# INFLUENCE OF PACKAGING CONDITIONS ON THE QUALITY OF PICKLED VENISON

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**Abstract**
Venison is well known as a traditional meat type in Europe, and it is lower in calories, cholesterol and fat content than common cuts of beef, pork or lamb. The aim of the current research was to determine physico-chemical parameters such protein, fat, pH, moisture content as well microbiological quality of pickled venison during storage. Beef as a control was analysed for comparison of obtained results. The meat (2×3×2 cm) pieces were pickled in vinegar marinade (composition: tomato sauce, mayonnaise, vinegar, lemon, onion, parsley, paprika, basil, black pepper, rosemary, salt) at 4±2 °C temperature for 48±1 h. The marinated meat was placed in polypropylene trays and hermetically sealed with high barrier polymer film under modified atmosphere ($C0_2$ 40%+$N_2$ 60%) without and with iron-based oxygen scavenger sachets (Mitsubishi Gas Chemical Europe Ageless®). As a control, packaging in air ambiance packed pickled products was used. During storage time, the moisture and protein values significantly ($p<0.05$) decreased and pH, fat content and colony forming units significantly ($p<0.05$) increased in the pickled venison samples of all packages. Slower changes in pH of pickled venison and in the protein and moisture content of marinated beef were observed in modified atmosphere with oxygen scavenger during storage.
**Key words:** venison, marinating, modified atmospheres, oxygen scavenger, storage time.

## Introduction

Venison is popular as a healthy food because of its low fat and high lean meat (Okabe et al., 2002; Stevenson et al., 1992). Venison is lower in calories, cholesterol and fat content than common cuts of pork, beef or lamb. All these attributes of venison are criteria demanded by today's discerning meat consumer (Hoffman and Wiklund, 2006). However, venison is a highly perishable product with a short shelf life. In scientific literature, investigation for venison shelf life extending using preservation of meat in modified atmosphere (Vergara et al., 2003), frozen packaging using vaccum- and nonvacuum-package (Farouk and Freke, 2008) is described.

Marination is an effective means of enhancing the quality and versatility of meats. Marination is the process of soaking or injecting of meat with a solution containing ingredients such as vinegar, lemon juice, wine, soy sauce, brine, essential oils, salts, tenderizers, herbs, spices and organic acids to flavour and tenderize meat products (Kargiotou et al., 2011; Pathania et al., 2010). This process could positively affect the shelf life of the meat due to the acidic or alkaline nature of the solution, and the antimicrobial and antioxidant activity of some marinade additives (Karigiotou et al., 2011). A good marinade will have a delicate balance of spices, acids and oil. Marinades are incorporated into meat by soaking texture and moisture retention, to enrich the meat flavor, to tenderize the fibers of muscle foods, and to preserve the products over a longer time (Alvarado and McKee, 2007).

Packaging makes food more convenient and gives the food greater safety assurance from microorganisms, biological and chemical changes so that the packaged foods may have a prolonged shelf life (Skandamis and Nychas, 2002). Packaging technology which modifies the atmospheric conditions of the package is popularly applied to extend the self-life of meat (Daszkiewicz et al., 2011). Modified atmosphere packaging (MAP) technology is one of the protection methods in which the surrounding atmosphere of the food is changed. Basic process in MAP is to remove the air inside the package and put in a gas or gas combination instead, and then seal hermetically (Gokoglu et al., 2011). Vergara et al. (2003) reported that for venison preservation gas composition ($C0_2$ 40%+$N_2$ 60%) is the most appropriate. But modified atmosphere packaging technologies not always completely remove oxygen, and oxygen penetrates through the packaging film. Using of oxygen scavengers can reduce oxygen level in package. Oxygen scavengers are made from easily oxidisable substances. Almost all oxygen scavenger sachets are based on the principle of iron oxidation. The sachets are made up of finely divided powdered iron, ferrous compounds and various catalysts, which under appropriate humidity conditions initiate the reaction, using up any residual oxygen to form non-toxic iron oxide (Brandon, 2009).

The aim of the current research was to determine physico-chemical parameters such protein, fat, pH, moisture content as well microbiological quality of pickled venison during storage.

