International Journal of Biological, Life and Agricultural Sciences
ISSN: 2415-6612
Vol:7, No:9, 2013

Quality Changes of Venison Marinated in Red Wine Marinade during Storage

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Abstract**—**The objective of the present study was to determine quality parameters changes of red wine marinade marinated venison during storage. Beef as a control was analysed. Protein, fat, moisture and pH content dynamics as well microbiological quality was analyzed. The meat pieces were marinated in red wine marinade at 4±2ºC temperature for 48±1h. Marinated meat was placed in polypropylene trays, hermetically sealed with high barrier polymer film Multibarrier 60 under modified atmosphere (CO_2 40%+N_2 60%) without and with oxygen absorber sachets, as a control packaging in air ambiance packed marinated venison and beef was used. Meat samples were analyzed after 0, 4, 7, 11 and 14 days of storage. During the storage of meat, protein and moisture content significantly ($p<0.05$) decreased, pH and colony forming units significantly ($p<0.05$) increased, fat content does not change in all treatments irrespective of the packaging method.

Keywords**—**Marinating, modified atmosphere, quality, venison.

I. Introduction

VENISON is a highly perishable product with a short shelf life. However, venison is well known as a traditional meat type in Europe [1], and it is lower in calories, cholesterol and fat content than common cuts of beef, pork or lamb [2]. The unique properties of venison are caused by different muscle fiber type content and reflect the physical, chemical and morphological composition of the meat. In meat processing, red and white muscle fibers produce different palatabilities, as judged by tenderness, juiciness, texture and flavor [3].

The word ''marinate'' comes probably from the Latin word ''marine'' to Italian, Spanish and French languages referring to soaking/pickling in salt brine. What is being meant by marinating today varies a great deal between countries. Sometimes salting, adding phosphates and some spices is considered as marinating [4]. Marination is the process of soaking or injecting 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 flavor and tenderize meat products [5], [6], [4]. Traditionally, meat has been marinated by soaking in acid solution [7], such as, vinegar, wine or fruit juice [8]. The mechanism of the tenderising action of acidic marinades is believed to involve several factors including weakening of structures due to swelling of the meat, increased proteolysis by cathepsins and increased conversion of collagen to gelatin at low pH during cooking [8], [9]. 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 [4]. Several methods were used to marinated meat, including immersing the meat in the marinade, injecting and tumbling with a marinade or combination of injecting and tumbling [10]. In the present research based on the scientific literature studies, immersion method for meat marinating was chosen.

Modern meat packaging techniques are intended to maintain microbial and sensory quality of the product. Changes in the packaging atmosphere (aerobic, vacuum or modified atmosphere) are used in the food industry to extend products shelf-life [11]. 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 [12]. From among the gases which may come into contact with food products under EU legislation [13], carbon dioxide, nitrogen and oxygen are most popularly applied in meat packaging [14]. For venison preservation gas composition (CO_2 40%+N_2 60%) is the most appropriate [15].

But modified atmosphere packaging technologies not always completely remove oxygen and oxygen penetrates through the packaging film. Using oxygen absorbers can reduce oxygen level in package. Oxygen absorbers are made from easily oxidisable substances, usually contained in sachets made of air permeable materials. These sachets are a variety of sizes, which are capable of absorbing nominally 20–20 000 cc of oxygen from the headspace. When oxygen absorber sachets placed inside a modified atmosphere pack, they can reduce the oxygen headspace to <0.01% within 1–4 days at room temperature. Almost all oxygen absorber sachets used commercially are based on the principle of iron oxidation [16].

The objective of the present study was to determine quality parameters changes of red wine marinade marinated 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 2012. The meat of farmed red deer (*Cervus elaphus*) was obtained from a local farm 'Saulstari 1', located in Sigulda region,

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Latvia; the beef of farmed cattle (Colloquially cows) from Ltd. 'Margret' located in Jekabpils region, Latvia, was used for control.

B. Sample Marination

Red wine marinade (composition: red wine, onion, vinegar, garlic, parsley, sweet pepper, basil, black pepper, rosemary, salt)was used for venison and beef pickling.

