopolymer film resistance to water transmission, different fatty materials were incorporated in the film structure, increasing the film hydrophobicity [8].

The suitability of chitosan film with added hydrophobic component, applied as a coating onto dried and ripened sausages to preserve texture characteristics, for achieving a longer storage period was considered in this paper. Thus, the objective of this study was to determine the effects of chitosan coating with addition of caraway essential oil on texture characteristics of traditional dry fermented Petrovská klobása sausage during an extended storage period.

2. Materials and method
The sausages were manufactured in a traditional manner from lean pork (80% w/w) and back fat (20% w/w), obtained from Landrace pigs. The animals were farmed in a standard production system with a prolonged fattening period (9-12 months; live weight above 130 kg), and slaughtered in a commercial slaughterhouse according to the routine procedure. Meat and back fat were minced to 10 mm particle size and mixed with red hot paprika powder (2.5 g/100 g), salt (1.8 g/100 g), raw garlic paste (0.2 g/100 g), caraway (0.2 g/100 g), and crystal sugar (0.1 g/100 g), until a homogeneous composition was achieved. The batter was stuffed in collagen casings (500 mm long and 55 mm in diameter) and the processes of smoking, drying and ripening were in an industrial ripening room (temperature ≈15°C, and average air RH of 76.1 %). The sausage drying process lasted until the required moisture content (<35%) was achieved (65 days) [9].

Chitosan film forming emulsion was prepared as described in Krkić et al. [10]. Chitosan powder (Sigma-Aldrich Chemical Co., St. Louis, Missouri, USA) was dissolved in acetic acid (1% vol.; Proanalitica, Belgrade, Serbia) to reach chitosan mass per volume ratio of 10 kg/m³ and then, caraway essential oil (Herba D.O.O., Belgrade, Serbia) at 1 % (v/v) was added to chitosan solution, together with Tween 20 (0.5 % vol, Superlab, Belgrade, Serbia), in order to obtain the coating emulsion.

After drying, one-half of the manufactured sausages were coated with three layers of coating emulsion, using a sponge brush (assigned as coated sausages). Every layer was left to dry overnight before the next layer was applied. The rest of the sausages were left uncoated (assigned as control sausage). After coating, all sausages were stored in a chamber with controlled temperature and relative humidity, 15°C and 75%, respectively for five months.

All determinations were made on three samples from each sausage group (coated and control) in duplicate. Samples for the analyses were taken after 0, 30, 60 and 150 days of storage.

Moisture content was quantified according to the ISO recommended standards [11]. Texture profile analysis (TPA) was performed as described by Bourne [12], at room temperature, using TA.XT2 Texture Analyzer (Texture Technologies Corp., Scarsdale, NY/ Stable Micro Systems, Godalming, UK) equipped with a standard cylindrical plate of 75 mm in diameter. The samples 2 cm thick and 2.54 cm in diameter (cylinders), after discarding the external layer of the sausage, were compressed twice to 50% of their original thickness at a constant test speed of 1 mm/s. The following parameters were determined: hardness (kg), adhesiveness, springiness, cohesiveness and chewiness (kg). Measurements were carried out six times for each sausage sample.

One way (ANOVA), Post-hoc (Duncan’s test) was performed using the software package Statistica 12.0 for Windows (Stat Soft, Tulsa, Oklahoma, USA). Differences were considered significant at P<0.05.

3. Results and Discussion
Changes in moisture content and texture characteristics of sausages during the storage period are shown in Table 1. Moisture content after 65 days of production was lower than 35%, as is demanded
by national legislation for dry fermented sausages [9], so at this time, the drying process was considered finished and the coating was applied (day 0 of storage).

During the storage period, the drying process continued in both groups of sausages, and as expected, changes in moisture content were measured as storage progressed, but the differences between control and chitosan coated sausages were not significant. This is probably due to the chitosan film’s high permeability to water vapour. Addition of hydrophobic caraway essential oil at the concentration applied was probably not effective in lowering the high water transmission rate of chitosan film to any great extent [13,14]. This could explain why the differences in moisture content were not significant between control and chitosan coated sausages, i.e. the chitosan film could not protect sausages from moisture loss. The moisture content at the end of the storage period (day 150) in both analysed groups of sausages was ~16%.

