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Dried Venison Quality Parameters Changes during Storage

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Abstract**—**The aim of the current research was to determine quality parameters changes of dried venison during storage. Protein, fat and moisture content dynamics as well microbiological quality was analyzed. For the experiments the meat (0.02×4.00×7.00 cm) pieces were marinated in "teriyaki sauce" marinade (composition: teriyaki sauce, sweet and sour sauce, taco sauce, soy sauce, American BBQ sauce hickory, sesame oil, garlic, garlic salt, tabasco red pepper sauce) at 4±2°C temperature for 48±1h. Sodium monophosphate (E339) was also added in part of marinade to improve the meat textural properties. After marinating, meat samples were dried in microwave-vacuum drier MUSSON–1, packaged in vacuum pouches made from polymer film (PA/PE) with barrier properties and storage for 4 months at 18±1°C temperature in dark place. Dried venison samples were analyzed after 0, 35, 91 and 112 days of storage. During the storage total plate counts of dried venison samples significantly ($p<0.05$) increased. No significant differences in the content of protein, fat and moisture were detected when analyzing dried meat samples during storage and comparing them with the chemical parameters of just dried meat.

Keywords**—**Drying, microwave-vacuum drier, quality, venison.

I. Introduction

VENISON is a dietary product with high biological value. Venison from red deer has lower energetic value; it is lower in calories, cholesterol and fat content compared with beef, pork or mutton [1], [2]. In recent years, consumer demand for low-fat meat has gained an increasing popularity. Red deer feed contains no genetically modified nutrients, since the production volumes of venison from red deer are much lower than pork and poultry, thus, venison is ecologically cleaner and more qualitative product [3]. It should be noted that venison is a product likely to spoil faster and it has a relatively short shelf-life. Making dried meat (jerky) is a popular and simple way to turn perishable product into a protein-rich, shelf-stable snack [4].

Drying meat for the purposes of food preservation no doubt began with the earliest civilizations. Meats were stripped or pulled, then dried with the help of the sun, wind, or fire. Native Americans would dry venison, buffalo and elk meat as a portable, nutritious food [5]. The name jerky is derived from the Spanish word "charque", meaning dried meat [6]. Traditionally jerky has been made from thinly sliced whole muscles which have been marinated and dried to improve shelf life [7].

The main aims of marinating have been considered to be tenderizing, flavoring and enhancing safety and shelf life of meat products due to inhibition of microbial growth [8]. Traditionally, meat is marinated by soaking and injecting it into a solution with low pH value, high concentration of salt, sorbates, benzoates, and various spices [9]; however, marinades are nowadays complex sauces which have a great effect on product appearance and taste [8]. Scientific literature indicates that teriyaki sauce, soy sauce, garlic etc. are most frequently used for meat marinating before drying [10]-[12].

Drying is a complex process involving simultaneous heat and mass transfer. It results in significant changes in chemical composition, structure and physical properties of foods. The heating process and loss of water cause stresses in the cellular structure that lead to changes in microstructure, such as the formation of pores and shrinkage [13]. In general, drying reduces the water content of perishable products such as meat, which ultimately lowers the water activity to the point where microorganisms are no longer able to access sufficient water necessary for their growth [6].

Hot-air drying has been to date the most common drying method employed for food materials. However, this method has many disadvantages, including poor quality of dried products, low energy efficiency, and a long drying time. Microwave-vacuum drying is a novel alternative method of drying, allowing to obtain products of acceptable quality. It permits a shorter drying time and a substantial improvement in the quality of dried materials, in relation to those dried with hot air and microwaves drying method [14]. By combining microwave energy within a vacuum, a product can be dehydrated without losing its characteristics shape [6].

The aim of the current research was to determine quality parameters changes of dried venison during storage.

II. Materials and Methods

A. Experimental Design

The experiments were carried out at the Department of Food Technology, Latvia University of Agriculture, in Year 2013.

