Lamb carcass composition

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review paper

Summary

Total value of sheep (lamb) carcass along with carcass weight depends as well on weight of individual carcass parts and their composition, i.e. the shares of muscle, fatty and bone tissue. In the goal of determining tissue composition of lamb carcass, different destructive and nondestructive methods are used. Many factors which influence carcass characteristics can affect significantly its composition too. Among the factors which influence the composition of lamb carcass, the most expressed one is genotype (breed), then sex, manner of feeding, body weight at slaughter and individual carcass parts. Except for the listed factors which influence the carcass composition, there should certainly be taken into account methods used to determine carcass composition. Regarding the significance of lamb carcass composition and the fact that dissection is still not more significantly represented in Croatian sheep breeding, forces should be joined to work on defining the most acceptable methods to be used in that area.

Keywords: *factors, lamb, tissues, carcass*

Introduction

Consumption and quality of food (meat/meat products) is determined firstly by specific consumer demands which are predetermined by tradition, customs and habits. Despite that fact, Ward et al. (1995) think that consume demands are generally directed toward meat of uniform quality, i.e., with the content of fat needed to achieve satisfactory juiciness and aroma. In the goal of responding to consumer demands, more and more attention is given to weight (shares) of individual parts of carcass and their tissues (Teixeira et al., 2006). In doing so, except for consumers and their demands one should keep in mind the producers too (yield, loss at slaughterhouse processing) and processors (processing characteristics of meat).

It can be said generally that the total value of sheep (lamb) carcass with slaughterhouse weight depends on the weight of individual carcass parts and their composition, that is, the shares of muscle, fatty and bone tissue (Farrell and Hopkins, 2007; Mioč et al., 2007; Oramari e al., 2014). Different destructive (dissection) and nondestructive methods (CT – computed tomography, NMR – nuclear magnetic resonance tomography, VIAscan – video image analysis and others) are used for that purpose. Destructive methods are based on separating individual parts from the carcass and determining their composition, while nondestructive methods are based on determining different measures and surfaces on the carcass and calculating the share of individual carcass parts and their composition to specially adjusted models.

Many factors which influence carcass characteristics can influence significantly its composition too. Pérez et al. (2002) and Mioč et al. (2007) emphasize genotype (breed), sex, feeding, body weight at slaughter and individual carcass part as the most prominent factors that influence the composition of lamb carcass. Considering the importance of lamb carcass, factors affecting its composition will be described in more detail in this paper.

Genotip (breed)

Many researches indicate that genotype (breed) has a significant influence to the share of individual carcass parts and their composition (Esenbuga et al., 2001; Macit et al., 2002; Miguélez et al., 2006; Pérez. et al., 2007; Peraza-Mercado et al., 2010). Macit et al. (2002) determined significant differences in shares of individual carcass parts of lambs of Awassi, Morkaraman and Tushin breeds. The highest share of loin was determined in Tushin lambs, and sirloin and ribs in Awassi lambs (Table 1). Miguélez et al. (2006) also determined significant differences in shares of individual carcass parts between the lambs of Churra, Castellana and Ojalada. The highest share of shoulder was determined in Churra lambs, breast in Castellana lambs and neck in Ojalada lambs. Except for that the authors also list significant differences in the composition of hind leg. So the highest share of muscle tissue in hind leg was determined in Castellana lambs, bone tissue in Churra lambs and fatty tissue in Ojalada lambs (Table 2). Pérez. et al., (2007) also determined significant differences in shares of individual carcass parts (Table 3) in lamb carcasses of Merino Precoz Aleman and Suffolk Down breeds. So in Merino Precoz Aleman a significantly higher share of shoulder was determined, whereas a higher share of neck was determined in Suffolk Down lambs. A significantly higher share of muscle tissue and residue was determined in shoulder of Merino Precoz Aleman lambs and a lower share of fatty tissue than the one determined in Suffolk Down lambs. As opposed to that, a significantly higher share of fatty tissue and a lower share of residue and losses were determined in hind leg of Suffolk Down lambs.