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±0.020kg pieces;
2) 0.250±0.020kg pieces of *longissimus dorsi* muscle were divided into smaller pieces of the size of 2×3×2cm, and red wine marinade was added;
3) prepared samples were marinated at 4±2°C temperature in the refrigerator for 48±1 h.

C. Packaging and Storage of Samples

Marinated meat samples were placed in polypropylene (PP) trays (210×148×35mm) and hermetically sealed with high barrier polymer film Multibarrier 60 (composition: APA/TIE/PA/EVOH/PA/TIE/PE/PE; thickness 60±2μm) under modified atmosphere (CO_2 40%+N_2 60%) without and with iron-based oxygen absorber sachets (Mitsubishi Gas Chemical Europe Ageless®, 100 cc), as a control packaging in air ambiance packed marinated venison and beef was used.

Meat samples were analyzed after 0, 4, 7, 11 and 14 days of storage in a modified atmosphere (MA) packaging and after 0, 4, 7 and 11 days of storage in air ambiance. Samples were stored at 4±2°C.

D. Physical, Chemical and Microbial Analysis

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 and 14 days of storage due to improper microbiological parameters of analyzed samples.

The following parameters were assessed:

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

E. Statistical Analysis

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.

III. Results and Discussion

A. Protein Changes

No significant differences ($p>0.05$) were found in protein content among under modified atmosphere (MA) without/with oxygen absorber and in air ambiance packaged marinated venison (Fig. 1).

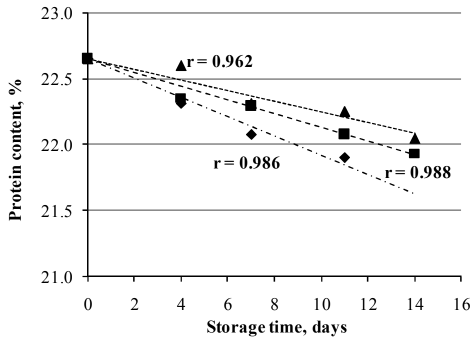

Fig. 1 Changes in protein content of venison marinated in red wine marinade during storage ♦- air ambiance; ■- CO_2 40%+N_2 60% (without oxygen absorber); ▲- CO_2 40%+N_2 60% (with oxygen absorber)

Protein content of marinated beef packaged under MA without oxygen absorber and under MA with oxygen absorber significantly different ($p<0.05$) (Fig. 2).

During storage protein content significantly decreased ($p<0.05$) of both investigated meat samples in all packages. Slow decline protein content of marinated venison and beef packed under MA with oxygen absorber was observed. The protein loss during storage could be explained by the fact that the marinated meat pH values increase due to decrease in soluble proteins.

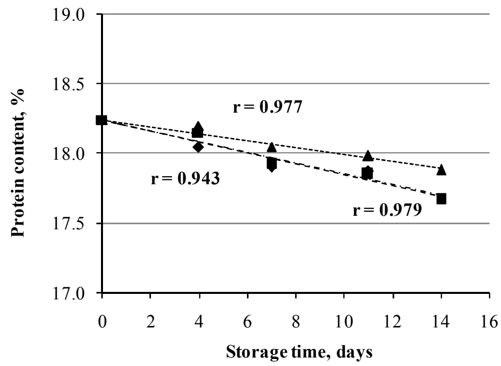

Fig. 2 Changes in protein content of beefmarinated in red wine marinade during storage ♦- air ambiance; ■- CO_2 40%+N_2 60% (without oxygen absorber); ▲- CO_2 40%+N_2 60% (with oxygen absorber)

A tight correlation was observed between storage time and protein content for venison and beef in all packages (Figs. 1 and 2).

B. Fat

During the storage of marinated meat, no significant changes ($p>0.05$) were observed in fat content. Initial fat content of marinated venison was 1.2% (beef – 1.8%). After 14 days of storage fat content was a similar. Such results could be explained with composition of red wine marinade which not contains ingredients with high fat content.

C. Moisture Changes

In the present research, no significant differences ($p>0.05$) were found among the moisture content of marinated venison and beef packaged in air ambiance and under MA without/with oxygen absorber.

