PHYSICAL, CHEMICAL AND HISTOLOGICAL CHARACREISTICS OF RAHMANI AND OSSIMI LAMBS WITH PARTICULAR REFERENCE TO *Longissimus dorsi* AND *Biceps femoris* MUSCLES

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SUMMARY

Eight male lambs each of Egyptian Rahmani and Ossimi breeds were used to study the effect of breed and age at slaughter on the chemical characteristics of meat in relation to histological traits. Lambs were weaned at four months of age and fed according to their weight on concentrate feed mixture and Egyptian clover or its hay. Four lambs per breed were slaughtered at 9 and 12 months of age. Longissimus dorsi (L. dorsi) at the 9th, 10th and 11th ribs (rib cut) and the Biceps femoris (B. femoris) muscles were separated from the right half of the carcass for chemical analysis and histological study. Samples of these muscles were divided into two parts, these for chemical analysis were dried off, while those for histological study were fixed in 10 % formol saline. Histological characteristics considered were number and diameter of muscle fibers, bundle and stroma section area and bundle: stroma. Physical (area of L. dorsi and proportion of lean, bone and fat), and chemical characteristics (moisture, ether extract, protein and ash) were measured in the rib cut.

Breed had no effect on area of L. dorsi and slaughter weight. Physical components of rib cut showed that fat percentage was lower (P<0.01) in Rahmani than in Ossimi by 5.9 % with no significant difference between the two breeds in the percentage of lean, bone and boneless meat. Meat chemical analysis indicated that moisture percentage was higher (P<0.01) and fat percentage lower (P<0.0001) in Rahmani than in Ossimi, while no difference in ash and protein percentages was recorded. Except number of fibers which was higher (P<0.05) in Ossimi than in Rahmani, no difference was found in all histological traits between the two breeds.

Slaughter weight was higher (46 kg) at age of 12 months over that at 9 months (31.4 kg). Area of L. dorsi, ash and protein contents as well as histological traits increased slightly, while moisture decreased (P<0.0006) and fat increased (P<0.0001) as age progressed.

L. dorsi had higher (P<0.0001) percentages of ash, fat, and protein but lower moisture (P<0.0001) than B. femoris. Type of muscle indicated that B. femoris was higher (P<0.0001) in the number & diameter of fibers, bundle and stroma areas compared to L. dorsi.

In conclusion, Rahmani lambs had significantly lower intra-muscular fat percentage compared to Ossimi. Similar trend was observed in the carcass of lambs slaughtered at 9 compared to 12 months of age.

Keywords: Sheep, Rahmani, Ossimi, carcass characteristics, chemical composition, muscle fibers

INTRODUCTION

Nutritive quality of meat depends mainly on the chemical composition (high protein and low fat contents), which are related to a great extent to age at slaughter (Swidan *et al.*, 1979; Hassan and El-Feel, 1991 and Amal El-Asheeri *et al.*, 2006). Slaughter of native sheep often takes place around 12 months of age which is close to age at puberty (Karam, 1957 and Hamdon *et al.*, 2006), to realize higher dressing percentage compared to younger age (Hassan and El-Feel, 1991 and Amal El-Asheeri *et al.*, 2006). With adulthood a remarkable change in the proportions of fat, lean and bone in the carcass was reported with relative increase in fat (Lawrence and Fowler, 1998). This is attributed to the changes in the balance of growth and sex hormones (Lawrence and Fowler, 1998) in addition to Insulin-like growth factor-I (Amal El-Asheeri *et al.*, 2006) that control muscles development (Oksbjerg *et al.*, 2004).

Several studies were conducted to describe growth features and chemical composition of meat of Ossimi and Rahmani lambs, based on the analysis of rib cut as an indicator of the physical characteristics of carcass (Darwish *et al.*, 1973; Hassan and El-Feel, 1991; Hassan, 1993; Awadalla *et al.*, 1997 and Amal El-Asheeri *et al.*, 2006).

No data are available to discuss the characteristics of Rahmani and Ossimi lambs based on the chemical composition and the histological traits which was the aim of the present study.

MATERIALS AND METHODS

Animals and Management

This study was carried out in the experimental farm of the Faculty of Agriculture, Cairo University on two equal groups of Rahmani and Ossimi male lambs (n = 8 each), which were born within two months (October and November). Lambs were allowed to suckle their dams for four months before weaning. Afterward they were kept loose in a semi-shaded open yard and fed according to their live body weight based on the NRC (1985) requirements. During winter and spring lambs were fed on concentrate feed mixture and the Egyptian clover (*Trifolium alexandrinum*) which was replaced by its hay during the rest of the year. Water was made available all the day- time. The average body weight at weaning of the lambs for the two breeds was 16.6±1.4 kg and 18.7±1.4 kg for Rahmani and Ossimi lambs with no significant difference between the two breeds.