B. The Object of the Research

The meat of farmed red deer (*Cervus elaphus*) was obtained from a local farm Saulstari 1, located in Sigulda region, Latvia.

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C. Components of Marinade

Teriyaki sauce marinade (composition: teriyaki sauce, sweet and sour sauce, taco sauce, soy sauce, American BBQ sauce hickory, sesame oil, garlic, garlic salt, tabasco red pepper sauce) was used for venison marinating.

D. Meat Marinating

Marinating process of the meat included the following steps:

1) longest lumbar muscle (*Musculus longissimus lumborum*) from venison was manually divided into smaller pieces of the size 0.02×4.00×7.00 cm, and teriyaki sauce marinade was added. To improve the meat textural properties sodium monophosphate was added in 1.2% from total amount of marinade [15];
2) prepared samples were marinated at 4±2°C temperature in the refrigerator for 48±1 h.

E. Meat Drying and Packaging

After marinating, the microwave-vacuum drier Musson-1 (OOO Ingredient, Russia) [16] was used for venison drying. Dried venison samples were packaged in the vacuum pouches made from polymer film (PA/PE) with barrier properties.

F. Dried Meat Storage Conditions

Packaged dried meat samples were stored at dark place at 18±1 °C temperature for 112 days. Quality parameters of dried venison samples were analyzed after 0, 35, 91 and 112 days of storage.

G. Standard Methods for Samples Quality Analysis

For chemical analyses, meat samples were homogenized using a household blender according to ISO 17604:2003 standard procedure. Meat samples were prepared for microbiological analyses according to LVS EN ISO 6887-2:2004.

The following parameters were assessed:

- total plate count (TPC) according to LVS EN ISO 4833:2003 incubating it at 30°C for 72 h;
- protein content according to ISO 937:1978 Kjeldahl nitrogen method;
- fat content according to LVS ISO 1443:1973;
- moisture content according to ISO 1442:1997;

H. Mathematical Data Processing

The results of analyses were processed using *SPSS* software *SPSS 17* package and *Microsoft Excel for Windows* 7.0. The following indexes were calculated for the obtained results: mean and standard deviation. Single factor analysis of variance (ANOVA) was used for data interpretation. The *p-value* characterizes the significance level of the obtained data ($p>0.05$ – data have no significant difference, $p\leq 0.05$ – data have significant difference).

III. Results and Discussion

A. Technological Parameters

During experiments optimum parameters for venison (2.5±0.1 kg) drying in a microwave-vacuum drier were developed: temperature − 36±2°C, working pressure in the chamber – 7.5/9.3 kPa, total number of revolutions – 6 min^{-1}, amount of supplied energy – 2856 kJ, and drying time – 32.24 min.

Meat was dried until content of moisture in samples without and with sodium monophosphate accordingly achieved 25.08±0.66% and 34.78±0.60% [7].

B. Total Plate Count Dynamics

The total plate count (TPC) (CFU g^{-1}) in dried meat not regulates with European Commission regulation No. 2073/2005. Therefore for obtained data interpretation Russian sanitary and epidemiological regulations Enactment date of sanitary and epidemiological rules and regulations "Hygienic Requirements for Safety and Nutrition Value of Food Products / Sanitary Rules and Regulations (SanPin) 2.3.2.1078–01" with permissible limit as 1×10^4 CFU g^{-1} was used [17]. Experimentally was detected that before drying TPC CFU g^{-1} of marinated venison without sodium monophosphate was 2.32 $\log_{10}$ CFU g^{-1} and with sodium monophosphate – 2.46 $\log_{10}$ CFU g^{-1}, obtained results was not exceed permissible level. There are not found significant ($p=0.079$) changes of TPC of venison samples after drying.

Significant TPC changes of dried venison samples (Fig. 1) with sodium monophosphate were indicated after 91 days storage, as a result the volume of TPC exceed permissible level – 1×10^4 CFU g^{-1}, and it was 4.01 $\log_{10}$ CFU g^{-1}.

