

CHANGES IN THE CHEMICAL COMPOSITION OF *Musculus quadriceps femoris* OF BEEF KEPT AT DIFFERENT TEMPERATURES

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Abstract: The study contains the result from the test of the vacuum – packed meat slices (*M. quadriceps femoris*) obtained from ox Simmental breed. After the primary treatment, the refrigeration and the sorting out, the meat slices were vacuum –packed and kept at a temperature of 4°C and 6°C. At the 2nd, the 3rd and the 5th day, a chemical analysis of the meat slices was made. At the 2nd and the 5th day it was made a microbiological test of the meat slices in relation to the overall number of bacteria, as well as a sensor analysis in terms of outward appearance, consistence, color, odor and taste. It was noted that, during the storage the water content in the meat slices significantly reduced, and the fat, protein and mineral substance content was increased. The overall number of bacteria was increased in the meat slices kept at a temperature of 6°C. The best sensor marks were given to the meat slices kept at a temperature of 4°C.

Key words: booth, *M. quadriceps femoris*, water, protein, fat

Introduction

Packaging of meat and meat products is the most dynamic area of the meat industry. It protects the organoleptic, physico - chemical and microbiological characteristics of these products during the manipulation from the producer to the consumer (*Brewer and Novakofski, 2006; Antoniewski et al., 2007*). The meat and meat products must be attractively packed today because consumer demands are constantly growing (*Philips et al., 2001*)

As the present consumer’s attention paid to the meat quality grows, the importance of the packing is growing as well. Packaging is the most dynamic domain of the meat industry.

Formerly, whole carcasses were distributed to the retail stocks where the bones were removed and the carcass was sliced into primary meat slices and kept

in a meat safe, while slicing meat for sale and packaging was being done as necessary. Today it is not the case. Today's trend of the packing technology, the vacuum-packing, allows a constantly growing number of vacuum-packing meat slices in the market by seeking to do this operation into the production halls instead for the retail stores. At all events, this does not happen at once, but in phases depending on the local circumstances.

Packing fresh meat slices for wholesale and for retail, as well as its distribution to the sales points, developed as the bone removal and the slicing process moved into the production halls. This practice expanded even more with the advent of the fresh meat slices vacuum-packing. This process appeared for the first time in the USA. As for Europe, the vacuum-packing has a significant progress in Britain, Ireland and France, and some less in Germany, Italy and Spain.

In R. Macedonia packaging of the fresh meat (vacuum packaging) starts its usage from 1990; therefore, today many assortments of products of fresh meat are packed in a vacuum. Packaging in vacuum slows down the oxidation processes, the growth of aerobic bacteria, weight loss and color changing, and is used for magnification and achieving maturation of the fresh meat. The objective of this research was to investigate the chemical and microbiological changes that occur during storage at 4 and 6°C and how they affect on the sensory characteristics of vacuum-packed pieces of fresh beef meat.

Materials and Methods

The weight of the beef half's before cutting was 100 kg. From the cold sides of the thigh together with the knee-joint it is separated by cutting which goes between the last flank and the first vertebra and then separates the abdominal wall which is close to the thigh. The knee-joint is separated from the thigh with a cut which passes through the joint wrist. Then the removal of the adipose tissue of the thigh is done with a knife and the thigh is finally removed. After removal of the thigh the polyhamstring muscle is separated from other muscles of the thigh after a natural connection. By cooling the pieces of meat, achieving the medium temperatures of 4° C they are vacuum packed in foil vacuum type Vebomatic. After vacuuming from the same meat 12 packages are taken randomly and they are divided into two groups, the first group was kept in a refrigerator at a temperature of 4°C and the second group is stored at a temperature of 6°C.

Meat cuts that are subject to examination are measured at 2nd, 3rd and 5th day on electronic scales Bizerba with a punctuality point of 0.1 g. Although they are packed in vacuum foil the measurement was carried out so the change in the weight of meat slices or shrinkage during storage to be followed. A test on the chemical composition, sensor analysis and microbiological analysis on the change

and development in microorganism in meat cuts during storage was done on the 2nd and 5th day. On the 3rd day only a chemical analysis of the meat cuts is carried out.

Moisture content was determined after drying to constant weight; protein content was determined by the Kjeldahl method and the factor 6.25 was used for conversion of nitrogen to crude protein; crude fat content was determined after extraction of lipids by means of an automated Soxhlet procedure (AOAC, 1995). The content of mineral substances is melt by combustion in muffle oven at a temperature of 550°C (Pozarskaja et al., 1964). The pH value of the meat is measured by pH-meter, German manufacturing type Lu-co. Sensory analysis was performed by using the 9 - level scale developed by the Higher Institute for local prudence in Moscow (VNIIMP) with 10 trained analyzers. Sensory analysis was done on the appearance, colour, consistency, smell and taste. Each sensor feature analyzer has the opportunity to assess in a rating from 1 to 9 where 1 indicates undesirable and 9 indicates desirable. Microbiological tests were performed according to usual practice that is used in the local industry by seedling of the aqueous solution from the taken tests of the nutritious ground and of the incubation at a temperature of 30°C in a period of 72 hours.