Experimental Design and Procedure

At approximately 9 and 12 months, four lambs per breed were randomly slaughtered as described by Amal El- Asheeri *et al.* (2006). Carcasses were sectioned down through the vertebral column to right and left sides. *Longissimus dorsi* (*L. dorsi)* at the 9^{th}, 10^{th} and 11^{th} ribs (rib cut) and *Biceps femoris (B. femoris)* muscles were separated from the right side for chemical analysis (AOAC, 2000) and histological study. Area (cm^2) of the fresh sections of *L. dorsi* muscle between the 8^{th}

and 9th ribs was recorded by a planimeter before separating rib cut into its physical components (lean, fat and bone).

Samples were separated from the two studied muscles in each age and breed and fixed in 10 % formol saline in glass vials till the histological techniques took place. The histological sections were prepared after Bancroft *et al.* (1996) and stained by Haematoxylin and Eosin (5%) solutions. Slides were examined microscopically (X 100) and digitally photographed. Two digital photocopies were taken, the first of the tissue section in three replicates, and the second of the Haemocytometer. The dimension of each square in the Haemocytometer slide (0.2 x 0.2 mm) was used as a standard to measure the histological traits. Two layers of digital photos were used, the digital image of the muscle section as first layer and the second was a transparent digital image of the Haemocytometer slide area. All measures were made using Auto Cad® (2004) software.

Histological measurements included number of muscle fibers per bundle, fibers diameter (μm), bundle cross sectional area (mm^2), and bundle: stroma ratio measured according to Ashmore *et al.* (1974) using the following equations:

- Fiber diameter (μm) = Fiber diameter (μm) (1st layer) x 0.2 divided by the corresponding area (μm) (2nd layer)
- Bundle cross sectioned area (mm^2) = Bundle area (μm^2) x 0.04 divided by the corresponding area (μm^2) (2nd layer) multiplied by 10^{-6}

Statistical Analysis

Data of physical components of the rib cut and chemical composition were analyzed using the General Linear Model (GLM) procedure of SAS (SAS, 2000). The design was spilt plot with repeated measurements in time and space. Differences between means were assessed by *t* test. Data in percentages were transformed to the arcsine square-root to normalize variance before analysis, using the following models:

Model (1) for the chemical analysis and histological traits

$Y_{ijkl} = \mu + x_i + a_j + m_k + (xam)_{ijk} + e_{ijkl}$

where: Y_{ijkl} = experimental observation,

μ = overall mean,

x_i = effect of breed (i, 1= Rahmani, 2= Ossimi),

a_j = effect of age at slaughter (j, 1= 9 months , 2= 12 months),

m_k = effect of type of muscle (k, 1= *L. dorsi*, 2 = *B. femoris*)

$(xam)_{ijk}$ = interaction effects, between breed, age and muscle type, all interactions were insignificant.

e_{ijkl} = random error.

Model (2) for body weight was

$Y_{ijk} = \mu + x_i + a_j + (xa)_{ij} + e_{ijk}$

where:

Y_{ij} = Experimental observation,

μ = Overall mean,

x_i = Effect of breed (i, 1= Rahmani, 2= Ossimi),

a_j = Age at slaughter (j, 1= 9 months , 2= 12 months),

$(xa)_{ij}$ = Interaction effects,

e_{ijk} = Random error

RESULTS

1. Physical Components of Ribs Cut

Breed had no effect on slaughter weight. The average of body weight at slaughter of Rahmani and Ossimi was 40.8±2.4 and 36.6±2.4 kg, respectively. Slaughter lambs at 12 months of age increased (P<0.001) the slaughter weight by 14.6 kg, from 31.4±2.3 to 46.0 ± 2.6 kg.

Fat percentage was higher (P<0.01) in Ossimi than that in Rahmani, while the differences in bone, lean and boneless meat were nonsignificant between the two studied breeds (Table 1).

Lean percentage was higher (P<0.002) and fat was lower (P<0.0001) at 9 months than 12 months old. This leads to an increase (P<0.002) in boneless meat by 6.6% at 12 months of age (Table 1). Age progress increased area of *L. dorsi* by 11.6%.