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Table 1
Proportions of carcass cuts of Awassi, Morkaraman and Tushin lambs (Macit et al., 2002)

Carcass cuts, %	Awassi	Morkaraman	Tushin
Neck	5,1	5,2	5,5
Shoulder	17,5	17,1	18,2
Foreshank + breast	15,3	15,7	15,1
Loin	15,3	13,8	16,7
Sirloin	6,6	5,3	5,5
Hind Leg	23,4	24,3	23,0
Ribs	8,7	7,9	7,1
Flank	3,6	3,9	3,9
Kidney	0,6	0,6	0,7

Table 2
Proportions of carcass cuts and tissue composition of hind leg of Churra, Castellana and Ojalada lambs (Miguélez et al., 2006)

Carcass cuts, %	Churra	Castellana	Ojalada
Hind leg	33,5	34,2	33,4
Loin	27,9	26,9	28,7
Shoulder	21,8	20,9	19,9
Neck	7,0	7,1	7,9
Breast	9,8	11,0	10,1
Hind leg, %			
Muscle	58,9	60,1	59,2
Bone	27,4	26,6	25,9
Intramucular + subcutaneous fat	10,5	10,1	11,6
Pelvic fat	2,2	2,2	2,3
Other	0,8	1,0	1,0

Table 3
Proportions of carcass cuts and tissue composition of shoulder and hind leg of Merino Precoz Aleman and Suffolk Down lambs according to breed, slaughter weight and sex (Pérez et al., 2007)

Carcass cuts and tissue composition of shoulder and hind leg, %	Breed		Slaughter weight, kg		Sex	
	Merino Precoz Aleman	Suffolk Down	10	15	Male	Female
Hind leg	37,71	37,27	36,95	36,26	36,74	36,48
Loin	15,00	15,70	18,05	16,52	17,00	17,51
Thorax	17,79	18,60	15,13	18,26	17,11	16,38
Shoulder	22,29	21,13	22,77	21,88	22,25	22,38
Neck	5,93	7,10	6,02	6,33	6,15	6,20
Tail	1,11	1,23	1,14	1,09	1,06	1,16
Shoulder, %						
Muscle	56,90	54,30	56,79	55,19	56,50	55,47
Bone	22,87	22,71	23,60	21,37	23,12	21,83
Fat	12,84	17,40	13,11	17,80	14,40	16,59
Other	3,68	2,25	3,34	2,76	3,04	3,03
Losses	3,16	2,61	3,01	2,61	2,49	3,07
Hind leg, %						
Muscle	57,62	55,78	57,76	56,82	57,31	57,27
Bone	22,98	23,74	24,28	22,28	23,56	22,96
Fat	11,82	16,62	12,07	15,67	13,62	14,21
Other	3,50	1,90	3,17	2,54	2,76	2,92
Losses	2,93	1,70	2,32	2,33	2,33	2,32

Sex

Many authors emphasize significantly different shares of individual carcass parts between male and female lambs. So Díaz et al. (2006) determined significant differences in individual carcass parts in carcasses of male and female lambs in lambs of Manchego breed slaughtered at 10, 12 and 14 kg of weight. In all three weight categories in carcasses of male lambs the authors determined significantly higher shares of neck, forelegs and front part of the ribs, while in carcasses of female lambs they determined significantly higher shares of loin with ribs. Kaić (2013) lists significant differences between individual parts in carcasses of male and female lambs in lambs of Lička pramenka breed slaughtered at average weight of 27.5 kg. In a carcass of male lambs of Lička pramenka there was determined a significantly higher share of breast with shanks, shoulder and hind leg and a significantly lower share of loin with ribs. In carcass of male lambs of crossbreeds Jezersko-solčava x Romanov with an average of 29.5 kg of weight at slaughter, Žgur et al. (2003) determined a significantly higher share of neck and forelegs, and in carcass of female lambs a significantly higher share of loin and sirloin. In carcass of male lambs of Segureña breed slaughtered at body weight between 19 and 25 kg, Peña et al. (2005) determined a significantly higher share of neck and forelegs than in carcass of female lambs, while in other parts of the carcass there were no statistically significant differences considering the sex of the lambs.