During storage moisture content significantly ($p<0.05$) decreased in both investigated meat samples irrespective of the packaging method. However, less moisture loss during storage was observed in marinated venison (75.04% –74.33%) and beef (69.05% – 68.10%) packed under MA with oxygen absorber. Moisture loss could be explained with water vapor permeation through the packaging materials. Moisture content of marinated venison (a) and beef (b) samples during storage is shown in Fig. 3.

A tight correlation was observed between storage time and moisture content for venison and beef in all packages (Fig. 3).

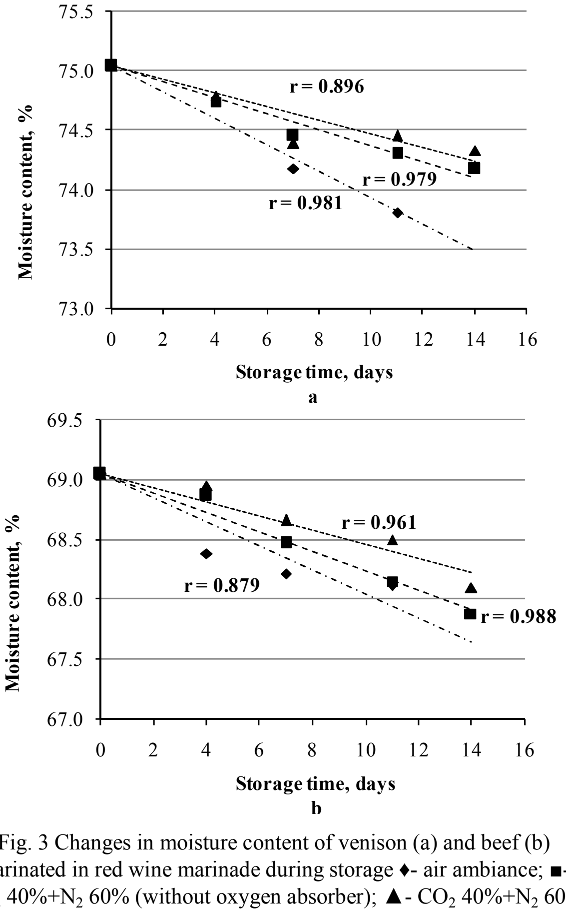

Fig. 3 Changes in moisture content of venison (a) and beef (b) marinated in red wine marinade during storage ♦- air ambiance; ■- CO_2 40%+N_2 60% (without oxygen absorber); ▲- CO_2 40%+N_2 60% (with oxygen absorber)

A. pH Changes

The conducted experiment did not indicate significant differences ($p>0.05$) among the mean pH values of venison packaged in air ambiance and under MA without/with oxygen absorber (Fig. 4).

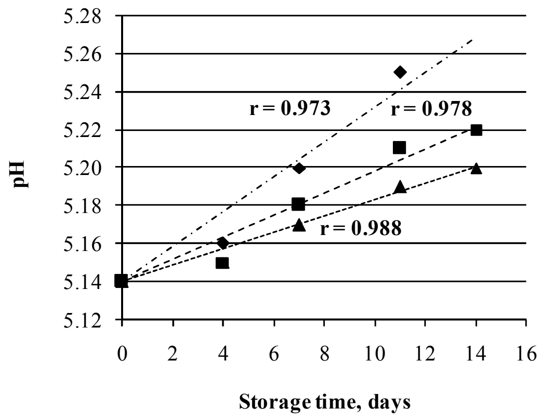

Fig. 4 Changes in pH values of venison marinated in red wine marinade during storage ♦- air ambiance; ■- CO_2 40%+N_2 60% (without oxygen absorber); ▲- CO_2 40%+N_2 60% (with oxygen absorber)

Mean pH of beef packaged in air ambiance and MA without oxygen absorber, and beef packaged in air ambiance and MA with oxygen absorber significantly different ($p<0.05$) (Fig. 5).

During storage of samples, pH significantly ($p<0.05$) increased in all packages. Pollard [17], Vergara [15] and Franco [18] are finding similar results. The changes in the pH values of meat were probably caused by process of meat autolysis [19]. The correlation coefficients showed close interconnection between pH values and storage time (Figs. 4 and 5).