The obtained lean % and fat % at 9 months of age are less than those reported by Swidan *et al.* (1979) (66.5 and 9.4 %, respectively at 8 months) in Rahmani lambs. Meanwhile, the present percentages at 12 months of age are less (55.7 %) in lean and higher in fat than that reported by Awadalla *et al.* (1997) on Rahmani lambs, at 11 months of age. The obtained values of bone at 9 and 12 months of age are relatively higher than those reported at 8 months by Swidan *et al.* (1979) (20.8 %) in Rahmani and at 11 months of age (20.0 %) reported by Awadalla *et al.* (1997) in the same breed.

Table 1. Mean ± S.E for body weight and physical components of the 9th, 10th and 11th ribs (ribs cut) and area of *L. dorsi* as affected by breed and age at slaughter (n= 8 per breed and age)

Traits	Breed		P	Age (month)		P
	Rahmani	Ossimi	Value	9	12	Value
Slaughter weight (kg)	40.8 ±2.4	36.6 ± 2.4	0.26	31.4 ± 2.3	46.0 ± 2.6	0.001
Rib cut (g)	372.5±28.6	288.9±28.6	0.06	252.3±26.5	409.1 ± 30.6	0.003
Lean %	57.1± 1.3	53.9 ± 1.3	0.12	59.2 ± 1.2	51.7 ± 1.4	0.002
Fat %	11.5 ± 1.3	17.4 ± 1.3	0.01	7.4 ± 1.2	21.5 ± 1.3	0.0001
Bone %	31. 4 ± 1.2	28. 8 ± 1.2	0.14	33.4 ± 1.1	26.8 ± 1.2	0.002
Boneless meat (%)	68.6 ± 1.2	71.2 ± 1.2	0.14	66.6 ± 1.1	73.2 ± 1.2	0.002
L. dorsi area (cm^2)	19.1± 1.5	17.5 ± 1.5	0.44	17.3 ± 1.4	19.3 ± 1.6	0.34

2. Meat Chemical Composition

Protein and ash contents of meat samples obtained from rib cut were not influenced by breed. However, Ossimi had higher fat (P<0.0001) and lower (P<0.01) moisture percentages (Table 2) by 0.9 and 0.5 %, respectively compared to Rahmani.

Lambs slaughtered at 12 months of age had lower percentage of moisture (P<0.0006) and higher percentage of fat (P<0.0001) than that of 9 months of age. Meanwhile, nonsignificant difference in ash and protein contents was found (Table 2).

Table 2. Mean ± S.E for chemical composition (%) of lamb as affected by breed, age and type of muscle based on the fresh matter (n= 8 per breed, per age and per type of muscle)

Effect	Moisture	Protein	Fat	Ash
Breed				
Rahmani	75.7 ± 0.2	18.7 ± 0.1	3.3 ± 0.1	1.1 ± 0.0
Ossimi	75.2 ± 0.2	18.9 ± 0.1	4.2 ± 0.1	1.1 ± 0.0
P value	0.01	0.25	0.0001	
Age (months)				
9	75.8 ± 0.1	18.9 ± 0.1	3.3 ± 0.1	1.1 ± 0.0
12	75.1 ± 0.2	18.6 ± 0.1	4.2 ± 0.1	1.1 ± 0.0
P value	0.0006	0.11	0.0001	
Type of muscle				
L. dorsi	74.5 ± 0.1	19.4 ± 0.1	5.1 ± 0.1	1.1 ± 0.0
B. femoris	78.9 ± 0.1	18.2 ± 0.1	2.5 ± 0.1	1.0 ± 0.0
P value	0.0001	0.0001	0.0001	0.0001

L. dorsi contained higher percentages of protein (P<0.0001), fat (P<0.0001) and ash (P<0.0001) compared to *B. femoris* muscle, while moisture was less (P<0.0001) by + 1.2, +2.6 +0.1 and - 4.4 %, respectively in B. *femoris*. The high content of fat in *L. dorsi* is most probably due to the high content in intramuscular fat.

The obtained value of protein percentage in the samples of *L. dorsi* muscle at 9 months of age is within the values reported in Ossimi and Rahmani lambs at 8-9 months of age (18.5-21.3 %) by Darwish *et al.* (1973) and Hassan and El-Feel (1991). The obtained value at 12 months of age (18.6 %) is close to that reported by Awadalla *et al.* (1997) (19.7 %) at 11 months of age by 1.1 %.

The values of ash content either at 9 or 12 months of age are within the values of previous reports (Darwish *et al.*, 1973 and Awadalla *et al.*, 1997) (0.8-1.3 %) in Rahmani and Ossimi at ages of 7 - 11 months.