Results were statistically elaborated by ANOVA MS Excel program (2003) in accordance to the established statistical methods. Determined average values, standard deviation, and \bar{x} - average of the experiment reliable intervals and presence of statistically important differences using Duncan test.

Results and Discussion

The results of the changes in the chemical composition of the meat cuts that are kept at a temperature of 4°C are presented in (Table 1).

Table 1. Change in the chemical composition of *Musculus quadriceps femoris* during storage at a temperature of 4°C

Indicator	2 nd day	3 rd day	5 th day
	$\bar{X} \pm Sd$	$\bar{X} \pm Sd$	$\bar{X} \pm Sd$
Weight (kg)	100 8,2	97,52 7,5	93,28 7,8
Water (%)	75.00 ± 0.012	74.88 ± 0.010	73.80 ± 0.010
Fat (%)	1.5 ± 0.028	1.52 ± 0.014	1.54 ± 0.012
Protein (%)	22.0 ± 0.010	22.02 ± 0.014	22.20 ± 0.011
Min.sub. (%)	1.5 ± 0,022	1.51 ± 0,011	1.52 ± 0.018
pH	6.14 ± 0,012	6,12± 0,010	5,92±0,08

As it can be seen from the presented data at beginning of the trial and regarding to the 2nd day after the production the average water content is 75.0%, protein 22.0%, 1.5% fat and mineral substances 1.5%.

On the 3rd day of storage at a temperature of 4°C there is a change in the weight of meat and its chemical composition, although the water content is reduced to 74,88%, while the fat and protein have increased to 1.52% fat and 22.02% protein and mineral substances are increased from 1 to 1.51%.

On the 5th day after manufacturing the chemical composition of meat cuts is changing because the water content had dropped to 73.80%, the weight increases to 1.54%, the level of protein is 22.20% and the content of mineral substances is 1.52%. Such changes in chemical composition result from the evaporation of free water from the pieces of meat.

On the 5th day keeping the water content is reduced in relation to the 2nd day to 1.2%, while fat increases and it is increased in relation to the beginning for 0.04% and protein is increased in relation to the beginning for 0.2%, and the content of mineral substances in relation to the beginning increases by 0.02%.

The results from the changes in chemical composition of meat cuts that are kept at a temperature of 6°C are presented in (Table 2).

Table 2. Change in the chemical composition of *Musculus quadriceps femoris* during storage at a temperature of 6°C.

Indicator	2 nd day	3 rd day	5 th day
	$\bar{X} \pm Sd$	$\bar{X} \pm Sd$	$\bar{X} \pm Sd$
Weight (kg)	100±8,18	98,80±7,7	97.78±7,5
Water (%)	75,00 ± 0,018	74,85 ± 0.010	73,70 ± 0,040
Fat (%)	1,5 ± 0,032	1,54 ± 0,040	1,56 ± 0,021
Protein (%)	22,0 ± 0,021	22,59 ± 0,022	22,61 ± 0,011
Min.sub. (%)	1,5 ± 0,021	1,52 ± 0,012	1,54 ± 0,014
pH	6,18± 0,010	6,15 ± 0,010	5,85±0,07

As it can be seen from the presented data from (Table 2) the weight of the meat on the 3rd day of storage at a temperature of 6°C is reduced and it is 98.80%, the water content is 74.85%, fat content is slightly increased and it is 1.54%, the protein is 22.59% and the mineral material is 1.52%.

On the 5th day of storage of the meat pieces there is a change in the reduction or lowering on the weight of meat cuts which is reduced to 97.78%

compared to those on the 2nd day, the water is reduced to 73.70% fat are increased to 1.56%, protein is present with 22.61% and mineral substances 1.54%.

On the 5th day of keeping pieces of meat at the temperature of 6°C the water content decreases in comparison the 2nd day to 1.3%, while fat increases and it is 0.06%, protein grows to 0.61% and mineral material is 0.04%.

During the keeping, by reducing the water content adequately the total content of dry substances is increased (proteins, fats, minerals). That increase of the dry substances is not proportional to all three components; it shows smaller or bigger variability.

The biggest increase on the 2nd, 3rd and 5th day is found in fats in the meat which is kept on 6°C. In the meat that is kept on 4°C there is constant and standard fat content and proteins. The differences that exist in the chemical structure in the pieces of meat kept on 4°C and 6°C are not statistically significant $p > 0.05$.

During the keeping there are some changes of microorganism in the meat, and those changes are influenced by reducing the water and then the concentration of dry substances increases, and then there is a change of the pH value. As a result of that change in the chemical structure of the pieces of meat which are set in during the keeping, changes are noticed in the microbiological pictures...pieces of meat that are kept on a temperature of 6°C there is significant increase in the number of bacteria contrasting with the pieces of meat that are kept on 4°C.

In the pieces of meat kept on 6°C, on the 5th day from the production the total number of bacteria was 130 in ml. but in the pieces of meat kept on 4°C the total numbers of bacteria was 80 in ml (Figure 1). The increased number of bacteria in the pieces of meat that are kept on 4°C is resulting on the better conditions during their evolution.