## Materials and Methods

The experiments were carried out at the Department of Food Technology, Latvia University of Agriculture, in 2011. The meat of farmed red deer (*Cervus elaphus*) was obtained from a local farm 'Saulstari 1', located in Sigulda region, Latvia; the beef of farmed cattle *(Colloquially cows)* from Ltd. 'Kebeco' located in

Jekabpils region, Latvia, was used for control.

Initially, five types of marinades were used those main component was vinegar. After sensory evaluation, as appropriate for meat marinating was set marinade with following composition: tomato sauce, mayonnaise, vinegar (9 %), fresh lemon, onion, parsley, paprika, basil, black pepper, rosemary, salt. pH of marinade was 3.3.

Marinating process of the samples included the following steps:

1) *Longissimus dorsi* muscle from venison and beef saddle cuts were manually divided by knife in 0.250±0.020 kg pieces;

2) 0.250±0.020 kg pieces of *Longissimus dorsi* muscle were divided into smaller pieces of the size of 2×3×2 cm, and vinegar marinade was added;

3) prepared samples were marinated at 4±2 °C temperature in the refrigerator for 48±1 h.

Marinated meat samples were placed in polypropylene (PP) trays (210×148×35 mm) and hermetically sealed with high barrier polymer film Multibarrier 60 (composition: APA/TIE/PA/EVOH/PA/TIE/PE/PE; thickness 60±2 µm) under modified atmosphere ($C0_2$ 40%+$N_2$ 60%) without and with iron-based oxygen scavenger sachets (Mitsubishi Gas Chemical Europe Ageless®), as a control packaging in air ambiance packed pickled products was used. Meat samples were analysed after 0, 4, 7 and 11 days of storage in a modified atmosphere (MA) packaging and in air ambiance. Samples were stored at 4±2 °C.

For physico-chemical analyses, meats were homogenised 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. Experiments were interrupted after 11 days of storage due to improper microbiological parameters of analyzed samples.

The following parameters were assessed:

- pH, measured using JENWAY 3520 (Barloworld Scientific Ltd., ESSEX, UK) pH-meter, according to LVS ISO 5542:2010;
- moisture content according to ISO 1442:1997;
- fat content according to LVS ISO 2446:1976;
- protein content according to ISO 937:1974 Kjeldahl nitrogen method.
- colony forming units according to LVS EN ISO 4833:2003.

The data was processed by analysis of variance (ANOVA) in order to determine the effect of packaging condition and storage time on each variable. Tukey's test was carried out to determine differences between groups. The level of statistical significance was $p<0.05$. Statistical analyses were performed using SPSS 15.0.software packages.

**Results and Discussion**

The conducted experiment did not indicate significant differences ($p>0.05$) in protein content among the in-air-packed and MA-packed meat with/without oxygen scavenger. Protein content tended to significantly decrease ($p<0.05$) with increasing storage period in all packages. Slow decline in protein content of venison package in air ambiance and beef package under MA with oxygen scavenger was observed due to solubility of protein fractions. The changes in protein content in pickled venison and beef samples during storage are shown in Figure 1.

The changes in proteins due to the storage of pickled meat samples we could explain with the protein composition and physical properties. Myosin is the most abundant muscle protein and exists as discrete thick filaments in the myofibril. Its solubility with respect to ionic strength and pH has been investigated widely, and it is well known that myosin is insoluble