The obtained result of ether extract (3.3 %) at 9 months of age is higher than that reported on Barki lambs (2.75 %) by Sami and Shehata (2006) at 8 months of age.

The moisture percentages at 9 and 12 months of age are relatively higher than that reported for Ossimi (56.5 - 59.9 %, Hassan and El- Feel, 1991) and Rahmani (57.3 - 68.3 %, Darwish *et al.*, 1973 and Awadalla *et al.*, 1997) lambs between 10 and 12 months of age.

3. Histological Traits

The lean incorporates several skeletal muscles, each is composed, mainly, of muscle fibers. These fibers are gathered in adjacent bundles, the fascicles, (F, Plates 1 & 2) of different sizes. Each bundle is surrounded by connective tissue, the perimesium, (P, Plates 1 & 2). These connective tissue, septa , furnishes the stroma which connects the muscular tissue in compact structure. Plates (1 & 2) show cross sections in lean of *L. dorsi* and *B. femoris* of Rahmani and Ossimi lambs at 9 and 12 months of age. *L. dorsi* has thinner fibers, with no distinct breed differences, which is in accordance with Table 3.

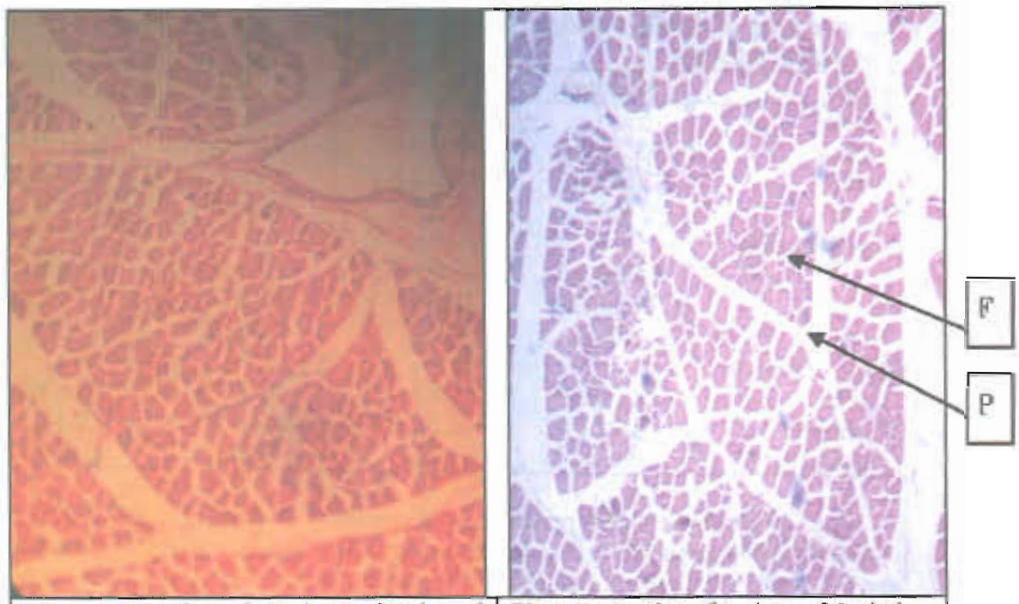

Plate 1a: Section of *L. dorsi* of Rahmani lambs slaughtered at 9 mo old (X 100)

Plate 1b: Section of *L. dorsi* of Ossimi lambs slaughtered at 9 mo old (X 100)