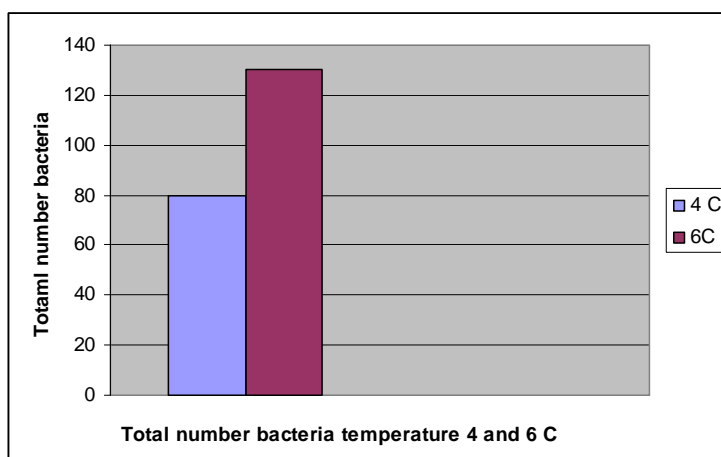


Figure 1. Graphic is showing the total number of bacteria in vacuum *M. quadriceps femoris* kept at a temperature +4°C and +6°C at 2nd and 5th day of production

The result from the sensor analysis of the meat slices kept at a temperature of 4°C and 6°C show the existence of many differences. The meat slices kept at a temperature of 4°C have considerably kept their sensor characteristics after the 5th day. On the other hand, there are considerable differences in the sensor characteristics of the meat slices kept at a temperature of 6°C during 5 days (Figure 2).

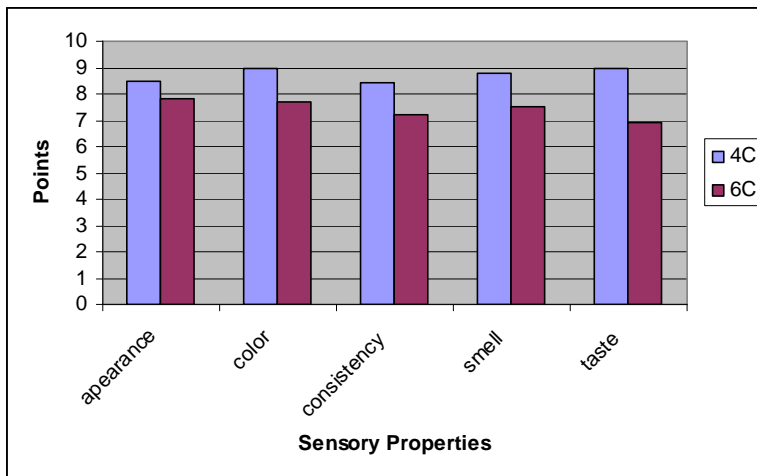


Figure 2. Figure for sensory characteristic of pieces of meat kept on 4°C and 6°C on the fifth day at the producing.

Pieces of meat kept on 6°C in 5 days period had significantly had sensory characteristics (taste and consistency) which are around 1/3 from those that they had on the 2nd day from the producing.

Many authors have examined the impact of sustainability on the vacuum packaging of beef meat (*Bell and Garout., 1994; Lawrence et al., 2003; Stamenković et al., 2007; Stetzer et al., 2008*), examined the sustainability of vacuum packed meat pieces cooling at different temperatures and they found that the meat cuts that have been kept at lower temperature had better sensory characteristics of meat cuts than those that have been kept at relatively higher temperatures. Our examinations are in accordance with the tests they have been doing previously.

Conclusion

During the keeping of meat at 4°C and 6°C the quantity of water is reduced in both tests. Differences in reduction are statistically not significant. With the

water content reduction the percentage of dry substances is growing. The biggest growth is found in fats, then in the proteins and it is smallest in minerals. In pieces of meat that are kept on 6°C, the total number of microorganism on the 5th day is significantly bigger and it is 80, and those kept on 4°C the total number bacteria is 50 in ml.

Sensory characteristics in pieces of meat which were tested on 2nd and 5th day after their production were changed. The biggest changes are found in meat kept on 6°C, and the smallest has the meat kept on 4°C between the 2nd and the 5th day.

Promene hemijskog sastava *Musculus quadriceps femoris* govedeg mesa čuvanog na različitim temperaturama

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Rezime

U radu su iznete promene koje nastaju kod vakmiranih komada govedeg mesa (*M. quadriceps femoris*) dobijenih od simentalске rase koji su vakimirani i održavani pri različitim temperaturnim uslovima od 4°C i 6 °C. Promene koje nastaju za vreme čuvanja mesa na tim temperaturama su ispitivane 2, 3, i 5 dana nakon proizvodnje mesa.

Konstatovano je da za vreme čuvanja komada mesa značajne promene se javljaju u smanjenju sadržaja vode, dok belkovini, masti i mineralne materije se uvećavaju. Ukupan broj bakterija za vreme čuvanja bio je veći kod komada mesa čuvanih na temperaturi od 6 °C. Najbolje senzorne karakteristike su imali komadi mesa čuvani na 4°C.

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