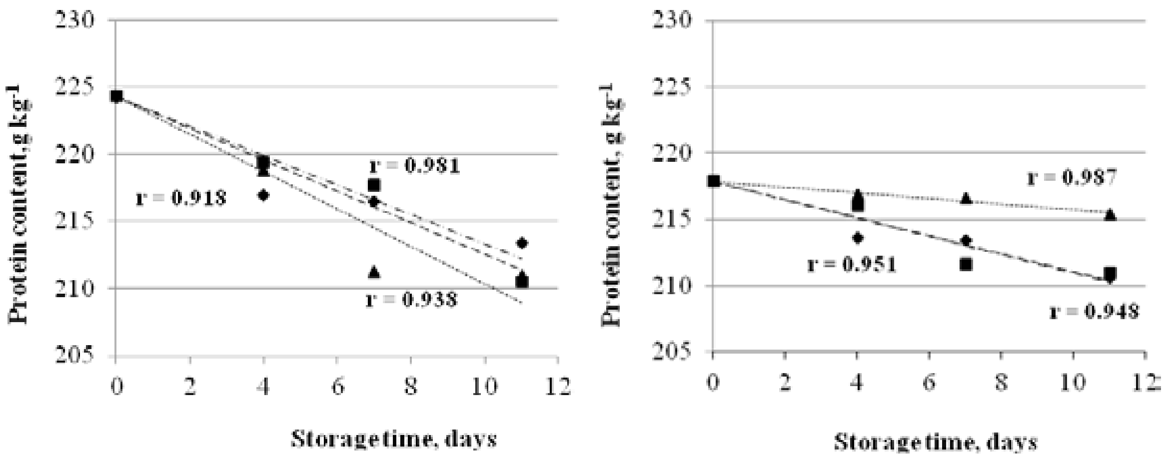


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Figure 1. Changes in protein content of venison (a) and beef (b) pickled in vinegar marinade during storage: ♦- air ambiance; ■- $C0_2$ 40%+$N_2$ 60% (without oxygen scavenger); ▲- $C0_2$ 40%+$N_2$ 60% (with oxygen scavenger).

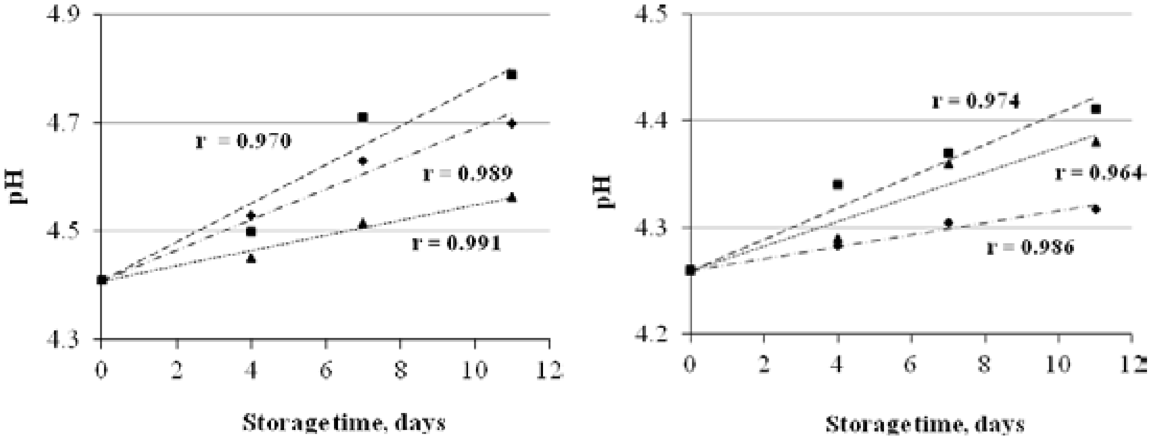


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Figure 2. Changes in pH values of venison (a) and beef (b) pickled in vinegar marinade during storage: ♦- air ambiance; ■- $C0_2$ 40%+$N_2$ 60% (without oxygen scavenger); ▲- $C0_2$ 40%+$N_2$ 60% (with oxygen scavenger).

at physiological ionic strength (0.15-0.2 M) and high ionic strengths but soluble at intermediate ionic strengths 0.3-0.6 M on pH 5.5 (Kerry et al., 2002). Taking into account the above information, the protein loss during storage could be explained by the fact that the marinated meat pH values increase due to decrease in soluble proteins. The correlation coefficients showed close interconnection between protein content and storage time (Figure 1).

During the storage of pickled meat, significant differences ($p<0.05$) were observed in fat content among the in air-ambiance-packaged and in-MA-with/without-oxygen-scavenger-packed venison and beef samples packaged in air ambiance and in MA with/without oxygen scavenger. Fat content increased throughout the entire period of storage of pickled meat packaged in air and in MA. Significant ($p<0.05$) increase in fat content was determined after 4 days of storage in all samples irrespective of the packaging method. Initial fat content of venison was 16.8 g $kg^{-1}$, and of beef - 18.7 g $kg^{-1}$. After marinating of samples, the fat content increased until 36.5 g $kg^{-1}$ (venison) and 25.2 g $kg^{-1}$ (beef). Such results could be explained by the fact that fat from mayonnaise (one of the main ingredients of vinegar marinade) overpasses meat. This process continues the first four storage days. After that, no significant differences ($p>0.05$) were found in the fat content.