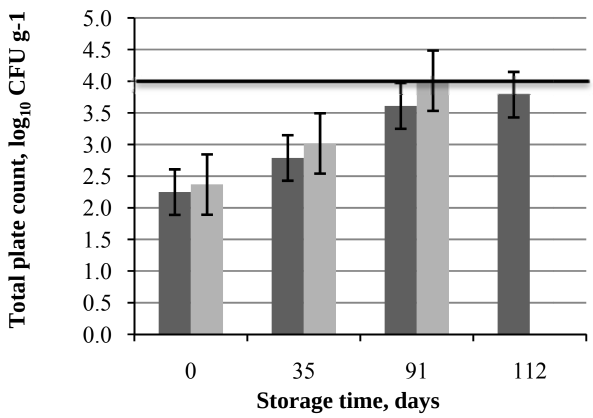

Fig. 1 The TPC dynamics in dried venison during storage
■ without sodium monophosphate ■ with sodium monophosphate
── admissible level of TPC 1×10^4 CFUg^{-1}

Such changes could be explained by relatively higher moisture content in analysed meat samples. However in dried venison samples without sodium monophosphate TPC CFU g^{-1} reach permissible level after 112 storage days and it was – 3.79 $\log_{10}$ CFU g^{-1}. Therefore the recommendable dried venison with sodium monophosphate shelf-life could be 91 days, but of venison without sodium monophosphate – 112 days.

C. Protein Changes

Protein content of marinated venison without sodium monophosphate before drying was 77.36±0.13 g 100 g^{-1} in dry weight (DW), but with sodium monophosphate – 77.18±0.15 g 100 g^{-1} in DW. Protein content changes of venison samples after drying was not significant (p=0.893). Protein content of dried venison without sodium monophosphate was obtained as 73.84±0.10 g 100 g^{-1} in DW, with sodium monophosphate – 72.21±0.42 g 100 g^{-1} in DW (Fig. 2).

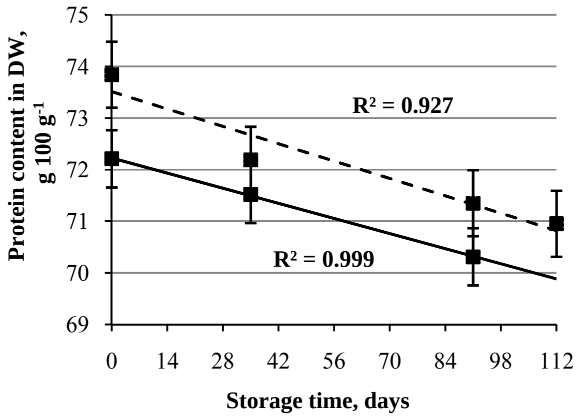

Fig. 2 The dynamics of protein content in dried venison during storage
without sodium monophosphate
with sodium monophosphate

Significant differences between dried venison samples without/with sodium monophosphate in protein content was not established (p>0.05), and during storage no significant changes in the content of protein was detected and it suggest that the biological value of meat samples almost do not changes.

D.Fat

Fat content of marinated venison samples without sodium monophosphate is higher than in the samples with sodium monophosphate. Obtained results could be explained with higher moisture content in analyzed dried meat samples with sodium monophosphate. Marinated venison samples without sodium monophosphate fat content was 5.38±0.51 g 100 g^{-1} in DW, with sodium monophosphate – 4.04±0.86 g 100 g^{-1} in DW.

After drying fat content in venison samples without sodium monophosphate increased till 6.80±1.44 g 100 g^{-1} in DW, with sodium monophosphate – till 6.44±0.42 g 100 g^{-1} in DW (Fig. 3). Such fat content changes could be explained with moisture decreases in meat samples after drying.

The conducted experiment did not indicate significant differences (p=0.084) between dried venison samples without/with sodium monophosphate in fat content. The decrease in the fat content in dried meat samples was insignificant (p=0.520) during storage.

