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PHYSIOLOGYCAL EFFECTS OF THE VEGETAL FAT ENRICHED FORAGES ON THE RABBIT SKELETAL MUSCLE COMPOSITION AND STRUCTURE

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Abstract

In this work it was determined the effects of vegetal fat enriched diets on the young rabbit skeletal muscle composition and structure following a 20 days period of experimental feeding.
At the end of the experimental period, the percentage of muscle fat in the Biceps femoris muscle was 1.12% in the control group, 1.21% in 3% supplemented group, 2.38% in 5% supplemented group and 2.54% in the 7% fat supplemented group.
The protein content of same muscle for the control group amounted to a rate of 22.92% showing a decreasing trend in the fat supplemented groups: 22.75%, 22.19% and, respectively, 22.02%.
Water content of muscle in the control group was 76.87%, while in the experimental groups the values were reduced: 76.31%, 75.53±2.21% and, respectively 75.30±3.09%.
The percentage of mineral salts in the control group amounted to a value of 1.27% while the experimental values were as follows: 1.22% in 3% fat supplemented group, 1.16% in the 5% supplemented group and 1.1% in the group of 7% fat supplemented rabbits.
The final pH values of same muscle have relatively low growth, proportionally to the concentration of fat, in order of 5.72, 5.60, 5.53, the maximum being in 7% fat supplemented group, while the control group that value amounted to 5.68, 24 hours from sampling.
Histological analysis reveals the structure of muscle fibers consisting in increasing the percentage of slow oxidative vs. fast oxidative fibers.

***Keywords**: vegetable fat, skeletal muscle composition, rabbit.*

INTRODUCTION

Although lipids support important gastro-intestinal hydrolysis processes and intraepithelial re-esterification of fatty acids absorbed across the intestinal wall, forage fats still retain some unchanged properties. Accordingly, these fats influence the morphological and physiological properties of the skeletal muscle tissue. The purpose of this paper was to determine the measure in which the diet fat influences the composition and structure of skeletal striated muscle in young domestic rabbits.

MATERIAL AND METHODS

The experiment concerned in feeding for 20 days of four Supercuni experimental rabbit groups aged 11 weeks using vegetal fat (linseed) enriched diets of different percent of fat as it follows:

- a control group (n= 5) fed by a standard diet containing 2% vegetal (linseed oil) fat;
- three experimental rabbit groups, 5 animals each one, fed as following:
- exp. group A, fed by a diet containing a 3% supplement linseed oil ;
1exp. group B, fed by a diet containing a 5% supplement linseed oil ;

- exp. group C, fed by a diet containing a 7% supplement linseed oil;

At the end of the experimental feeding, the animals were slaughtered and the *Biceps femoris* muscle was sampled. Skeletal muscle (*Biceps femoris*) composition (protein, fat, water and ash), *p*H and histology were analyzed. Water content was determined by drying in oven at 103 ± 2°C. Fat content was determined by extraction with organic solvents using the Soxlet method. Mineral salt content was determined by calcination at 550°C of samples dehydrated for 16-18 hours. Muscle protein contents were determined by calculating the difference between fat, water and mineral contents and total muscle mass, according to standards of AOAC [1]. The samples were processed for histological study than they were Giemsa stained.

Post-sampling evolution of muscle *p*H was monitored using a Hanna *p*H meter. Evolution of muscle *p*H was monitored from the moment of slaughter up to 24 hours after slaughter. The results were statistically processed in terms of mean and standard error of the mean and the differences between groups were statistically compared based on Student's *t* test [Tacu, 1968]. The level of significance was established for $P < 0.05$.

RESULTS AND DISCUSSION

The percentage of muscle fat was 1.12±0,17% in the control group, 1.21±0,14% in 3% supplemented group, 2.38±0,83 % in 5% supplemented group ($P<0.05$) and 2.54±0,99% in the 7% fat supplemented group ($P<0.01$). Aspectul grafic din fig 1 indică o creştere a procentului de grăsime din carne aproape proporțională cu procentul de grăsime din furaj, cel puţin pe intervalul de concentraţii de ulei vegetal din hrană pentru care s-au făcut cercetările.