In the present research, no significant differences ($p>0.05$) were found among the pH of venison packaged in air ambiance and under MA with/without oxygen scavenger. Mean pH of beef packaged in air and MA without oxygen scavenger was significantly different ($p<0.05$). During storage of samples, pH increased. Results are similar to the finding of Pollard et al. (2002), Vergara et al. (2003) and Franco et al. (2012). Moore and Gill (1987) suggested that tissue breakdown during marinating and storage of marinating meat may be responsible for this increase. The average pH of meat was significantly ($p<0.05$) higher after 11 days than after 4 days storage irrespective of the packaging method. pH changes in venison and beef pickled in vinegar marinade during storage are shown in Figure 2.

A tight correlation was observed between storage time and pH for venison and beef in all packages (see Figure 2).

The results of the present study did not show significant variations ($p>0.05$) in the moisture content of beef packaged in air ambiance and in MA with/without oxygen scavenger. Significant differences were observed ($p<0.05$) in MA without oxygen scavenger and under MA with oxygen scavenger packaged beef. However, moisture content significantly ($p<0.05$) decreased in both investigated packaging techniques of meat samples. Less moisture loss during storage was observed in beef (727.0 – 690.8 g $kg^{-1}$) packed under MA with oxygen scavenger and in venison (729.8 – 695.7 g $kg^{-1}$) packed under MA without oxygen scavenger. It could be explained with water vapour permeation through the packaging materials. Moisture content of pickled venison and beef samples during storage is shown in Figure 3.

A tight correlation between the meat samples in storage time and moisture content was observed (Figure 3).

The Latvian current legislative act does not regulate the permissible level of mesophylic aerobic and facultative anaerobic microorganism count in marinated meat. Commission Regulation (EC) No 2073/2005 on microbiological criteria for foodstuffs requires that maximal threshold of mechanically

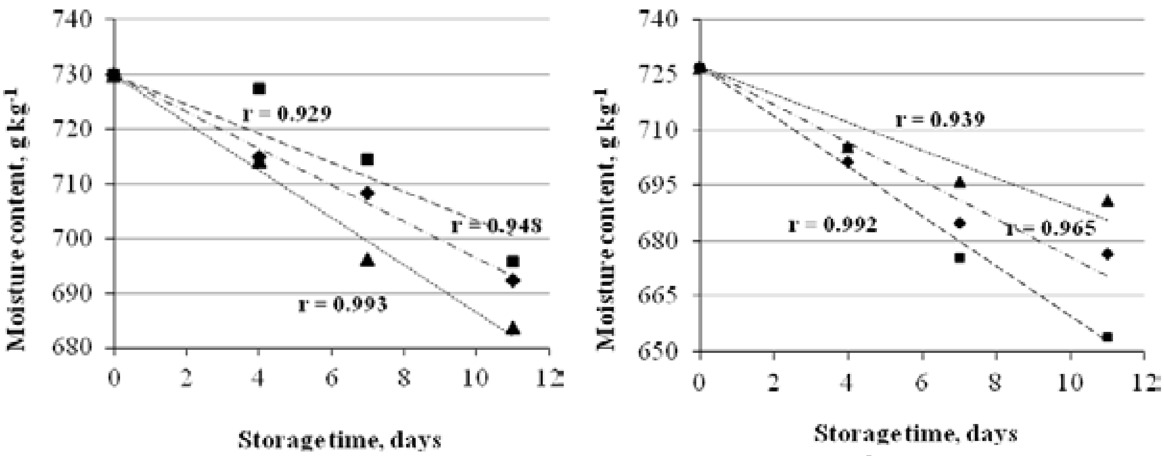


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Figure 3. Changes in moisture content of venison (a) and beef (b) pickled in vinegar marinade during storage: ♦- air ambiance; ■- $C0_2$ 40%+$N_2$ 60% (without oxygen scavenger); ▲- $C0_2$ 40%+$N_2$ 60% (with oxygen scavenger).

separated meat is $5\times10^6$ cfu $g^{-1}$ which also was seen as a critical threshold for microbiological analyses for this experiment.