It is generally considered that a female lamb carcass has more fatty and less muscle and bone tissue than a male lamb carcass (Hammell and Laforest, 2000). In light lambs Ille de France and Gentile di Puglia breed, Barone et al. (2007) list significant differences in the composition of their carcass. In carcass of male lambs the authors determined a significantly higher share of muscle tissue in shoulder and bone tissue in hind leg, whereas in a female lamb carcass they determined a significantly higher share of fatty tissue in neck, breast, shoulder and hind leg. Díaz et al. (2006) determined significant differences in carcass composition between male and female suckling lambs of Manchego breed. Male lamb carcass had a significantly higher share of muscle tissue in neck, shoulder and flank, while a significantly higher share of fatty tissue in loin with ribs, flank and hind leg was determined in female lamb carcass. In male and female lambs of Lička pramenka breed Kaić (2013) also lists significant differences in carcass composition. In carcass of male lambs there was determined a significantly higher share of muscle tissue in breast with shanks, shoulder, loin with ribs and a lower part of ribs. Carcass of male lambs also had significantly more bone tissue in neck, lower part of ribs, sirloin and hind leg. Opposite to that, there was determined a significantly higher share of fatty tissue in neck, breast with shanks, shoulder, loin with ribs, lower part of ribs, sirloin and hind leg in carcass of female lambs. Santos et al. (2007) emphasize a higher share of muscle tissue in all carcass parts, especially in neck, loin and hind leg in female lamb carcass of Churra da Terra Quente breed. In male lamb carcass in the neck the authors determined a significantly higher share of fatty tissue, whereas significant differences in shares of bone tissue between carcasses of male and female lambs were not determined. Opposite to the listed, Pérez et al. (2007) did not determine significant differences in shares of individual parts, nor in the composition of shoulder and hind leg in carcasses of male and female lambs of Merino Precoz Aleman and Suffolk Down breed (Table 3).

Taking into account the total tissue composition of carcass, Díaz et al. (2003) claim that male lamb carcass has a higher share of muscle (54.64 : 52.75) and bone (24.56 : 22.43) tissue, while in female lamb carcass there is significantly more fatty tissue (19.7 : 14.05). Peña et al. (2005) emphasize uniform shares of muscle tissue in carcasses of male and female lambs (54.4 : 54.0), a significantly higher share of fatty tissue in female lamb carcass (19.7 : 17.6), and a higher share of bones in male lamb carcass (20.9 : 19.2).

Rearing system and feeding

Rearing system and feeding the lambs also influence the share of individual carcass parts and their composition. So Cividini et al. (2007) list significant differences in shares of individual carcass parts between the lambs reared in a closed system and the ones kept in pasture. In carcasses of pasture lambs the authors determined a significantly larger part of shoulder and hind leg. Carrasco et al. (2009) also list significant differences in shares of individual carcass parts between pasture lambs, lambs that were fed supplemental nourishing feed along with milk and pasture, and lambs that were kept in a closed system. In carcasses of pasture lambs there was determined a significantly higher share of front part of the ribs and a lower share of breast than in carcasses of the lambs that were fed supplemental nourishing feed along with milk and pasture, and the lambs that were kept in a closed system.

It is considered that in carcasses of pasture lambs there is a significantly lower share of fatty tissue (mostly less subcutaneous fat than intramuscular fat) than in lambs fed supplemental nourishing feed (Díaz et al., 2002; Borton et al., 2005; Joy et al., 2008). But, when you add supplemental nourishing feed to the meal of the pasture lambs, the shares of fat in their carcasses are similar to those obtained from the lambs from a closed rearing system and fed supplemental nourishing feed (Carrasco et al., 2009). The source of available energy influences significantly the shares of individual tissues in lamb carcasses and can be changed through feeding system based on different combinations of milk, pasture and supplemental nourishing feeds (Carrasco et al., 2009). Along with the listed, Borton et al. (2005) list that as opposed to the lambs kept in a closed rearing system and fed supple-

mental nourishing feeds, pasture lambs grow significantly slower and they can be reared to larger body weights with no negative consequences of accumulating larger shares of fat. Aalhus et al. (1991) also emphasize that in comparison to the lambs kept in a closed system, pasture lambs have significantly less fatty tissue and more muscle tissue due to more physical activity. Carrasco et al. (2009) determined significantly more muscle and bone tissue and less fatty tissue in lambs fed on milk and pasture than in lambs that were fed supplemental nourishing feed along with milk and pasture and the lambs kept in a closed system. A smaller share of fatty tissue in carcasses of pasture lambs is explained by their increased energy needs due to increased basal metabolism whose larger activity is caused by pasture and more intensive physical activity characteristic for pasture lambs (Díaz et al., 2002).