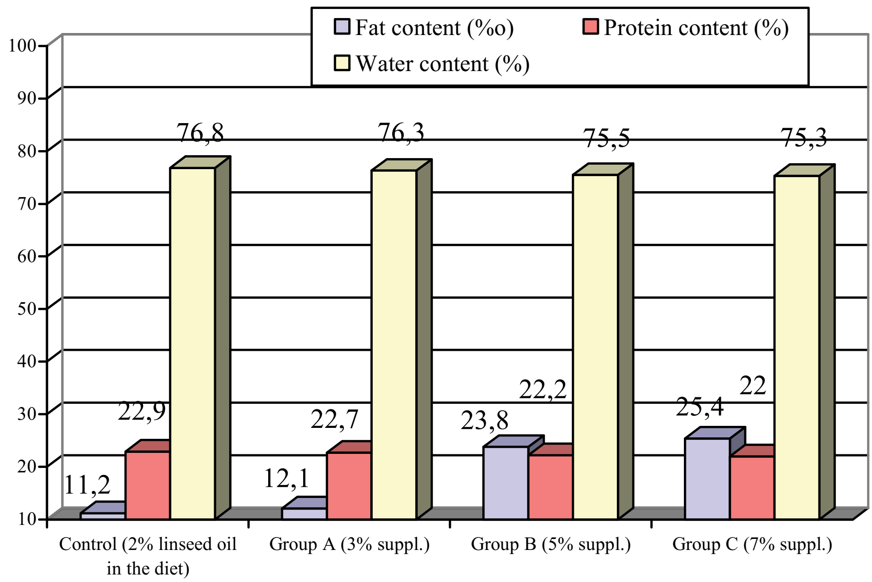
The graphics of figure 1 shows an increase in the percentage of fat in the skeletal muskle almost proportional to the percentage of fat in the forage, at least in the concentration range of the oil forage which had been researched. Fat, calculated as a percentage of dissected fat ranges between 3% and 6% of muscle composition (Blasco and Ouhayoun, 1996).

The protein content of muscle for the control group amounted to a rate of 22.92±1,98 %, showing a decreasing trend in the fat supplemented groups: 22,75±2,29 in group B (3% suppl.), 22,19±0,51 ($P<0.05$) in group C (5% suppl.) and 22,02±1,61 ($P<0.05$) in group C (7% suppl., fig. 1).

According to the scientific data, the effect of protein in the ration during the life reflects in the composition and properties of muscle and adipose tissues, and after slaughter, reflects on the carcass quality and meat composition. Effect on meat composition must be analyzed through the relationship PD / ED (digestible protein / digestible energy). If the PD / ED ratio is low and total protein intake does not cover the daily requirements of protein, growth is impaired and slaughter efficiency is reduced (Lebas and Ouhayoun, 1987). If the PD / ED is higher than optimal, muscle protein synthesis achieves the maximum possible, and the excess is used as an energy source (Lebas, 1989). In this case, the composition of weight gain may remain constant (Xiccato , 1999) and fat deposits may suffer a slight reduction. If the PD / ED is very high (over 14 g MJ^{-1}), daily gain and feed conversion are damaged, kidney fat is reduced and mortality may increase (Maertens *et al.*, 1988).

Water content of muscle in the control group was 76.87%, while in the experimental groups the values were reduced: 76.31%, 75.53% and, respectively 75.30% (fig. 1). Decreased water content in muscle tissue became significant after statistical processing only in group C, where P <0.05.

Fig. 1. The evolution of fat, protein and water content in young rabbits skeletal muskle fed by different levels of linseed oil diets for 20 days vs. a control group fed by a standard diet

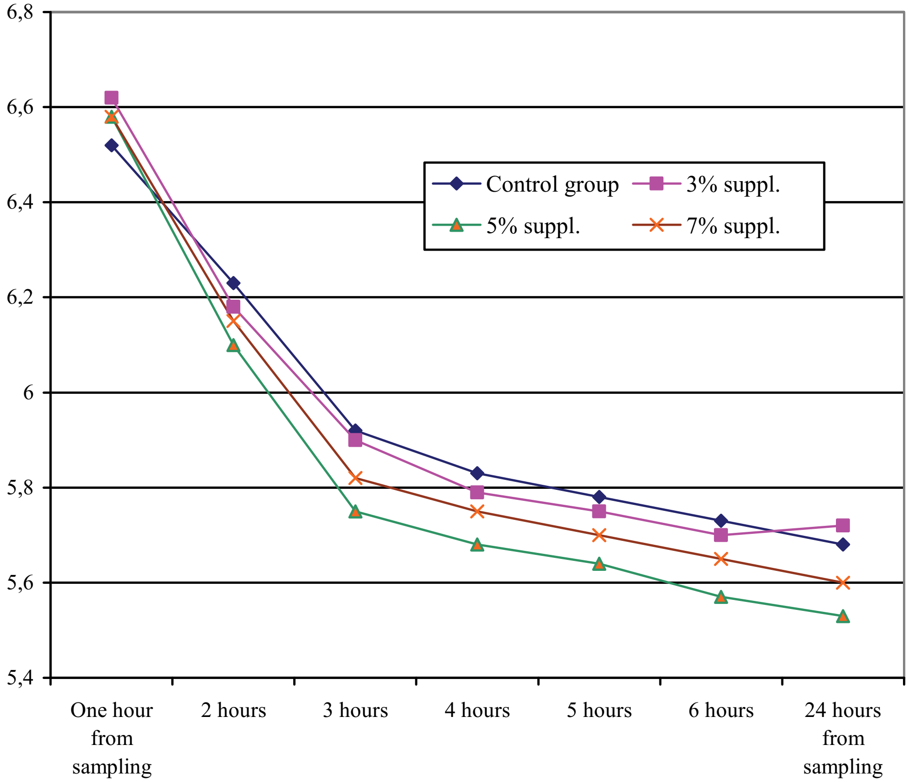


The mineral salts in the control group amounted to a value of 1.27% while the experimental values were as follows: 1.22% in 3% fat supplemented group, 1.16% in the 5% supplemented group and 1.1% in the group of 7% fat supplemented rabbits.