During storage of meat samples, a significant ($p<0.05$) increase in colony forming units was observed (Figure 4). The applied packaging conditions (air ambiance and MA without/with oxygen scavenger) did not significantly ($p>0.05$) affect the microbiological quality of meat. Microbiological parameters of meat after 11 days exceeded the permissible level. The highest count was found in the meat samples packed in air ambiance ($6.5\times10^6$ cfu $g^{-1}$).

The correlation coefficients showed a close interconnection between total microbial counts and storage time (Figure 4). During storage, a lower intensity of the increase in colony forming units in samples packed under MA with oxygen scavenger has been observed compared with the samples packed under MA without oxygen scavenger. At the beginning of storage, many liquid marinades have a pH of around 4.0, which makes them microbiologically stable but does not give the marinated meat a sour taste (Sheard, 2006). The obtained results showed that microbial counts increase when pH of marinated venison rises to 4.8, and of marinated beef – to 4.4.

**Conclusion**

1. Significant changes ($p<0.05$) in fat and moisture content were determined among the venison samples packaged in-air ambiance and under MA with/without oxygen scavenger, as well as in pH value and fat content among the packages of the analysed beef samples.

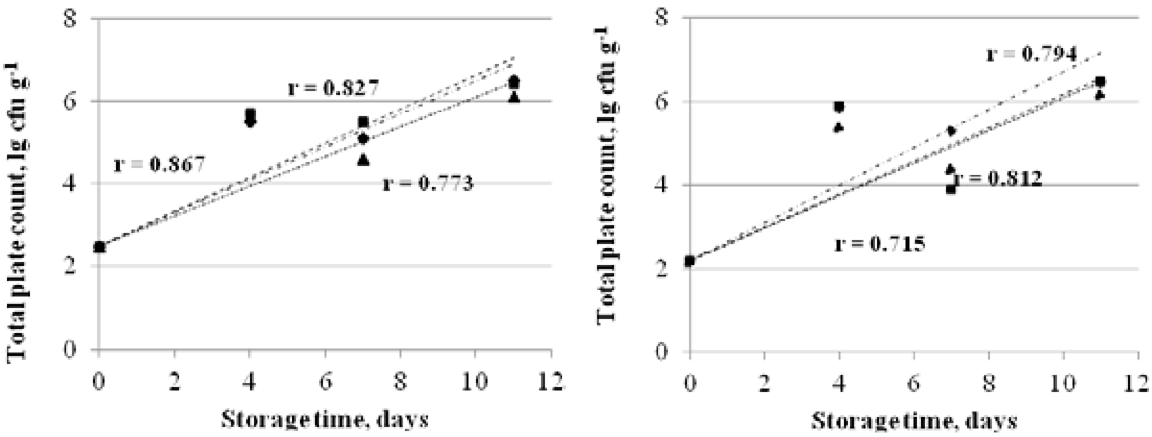


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Figure 4. Microbial counts in venison (a) and beef (b) pickled in vinegar marinade during storage: — · — air ambiance; — — — $C0_2$ 40%+$N_2$ 60% (without oxygen scavenger); --- $C0_2$ 40%+$N_2$ 60% (with oxygen scavenger).

2. During storage, all quality parameters (protein, fat, pH, and moisture) significantly changed ($p<0.05$) irrespective of the packaging method.
3. In all packages during storage, colony forming units significantly ($p<0.05$) increased, but no significant ($p>0.05$) changes in colony forming units were observed between the venison and beef packages.
4. Changes in some quality parameters during storage tended to be slower in pickled venison and beef samples packaged in MA with oxygen scavenger.

**Acknowledgement**

The work of the doctoral student L. Šiliņa is supported by the ESF project No. 2009/0180/1DP/1.1.2.1.2./09/IPIA/VIAA/017.

This research and publication have been prepared also within the State Research Programme 'Sustainable use of local resources (earth, food, and transport) – new products and technologies (NatRes)' (2010.-2013.) Project No. 3. 'Sustainable use of local agricultural resources for development of high nutritive value food products (Food)'.

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