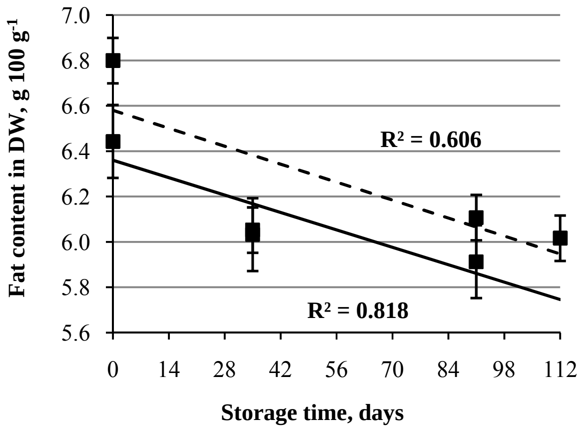

Fig. 3 The dynamics of fat content in dried venison during storage
without sodium monophosphate
with sodium monophosphate

E. Moisture Changes

Moisture content of marinated venison without sodium monophosphate was obtained as 72.85±0.75%, with sodium monophosphate – 74.25±0.78% (p>0.05).

Meat capacity to bind water depends on the number of hydrophilic groups existent in proteins. The larger the difference between the pH value of the ambiance and the isoelectric point of meat proteins (pH 5.2-5.4), the higher is the meat capacity to bind water [18]. Obtained results indicated that marinated venison with sodium monophosphate higher pH value increases meat capacity to bind water.

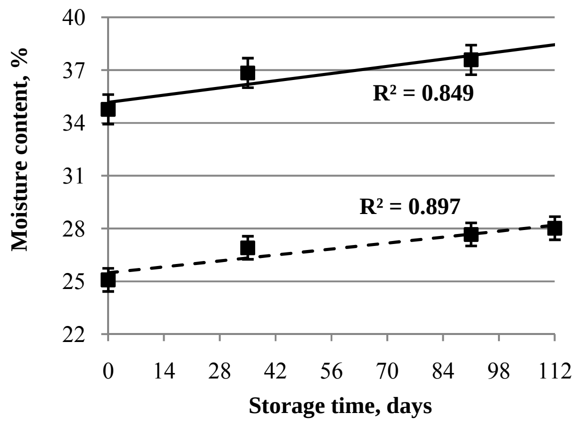

Fig. 4 The dynamics of moisture content in dried venison during storage
without sodium monophosphate
with sodium monophosphate

The moisture content of dried venison samples without/with sodium monophosphate was 25.08±0.66% and 34.78±0.60% respectively (Fig. 4). The experimental data shows that the dried venison samples without sodium monophosphate and with sodium monophosphate moisture content significantly different (p<0.05). After drying, moisture content of the meat samples with sodium monophosphate was higher than in meat samples without sodium monophosphate. The higher the moisture content of the meat samples were marinated with sodium monophosphate than marinated meat samples without sodium monophosphate was found before drying. Phosphates increase meat protein water binding and emulsifying ability. After slaughter adenosine triphosphate (ATP) in various biochemical reactions to form lactic acid, the pH value of the meat is reduced and water binding capacity decreases. Therefore, the use of phosphates resulted in increased pH value and restored natural water ability [19].

During storage, changes in the moisture content of dried venison samples is not significant (p=0.112).

IV. Conclusion

Experimentally, it was ascertained that the shelf-life of dried venison packaged in vacuum pouches made of polymer film (PA/PE) with barrier properties and stored at a temperature of 18±1°C in a dark place is 91 days with sodium monophosphate and 112 days − without sodium monophosphate. As it was already mentioned, the moisture content after drying being higher in the samples of venison with sodium monophosphate affects the storage time of the analyzed products.

No significant differences in the content of protein, fat, and moisture were detected when analyzing dried meat samples during storage and comparing them with the chemical parameters of just dried meat.

This may prove that the biological value of dried venison does not change significantly during storage after being dried in a microwave-vacuum drier.

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