The final *p*H values of muscle have a relatively increase along the period of monitoring (0 – 24 hours), proportionally to the concentration of fat (fig. 2).

The scientific data present a number of factors that can influence the pH of the meat. In an experiment conducted by Dalle Zotte (2008) consisting of the effect of different factors (nutritional, age, breed, etc.) on meat rabbit *p*H, authors found that age determines the most important and significant influence. The authors confirm that muscle glycolytic metabolism (anaerobic glycolysis) increases with age and has important effects on the evolution of post mortem *p*H. The second factor of variability was given to the mother rabbit food. Some significant differences in *Latissimus dorsi* muscle *p*H were observed between the different groups of rabbits noting the significant differences in terms of glycogen stores. These effects were attributed to maternal physiological state [Dalle Zotte, 2008].

Fig. 2. The values of the skeletal muskle tissue pH in rabbits fed by different levels of sunflower oil enriched diets vs. a control rabbit group fed by a standard diet



Maertens *et al*. (2008) showed that the fatty acid profile of the skeletal muscle tissue from rabbits can be easily adjusted by the fatty acid profile of the feed and the use of sunflower oil (12.8%) leads to a similar content of ω-3 and ω-6. Administration of such a diet for a period of just two weeks before slaughter leads to a level of ω-3 already twice higher than that of a control group (Maertens *et al*., 2008).

Histological analysis reveals an increase of the percentage of slow oxidative to fast oxidative (glycolytic) cells in the analyzed tissue. It is also constantly found an increase of the connective tissue and the appearance of small aggregates of fat cells among the muscle cells. Scientific data mention the effects of vegetable fat enriched diet feeding on the appearance and composition, color and flavor of the meat rabbit muscle (Ouhayoun *et al*., 1987, Oliver *et al*., 1997), some of which being analyzed in this paper.

The results of Dalle Zotte *et al*. (2008) show that food restriction reduces the proportion of oxidative fibers of rabbit skeletal striated muscle tissue, which later (after slaughter of adult rabbits) influence the composition and organoleptic qualities of the meat. Other studies of the effects of various nutritional factors on the structure of meat were made by Solomon *et al*., (1988) on pig and Seideman and Crouse (1986, cited by Dalle Zott, 2008) on lamb. These authors showed that the muscle tissue shows significant changes under the action of nutritional factors (composition, structure of the food, feeding levels) and under the influence of other factors (age, for example). One of the influences is to improve the oxidative proportion of fast fibers, which has been linked to the increased of aerobic metabolism.

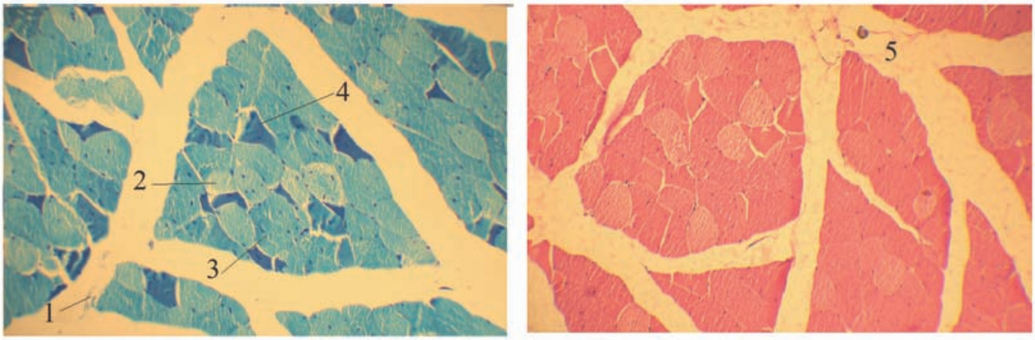


Fig. 3. Histological features of the *Biceps femoris* muscle from rabbits fed by fat enriched forages. 1 – conective tissue; 2 – slow oxidative fiber; 3 – intermadiate fiber; 4- fast oxidative fiber; 5 – fat cells

CONCLUSION

Feeding the rabbits by vegetal fat enriched diets led to specific modifications of the striated skeletal muscle composition and structure, respectively, increase of fat content and decrease of protein, water and ash contents, accordingly to the diet fat percent level. Histological changes of the skeletal muscle are dominated by changing the ratio of different types of muscle fibers as well as the appearance of cells of the adipocyte type through the muscle fiber bundles.

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