Tissue Composition and Muscularity of Lamb Legs Fed with Sunflower Seeds and Vitamin E

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***Abstract*—**The purpose of this study was to evaluate the tissue composition and carcass muscularity of 32 legs of Ile de France lambs fed with diets containing sunflower seeds and vitamin E, with mean body weight of 15 kg, lodged in individual pens at 15 kg and slaughtered at 32 kg of body weight. The treatments influenced (P<0,05) leg weight, femur length and muscle:bone ratio, being the highest values (2,13 kg, 16,19 cm and 7,38, respectively) in lambs that received diet without sunflower seeds and vitamin E. The other variables were not affected (P>0,05) by the treatments. The interaction of the sunflower and vitamin E was positive for bone total weights and intermuscular fat.

***Keywords*—**sheep, conformation, feedlot, nutrition, sugar-cane

I. Introduction

DESPITE the consumption of mutton is still considered low compared to the meat of other species, the perspectives of sheep breeding in Brazil appear to be favorable. The per capita consumption of sheep meat is estimated in 0,6 kg / inhabitant / year, however in the major metropolitan centers this value may reach 1,5 kg / inhabitant / year.Due to its high growth rate, lamb is the category that presents the highest production efficiency, resulting in higher yields of carcass and meat quality [1]. His production is usually associated with feedlot, a practice that lets explore the biggest gain potential of the animal in the juvenile phase. However, the end of feedlot lambs may be an economically unviable practice, due to the expenses on food, which can represent about 70% of the total production cost [2]. In this context, it is encouraged the use of cheaper food, and of easy availability to form the animal diet, enabling the production system.To be efficient in this increasingly competitive market, it is necessary that the lamb has desirable quality parameters, both quantitative and qualitative [3]. Thus, the use of methods to assess the carcass and that allowed predicting its quality and muscle, bone and fat composition is essential. Evaluation of quantitative traits in vivo and of the carcass can jointly predict the yield and composition of the commercial cuts.

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The most accurate method to determine the composition of the carcass is the dissection, which is the separation of muscles, bones, fat and other components. However, the dissection of the whole carcass or half carcass is justified only in special cases, to be slow, laborious and costly being the most common the dissection of the main commercial cuts. The most used are the palette and / or the leg, having a high correlation coefficient with the overall composition of the carcass, together constituting over 50% of the lamb carcass [4] - [5]. Preferably the dissection is performed in the leg by finding in it the biggest accumulation of muscle mass [6], being their tissue composition of great importance for evaluating the carcass quality [7].

The proportion of muscle in the carcass can also be estimated by the leg muscularity index, which considers the average depth of one group of muscles surrounding the femur in relation to the length of this bone [8]. The leg muscularity index represents the muscle:bone ratio, being as bigger as the amount of meat in the carcass. However, [8] it was showed that the muscle:bone ratio is an objective measure often associated with increased deposition of muscle mass, but often, this high ratio, may be the reflex of lighter bones and not necessarily heavier muscles. Hence the importance of considering the parameters separately muscle: bone ratio and muscularity index.

The aim of this work was to determine the tissue composition, the muscularity index and the muscle: bone ratio from the leg of Ile de France lambs fed with sunflower seeds and vitamin E.

II. Material and Methods

The experiment was conducted at the Faculdade de Ciências Agrárias e Veterinárias - FCAV / Unesp, Jaboticabal, São Paulo. It was used 32 lambs Ile de France, intact male, weanling with 15kg of body weight lodged in individual pens of approximately 1,0 m2 with slatted and suspended floor, equipped with individual feeders and water fountains installed in covered sheds. The animals were divided into four treatments according to the following diets: D1 – sugar-cane + concentrate without sunflower seeds; D2 – sugar-cane + concentrate with sunflower seeds; D3 – sugar-cane + concentrate without sunflower seeds and 1000 mg of E vitamin / kg of dry matter (DM) of the diet; D4 – sugar-cane + concentrate with sunflower seeds and 1000 mg of E vitamin / kg of dry matter. It was used sugar-cane from the forage variety IAC 86-2480, chopped and fresh. The concentrate consisted of ground corn, soybean bran, urea, sodium chloride, calcium carbonate, dicalcium phosphate and vitamin

and mineral supplements, making isoproteic (19% GW) and isoenergetic diets (2.6 Mcal of metabolizable energy / kg of DM), according to [9]. The diet with roughage: concentrate ratio of 50:50, was offered freely at 8:00 and 17:00 o'clock, allowing 10% of leavings.