Body weight at slaughter

Carcass composition, that is, individual carcass parts and shares of its muscle, fatty and bone tissue are in correlation with body weight of lambs at slaughter (Delfa and Teixiera, 1998; Pérez et al., 2002; Yakan and Ünal, 2010). Hammond et al. (1983) claim that along with the increase of body weight in lambs, more expressed changes in individual parts of carcass appear; the share of ribs increases, whereas the share of neck, hind leg and shoulder decreases. Yakan and Ünal (2010) claim that along with the increase of body weight, the share of neck and breast with flank decreases. Žgur et al. (2003) emphasize that along with the increase of body weight in lambs, the share of neck, loin and ribs with flank increases, while the share of shoulder and hind leg decreases. Still, Díaz et al., (2006) emphasize that along with the increase of body weight in lambs only the share of loin with ribs increases, whereas the share of other parts doesn't change significantly.

Pérez et al. (1993) list significant differences in shares of fatty and bone tissue in carcasses of suckling Manchego lambs slaughtered at body weight of 10 and 14 kg. The authors claim that along with the increase of body weight, the share of bone tissue decreased and the share of fatty tissue increased. Opposite to that, the share of muscle tissue did not change significantly. Abdullah and Qudsieh (2008) determined significant differences in shares of individual tissues in carcasses of Awassi lambs slaughtered at higher body weights (20, 30 and 40 kg). Namely, the authors claim that with the increase of body weight of the lambs for slaughter, the share of muscle and bone tissue significantly decreases and the share of fatty tissue (subcutaneous and intramuscular) increases. Considering the fact that muscle, fatty and bone tissue make the basis of the carcass, changes in shares of one of them surely influence the share of others (Abdullah and Qudsieh, 2008). Thereby it should be certainly taken into account that muscle and bone tissue develop significantly earlier and they intensify, whereas fatty tissue develops later and is formed more intensely in the final phase of development of animal organisms (Mioč et al., 2007; Abdullah and Qudsieh, 2008). Table 3 presents the influence of body weight to shares of individual parts of shoulder and hind leg.

Carcass part

Due to consumer demands, a great attention is given to weight (shares) of individual carcass parts and their tissues lately (Teixeira et al., 2006). Each individual carcass part is characterized by its weight and the share of muscle, fatty and bone tissue (Hamid et al., 2008), and it is additionally also under the influence of many other factors (breed, sex, feeding, body weight at slaughter). Considering the fact that muscle, fatty and bone tissue are the main components of the carcass, the change of one of them surely influences the other in individual carcass parts (Abdullah and Qudsieh, 2008). Except for that, it should be mentioned that in the countries where commercial cutting of the carcasses is customary, each part has its sales value and a certain culinary purpose (Vionara, 1996). Table 3 presents variations of the shares of individual parts of lamb carcasses and the shares of individual parts of shoulder and hind leg regarding the breed, body weight at slaughter and sex.

For the purpose of determining the entire composition of a lamb carcass, shoulder, hind leg or loin are the most frequently used parts (Miguélez et al., 2006; Rodríguez et al., 2008; Carrasco et al., 2009; Endo et al., 2012). Except for the extremely high correlation coefficients with carcass composition, the authors emphasize that it is about pieces of meat which dissection is the easiest to be performed on. The reason for that are larger pieces of meat where there are significantly fewer losses during dissection than in other carcass parts. Considering the fact that hind leg and shoulder make over 50% of a lamb carcass, Cezar and Sousa (2007) emphasize that most researchers primarily decide to determine their tissue composition.

Instead of a conclusion

Except for the listed factors which affect the carcass composition, methods which are used to determine the lamb carcass composition should also be taken into account. Different destructive methods (dissection) are most frequently used in sheep breeding. Using them makes field research primarily easy or difficult (partial/complete dissection, manners and kind of tissue which is separated), and then comparing the results with the results of other researches. Regarding the significance of lamb carcass composition and the fact that dissection is still not significantly represented in Croatian sheep breeding, forces should be joined to define the most acceptable method to be used in this area.

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