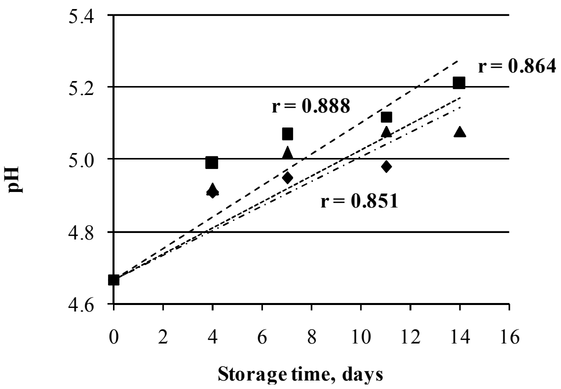

Fig. 5 Changes in pH values of beef marinated in red wine marinade during storage ♦- air ambiance; ■- CO_2 40%+N_2 60% (without oxygen absorber); ▲- CO_2 40%+N_2 60% (with oxygen absorber)

B. Microbiological Changes

Commission Regulation (EC) No 2073/2005 [20] on microbiological criteria for foodstuffs requires that maximal threshold of mechanically separated meat is

5×10^6cfu g^{-1} which also was seen as a critical threshold for microbiological analyses for this experiment. During storage of marinated venison (a) and beef (b) samples, a significant ($p<0.05$) increase in colony forming units was observed (Fig. 6).

However, packaging conditions (air ambiance and MA without/with oxygen absorber) did not significantly ($p>0.05$) affect the microbiological quality of meat. Microbiological parameters of meat packaged in air ambiance after 11 days exceeded the permissible level. After 14 days microbiological parameters of meat packaged under MA without/with oxygen absorber exceeded the permissible level and experiments were interrupted. During storage, a lower intensity of the increase in colony forming units in samples packed under MA with oxygen absorber has been observed. 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 [21]. The obtained results showed that microbial counts increase when pH of marinated venison and marinated beef rises to 5.2. The correlation between total microbial counts and storage time is high (Fig. 6).

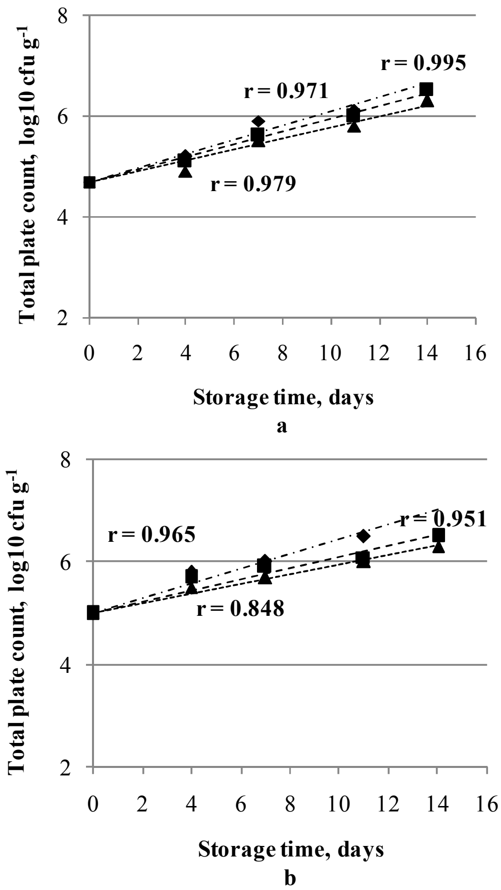

Fig. 6 Microbial counts in venison (a) and beef (b) marinated in red wine marinade during storage ♦- air ambiance; ■- CO_2 40%+N_2 60% (without oxygen absorber); ▲- CO_2 40%+N_2 60% (with oxygen absorber)

IV. Conclusion

The results of this investigation did not indicate a significant influence of the applied packaging type (air ambiance, modified atmosphere (MA) without oxygen absorber and MA with oxygen absorber) on changes in protein content, fat content, moisture content, pH values and microbiological quality of picked venison.

During storage all quality parameters significantly changed ($p<0.05$) irrespective of the packaging method.

However, quality parameters changes during storage tended to be slower in marinated venison and beef samples packaged under MA with oxygen absorber.

This may suggest that MA with oxygen absorber is the most suitable method of storing marinated venison.

Acknowledgment

The work of the doctoral student L. Silina 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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