When it was reached 32 kg of body weight, the lambs were weighed and fasted of a solid diet for 16 hours, being numbed by electronarcosis and then slaughtered by electro-section of the jugular veins and carotid arteries. After evisceration, the carcasses were weighed and transferred to cold storage at 6ºC for 24 hours, hanging by the gastrocnemius tendons. After weighing, the carcasses were split longitudinally and sectioned into five anatomic regions: neck, shoulder, ribs, loin and leg, according to the methodology adapted from [10]. With the acquisition of the commercial cuts the left legs were identified, stored in plastic bags and frozen at -18°C to facilitate the subsequent activities of dissection. The defrosting of the leg was held in the refrigerator at 10ºC for 24 hours for subsequent individual weighing.

Before the dissection, it was withdrawn from the legs all the extra tissue, the associated fat, the channels of fat, other soft tissues medial to the pelvic bone and the caudal vertebrae, except for the first two. The distal end of the tibia bone were removed, leaving the gastrocnemius tendon loose, and then it was realized the toilet above the sacral vertebrae, removing the fold of the flank muscles, the fat in the pelvic canal and the tarsometatarsal joint [11].

The clean legs were weighted and the dissection started with the help of a scalpel and a knife to determine the composition of tissues: subcutaneous fat (external fat located directly beneath the skin), intermuscular fat (fat beneath the deep fascia, associated with muscles), muscles (total muscle dissected after the complete removal of all attached subcutaneous and intermuscular fat) and bones (total of bones dissected after the complete removal of all muscles and attached intermuscular and subcutaneous fat), which were weighed individually to be expressed in percentage and in relation of the weight of the leg, as cited by [12]. The five muscles lining the femur, Biceps femoris Semitendinosus, Adductor, Semimembranosus and Quadriceps femoris were removed and weighed separately to determine the muscularity index of the leg. The others that not directly involved the femur were removed and weighed together to determine the percentage of total muscle. The bones were weighed together and then the femur was weighed individually, and its length measured with the aid of tape-measure, after being put in a compartment of attachment, allowing the measure to be made in its entire length, from the great caudal part of the trochanter to the femoral trochlea. The methodology used for dissection of the legs was proposed by [13]. The muscularity index of the leg was calculated according to [8]:

$$IM = \sqrt{\frac{PM5/CF}{CF}}$$

Being IM = muscularity index; PM5 = weight (g) of the five muscles lining the femur (Biceps femoris, Semitendinosus, Adductor, Semimembranosus and Quadriceps femoris) and CF = length (cm) of the femur.

The experiment was a completely randomized design with factorial arrangement of 2 x 2 (2 diets (inclusion or not of sunflower seeds) and 2 levels of vitamin E (0 and 1000 mg of vit. E / kg of DM diet)). Data were subjected to analysis of variance and the means compared by Tukey test at 5% significance, using the Computational Program [14] to perform the statistical analysis.

III. Results and Discussion

The composition of the tissue, the muscle: bone ratio and the muscularity index of the legs of Ile de France lambs fed with sunflower seeds and vitamin E are shown in Table I. The variables total muscle, muscle weight, total and subcutaneous fat, femoral weight and muscularity index did not differ (P>0,05) among treatments, and also no interaction sunflower seeds and the vitamin E for the same variables. However, for the weight of the leg, the femur length and muscle:bone ratio there was difference (P<0,05) among the treatment and interaction sunflower seeds and vitamin E for total bone and intermuscular fat.

The weight of the leg, femur length and muscle: bone ratio differed (P <0,05) among treatments with and without vitamin E, being the highest values (2,13 kg, 16,19 cm and 7,38 kg , respectively) in lambs fed in diets without vitamin E, regardless of the inclusion of sunflower seeds. [15] evaluating the leg tissue composition of crossbred lambs ¾ Ile de France, ¼ Ideal, slaughtered at 32 kg of body weight, subjected of two feed systems formulation, reported 2,16 kg for leg weight and 16.35 cm for femur length, similar to the results of this study, although the muscle: bone ratio obtained by the same authors was lower (4,19).

The leg muscularity index of 0,47 was similar to that obtained by [16], evaluating Ile de France lambs slaughtered at 32 kg of body weight, fed with corn silage or sugar- cane in two concentrate levels and also the index of 0,49 reported by [17] when working with Suffolk lambs ending in feedlot receiving corn silage and concentrate *ad libitum* and slaughtered at 32 kg of body weight. However, it was higher than the value of 0,34 reported by [18], when studying Santa Ines lambs receiving levels of inclusion of silk- flower hay in the diet, slaughtered when they reached 32 kg of body weight or 70 days of experiment. This superiority can be attributed to greater aptitude for meat production of the Ile de France race used in this work. In lamb carcasses from mating with Romney females with Romney, East Friesian x (Finn x Texel) and Finn x Poll Dorset males, slaughtered at 150 days, [10] it was obtained muscularity index of 0,46, similar to that found in this study .