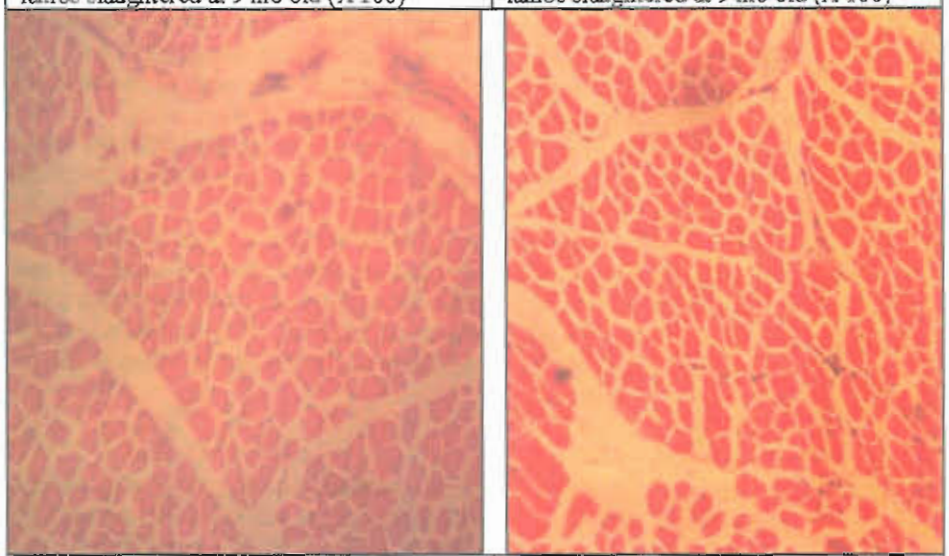

Plate 2 a: Section of *B. femoris* of Rahmani lambs slaughtered at 9 mo old (X 100)

Plate 2 b: Section of *B. femoris* of Ossimi lambs slaughtered at 9 mo old (X 100)

Number of fibers per bundle is higher (P<0.05) in Ossimi than in Rahmani lambs. Meanwhile, fiber diameter (μ m), bundle area, stroma area and bundle: stroma area (mm^2) are similar in the two breeds (Table 3).

Age at slaughter has no effect on the all studied histological traits (Table 3). The greatest change, however insignificant, was that in fiber diameter and bundle: stroma ratio (13 and 11 %, respectively). This trend of change indicates more build up of fibers than stroma area due to the increase in fiber diameter.

Type of muscle showed differences (P< 0.0001) in all studied histological traits. *L. dorsi* muscle was less in number and diameter of fibers, bundle and stroma sectional areas and the ratio of bundle: stroma compared to *B. femoris* muscle (Table 3). The percentage of increase in *B. femoris* reached 38.2, 78.8 and 53.2 for number of fibers/ bundle, fiber diameter and bundle cross sectional area, respectively (Plates 1 & 2 and Table 3).

Table 3. Mean±S.E Histological parameters of lamb muscles as affected by breed, age at slaughter and type of muscle

Effect	No of fibers/ bundle	Fiber diameter (μ m)	Bundle area m m^2	Stroma area m m^2	Bundle: Stroma area
Breed					
Rahmani	63.6±1.4	75.3±2.2	0.188±.80	0.023±.04	8.2 :1
Ossimi	67.5±1.3	78.2±2.2	0.191±.79	0.024±.04	8.0 :1
P value	0.05	0.35	0.81	0.73	0.23
Age (month)					
9	65.4±1.3	75.4±2.0	0.189±.74	0.024±.03	7.9 :1
12	65.6±1.5	78.1±2.3	0.191±.85	0.023±.04	8.3 :1
P value	0.91	0.38	0.85	0.47	0.21
Type of muscle					
L. dorsi	55.0±1.4	55.1±2.2	0.171±.80	0.021±.04	8.0 :1
B. femoris	76.0±1.4	98.5±2.2	0.262±.80	0.026±.04	10 :1
P value	0.0001	0.0001	0.0001	0.0001	0.0001

DISCUSSION

The heavier slaughter weight, in addition to the increase in *L. dorsi* area, the higher percentage of lean and lower percentage of fat in Rahmani lambs compared to Ossimi (Tables 1 and 2) may give this breed an advantage in sheep production systems. The increase in fiber diameter in Ossimi than in Rahmani (Table 3) may be due to the accumulation of protein (Carpenter *et al.*,1996). This suggestion is supported by the increase in protein content in Ossimi breed (Table 2) however, nonsignificant.

The decrease (P<0.002) in lean and the increase (P<0.0001) in fat percentages out of the physical components of lambs slaughtered at 12 months of age relative to that slaughtered at 9 months (Table 2), may draw the attention for the nutritive quality of the 9 months old lambs from the consumers' health point of view (Table 2).

The comparison between *L. dorsi* and *B. femoris* muscles indicated the higher nutritive quality of *L. dorsi*. This is showed by the chemical characteristics of *L. dorsi*

than *B. femoris*, low moisture and higher (P<0.0001) contents of protein and fat (Table 2). Histological study supports this suggestion as the former had thinner fiber diameter, lower stroma area and bundle: stroma ratio (Table 3). This conclusion comes in agreement with the findings of Carpenter *et al.* (1996) and Tschirhart, Tara (2003), who reported that lamb muscles histology is closely related to the physical and chemical characteristics of these muscles. Up to the knowledge of the authors no data are available to discuses the histological traits with the organoliptic criteria.