Table 1. Evolution of texture profile and moisture content of Petrovská klobása sausages throughout the storage period

| Day of storage | Sausage | Hard.** | Adh. | Spr. | Coh. | Chew. | Moisture (%) |
|----------------|---------|---------|------|------|------|-------|--------------|
| 0              | Control | 6.64    | -76.49 | 0.385 | 0.401 | 2.66  | 31.48        |
| 30             | Control | 10.91   | -33.32 | 0.356 | 0.338 | 3.73  | 24.86        |
|                | Coated  | 10.98   | -31.11 | 0.368 | 0.322 | 3.56  | 24.38        |
| 60             | Control | 12.04   | -22.95 | 0.352 | 0.400 | 4.73  | 20.62        |
|                | Coated  | 14.24   | -35.29 | 0.332 | 0.374 | 5.31  | 19.71        |
| 150            | Control | 21.42   | -25.41 | 0.370 | 0.337 | 7.18  | 16.17        |
|                | Coated  | 19.39   | -23.01 | 0.354 | 0.395 | 7.46  | 16.32        |

**ns – no statistically significant differences (P < 0.05) were measured between control and coated sausages on any one storage day for any of the factors studied; *Hard. – Hardness; Adh. – Adhesiveness; Spr. – Springiness; Coh. – Cohesiveness; Chew. – Chewiness

The texture characteristics are influenced by the drying process, as after fermentation, drying is a major factor affecting binding and rheological properties of fermented sausages [5,6]. Hardness and chewiness of both groups of sausages, as expected, increased progressively during the storage period. These changes both in hardness and chewiness could be explained by the changes in moisture content in these sausages during storage, since the correlation factors between hardness and chewiness with moisture content were -0.93 and -0.94, respectively. Significant negative correlations between moisture content and hardness and chewiness were registered previously [5,15]. During the whole storage period, hardness and chewiness differences between sausage groups were not significant (P>0.05). Also, during the storage period, there was no significant effect of chitosan film coating on adhesiveness, springiness and cohesiveness.

Previous results considering application of chitosan film for dry fermented sausage coating suggested that this application can lower the intensity of lipid oxidative changes in dry fermented sausages during storage, and that coated sausage had better sensory properties during storage [10,16]. Unfortunately, this positive influence of chitosan coating on prevention of changes in the texture characteristics of Petrovská klobása during storage could not be confirmed.

Further investigation might be directed towards application of chitosan coating with a higher percentage of hydrophobic compound or a combination of different hydrophobic compounds, in order to obtain coating with lower moisture permeability and thus better preservation of sausage from moisture loss and consequently texture deterioration.
Acknowledgment
This study was supported by the Ministry of Science and Technological Development of the Republic of Serbia, Project No. TR31032.

References
[1] Ikonić P, Jokanović M, Petrović Lj, Tasić T, Škaljac S, Šojić B, Džinić N, Tomović V, Tomić J, Danilović B and Ikonić B 2016 Int. J. Food Prop. 19 1924–37
[2] Ikonić P, Petrović Lj, Tasić T, Džinić N, Jokanović M and Tomović V 2010 Acta Period. Technol. 41 19–31
[3] Tasić T, Ikonić P, Mandić A, Jokanović M, Tomović V, Savatić S and Petrović Lj 2012 Food Control 23 107–12
[4] Szczesniak A S 2002 Food Qual. Prefer. 13 215–25
[5] Gonzalez-Fernandez C, Santos E M, Rovira J and Jaime I 2006 Meat Sci. 74 467–75
[6] Barbut S 2007 Handbook of Fermented Meat and Poultry ed F Toldrá, Y.H Hui, I Astiasarán, W K Nip, J G Sebranek, E T F Silveira, L H Stahnke and R Talon (Blackwell Publishing: Ames, IA) pp 217–26
[7] Altiok D, Altiok E and Tihminlioglu F 2010 J. Mater. Sci.: Mater. Med. 21 2227–36
[8] Souza V, Monte M and Pinto L 2011 Int. J. Food Sci. Technol. 46 1856–62
[9] Serbian Regulation 2015 Rulebook on Quality of Meat Products Official Gazette of the Republic of Serbia 94
[10] Krkić N, Šojić B, Lazić V, Petrović Lj, Mandić A, Sedej I, Tomović V and Džinić N 2013 Food Control 32 719–23
[11] International Organization for Standardization 1997 Determination of Moisture Content; 1442: 1997 (Geneva: ISO)
[12] Bourne M C 1978 Food Technol. 32 62–6
[13] Hromiš N, Lazić V, Markov S, Vaštač Ž, Popović S, Šuput D, Džinić N, Veličanski A and Popović Lj 2015 J. Food Eng. 158 86–93
[14] Hromiš N 2015 Tehnološki fakultet Novi Sad, Univerzitet u Novom Sadu
[15] Bozkurt H and Bayram M 2006 Meat Sci. 73 344–50
[16] Krkić N, Šojić B, Lazić V, Petrović Lj, Mandić A, Sedej I and Tomović V 2013 Meat Sci. 93 767–70