According to [19], the muscles have grown fast in young animals; the fat content is higher in adult animals, with the

bones having a lower growth rate compared to other parts of the carcass and cuts.

In the interaction, the total bone value (0,40 kg) was higher in treatment without the inclusion of sunflower seeds and vitamin E, according to data contained in Table II. Evaluating the leg tissue composition of Suffolk lambs fed with different energy levels in *creep-feeding*, slaughtered with the mean body weight of 31 kg, [20] reported 0,46 kg, a higher value than this study, and it should be considered that the authors used larger sheep, represented by Suffolk race.

The intermuscular fat was higher (0,10 kg) when it was used sunflower seeds without vitamin E, and lower (0,07 kg) in the diet without sunflower seeds and without vitamin E (Table III). Evaluating the qualitative parameters of the carcass and the meat of crossbred lamb ¾ Ile de France ¼ Ideal, slaughtered at
32 kg of body weight, subjected to two systems of feed formulation, [15] found a similar value.

TABLE III
DEPLOYMENT OF THE INTERACTION OF SUNFLOWER SEEDS AND VITAMIN E FOR THE VARIABLE TOTAL INTERMUSCULAR FAT OF LAMB LEG

Variable	Without sunflower seeds	With sunflower seeds	P
Without vitamin E	0,07aB	0,10aA	0,0129*
With vitamin E	0,09aA	0,08aA	0,2358
P	0,0610	0,0610	

a,b Means followed by different letters in the column, differ by Tukey test (P <0.05). The Means followed by different letters in the line differ by Tukey test (P<0,05).

IV. CONCLUSION

There was little effect of the inclusion of sunflower seeds and vitamin E in the diet in leg muscularity of lambs, although the tissue composition has been benefited by edible ingredients.

TABLE I
TISSUE COMPOSITION AND MUSCULARITY INDEX OF LAMB LEGS RECEIVING DIETS WITH SUNFLOWER SEEDS AND VITAMIN E

Variable	Vitamin E		Sunflower Seeds		Interaction	CV(%)
	Without	With	Without	With		
Weight of the leg (kg)	2,13a	1,98b	2,08	2,03	0,0951	6,83
Total muscle (kg)	1,51	1,43	1,47	1,46	0,4074	7,06
Leg muscle:						
Weight of five muscles (kg)	0,89	0,87	0,89	0,87	0,4693	6,52
Biceps femoris (kg)	0,21	0,21	0,22	0,20	0,9596	10,33
Semitendinosus (kg)	0,08	0,08	0,08	0,08	0,5023	13,78
Semimembranosus (kg)	0,20	0,19	0,20	0,19	0,6243	7,82
Adductor (kg)	0,09	0,08	0,08	0,09	0,5987	9,36
Quadríceps femoris (kg)	0,29	0,29	0,29	0,29	0,1124	6,50
Total fat (kg)	0,21	0,22	0,22	0,21	0,0755	12,73
Subcutaneous fat (kg)	0,13	0,13	0,14	0,12	0,6485	20,24
Intermuscular fat (kg)	0,08	0,08	0,08	0,09	0,0116*	16,32
Total bone (kg)	0,38	0,37	0,37	0,37	0,0214*	11,11
Weight of the femur (kg)	0,12	0,13	0,12	0,13	0,1439	8,15
Length of the femur (cm)	16,19a	15,82b	16,13	15,88	0,3384	1,84
Others (kg)	0,05	0,07	0,05	0,07	0,7276	49,15
muscle:bone ratio	7,38a	6,76b	7,27	6,86	0,3755	6,98
Muscularity index	0,46	0,47	0,46	0,47	0,8370	4,62

a,b Means followed by different letters in the line differ by Tukey test, * Significant at 5% probability, CV = coefficient of variation; = Other nerves, tissue and chips.

TABLE II
DEPLOYMENT OF THE INTERACTION OF SUNFLOWER SEEDS AND VITAMIN E FOR THE VARIABLE TOTAL BONE OF LAMB LEG

Variable	Without sunflower seeds	With sunflower seeds	P
Without vitamin E	0,40aA	0,36aA	0,1445
With vitamin E	0,34bA	0,39aA	0,0549
P	0,0440*	0,1750	

a,b Means followed by different letters in the column, differ by Tukey test (P <0.05). The Means followed by different letters in the line differ by Tukey test (P<0,05).

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