The increase in fiber diameter and bundle area with age progress (Table 3) may be attributed to the increase in Insulin-Like Growth Factor I (IGF-I) around the period between 9 and 12 months of age (Amal El-Asheeri *et al.*, 2006). IGF-I is involved in postnatal growth (McGuire *et al.*, 1992), through mediating the anabolic actions of growth hormone (Jones & Clemmons, 1995 and Liu & LeRoith, 1999). Also, IGF-I acts on muscle hypertrophy (Beermann *et al.*, 1987 and Mathison *et al.*, 1998) and stimulates muscle cells uptake of amino acids, and protein synthesis (Shimizu *et al.*, 1986).

In conclusion, Rahmani lambs had significantly lower intra-muscular fat percentage compared to Ossimi. Similar trend was observed in lambs slaughtered at 9 compared to 12 months of age.

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الخصائص الطبيعية والكيميائية والهستولوجية للعضلة العينية وعضلة الفخذ في حملان الرحماني والأوسيمي

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1- قسم الإنتاج الحيواني – كلية الزراعة – جامعة القاهرة – الجيزة – ج.م.ع. ، 2- أكاديمية البحث العلمي والتكنولوجيا – شارع قصر العيني – القاهرة – ج.م.ع

استخدم في هذه الدراسة ثمانية حملان حديثة الولادة من أنواع الأوسيمي والرحماني لدراسة تأثير النوع والعمر عند الولادة علي التركيب الكيميائي للحوم وعلاقتها بالخصائص الهستولوجية لعضلات الجسم. تم فطام الحملان عند عمر أربعة أشهر وغذيت طبقا للوزن علي مخلوط من العلف المركز إلي جانب البرسيم أو دريس البرسيم. تم اختيار أربعة حملان عشوائيا من كل نوع للذبح عند عمر 9 أشهر ومثلهم للذبح عند عمر 12 شهر. تم فصل العضلة العينية (عند الضلوع من التاسع حتي الحادي عشر) وعضلة الفخذ من الجانب الأيمن للذبيحة لإستخدامهم في التقديرات الكيميائية للحوم ولدراسة الخصائص الهستولوجية للعضلات. تم تقسيم العينات المأخوذة من العضلات إلي جزئين ، الأول تم تجفيفه لإجراء التقديرات الكيميائية (الرطوبة – البروتين – الدهون – الرماد) ، والثاني تم تثبيته في محلول فورموسالين 10% لإجراء الدراسة الهستولوجية (عدد وقطر الألياف العضلية – مساحة الحزم العضلية والنسيج الأساسي و النسبة بينهم). تم تقدير مساحة العضلة العينية كما تم فصلها لمكوناتها الأساسية (عظام – عضلات – دهون).

أوضحت النتائج أن النوع ليس له تأثير علي كل من مساحة العضلة العينية ووزن الذبيحة. بينما أوضح تحليل العضلة العينية إلي مكوناتها الأساسية إلي أن حملان الرحماني كانت أقل ($P<0.01$) في نسبة الدهن من حملان الأوسيمي بنسبة 5.9 % دون وجود أي فروق معنوية في نسب اللحم الأحمر والعظام واللحم الخالي من العظم. أوضح التحليل الكيميائي للحم أن نسبة الرطوبة كانت أعلي ($P<0.01$) والدهون كانت أقل ($P<0.0001$) في حملان الرحماني عنها في الأوسيمي ، بينما لم يكن هناك أي فرق في نسب البروتين والرماد بين النوعين. فيما عدا عدد الألياف العضلية التي كانت أعلي ($P<0.05$) في الأوسيمي عنه في الرحماني ، لم يكن هناك فروق معنوية في الصفات الهستولوجية الأخري تحت الدراسة.

كان وزن الذبح أعلي عند عمر 12 شهر (46 كجم) مقارنة بعمر الذبح عند 9 أشهر (31.4 كجم). زادت المساحة العضلية ونسبة البروتين والرماد والقيم المقاسة هستولوجياً بنسب بسيطة مع تقدم العمر ، بينما انخفضت الرطوبة ($P<0.0006$) وارتفعت نسبة الدهن ($P<0.0001$) مع تقدم العمر.

احتوت العضلة العينية علي نسب أعلي ($P<0.0001$) من الرماد والدهن والبروتين ونسبة أقل من الرطوبة عن عضلة الفخذ. بينما ارتفع ($P<0.0001$) عدد الألياف العضلية وقطر الألياف العضلية في عضلة الفخذ مقارنة بالعضلة العينية.