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COMPARATIVE STUDY ON CARCASS CHARACTERISTICS IN LAMBS FROM THE BULGARIAN DAIRY SYNTHETIC POPULATION AND ITS F_1 CROSSES WITH ILE DE FRANCE AND MUTTON CHAROLAIS

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Abstract: The objective of this study was to determine the effects of the father's breed onto the carcass characteristics in lambs from the Bulgarian Dairy Synthetic Population and its F_1 crosses with Ile de France and Mutton Charolais breeds. The scientific study took place at the Sheep Farm with the Agricultural Institute of Stara Zagora, Bulgaria. Object of the study were lambs from the Bulgarian Dairy Synthetic Population and its crosses with Ile de France and Mutton Charolais breeds. After reaching a live weight of 21-24 kg, 9 male lambs of different crosses were slaughtered. Slaughter took place at a licensed slaughter house. The lamb carcasses were chilled for 24 hours. Following this, linear measurements were made on the left carcass halves.The father's breed has a significant proven effect onto the large and small circumference of the leg ($P\leq 0.001$) and a proven effect onto the carcass length ($P\leq 0.01$). The Ile de France crosses feature 17.44% bigger leg circumference in comparison with the animals from the reference group. Similar is the situation with the Mutton Charolais crosses where we have 14.93% bigger leg circumference compared to that in the reference group. Determined is also an effect onto the weight of the chilled carcass and the carcass yield. The lambs from the trial groups have a proven bigger leg weight ($P\leq 0.001$), proven bigger chilled carcass weight ($P\leq 0.01$) and they show a trend for proving the effect on the carcass yield ($P\leq 0.05$).

Key words: crosses, carcass, linear measurements, cuts of meat

Introduction

In order to increase the production and improve meat quality, industrial crossing with various meat sheep breeds is most often used. In Bulgaria, Ile de France and

Mutton Charolais are the two breeds most commonly used for crossing. Their meat is more tender, more juicy, without strong, haunting smell, it has high protein content and a lower content of the fats *(Nedelchev, 2005; Dimitrov et. al., 2009; Jandasek et al., 2014; Slavov et al., 2015)*. This is of key importance for the consumers since according to doctors and nutritioners, healthy meat should be lean *(Simopoulos, 2002; Janiszewski et al., 2016)*.

Both Ile de France and Mutton Charolais cross lambs reach their target weight for a shorter period of time *(Cividini et al., 2005; Paim et al., 2013)*. Their faster growth together with their better muscle gain result in better carcass quality *(Banks and Ross, 2003; Pannier et al., 2014)*, which means better efficiency on the farm and better lean meat yield *(Pethick et al., 2006)*. Using the Mutton Charolais and Ile de France breeds for industrial crossing significantly increases meat productivity. This becomes possible thanks to the better muscle gain in those parts of the carcass producing the primal meat cuts *(Slavov et. al., 2005; Laleva et. al., 2007; Pascal et al., 2009; Partida et al., 2012)*. With regard to the leg circumference and eye muscle area, the Mutton Charolais crosses are performing better than the Ile de France crosses, but worse in terms of percentage of the carcass deboned meat and carcass yield *(Yankov, 2008)*.

The objective of this study was to determine the effect of the father's breed onto the carcass characteristics in lambs from the Bulgarian Dairy Synthetic Population and their F_1 crosses with Ile de France and Mutton Charolais.

Material and methods

The scientific study took place in 2015 at the Sheep Farm with the Agricultural Institute of Stara Zagora, Bulgaria. Object of the study were male lambs from the Bulgarian Dairy Synthetic Population and its crosses with Ile de France and Mutton Charolais breeds. The method of analogues was used to set up those three groups of animals. At the start of the study, the animal average live weight was respectively 14.86 kg for the first group, 14.11 kg for the second group and 13.80 kg for the third group. The lambs were raised in boxes until they reached a live weight of 21-24 kg. The boxes were equipped with feeders and drinkers. The animals from the three groups were fed with concentrate mixture (acc. Table 1) and alfalfa hay free. After the animals reached the target weight, 3 male lambs from each group were slaughtered. Slaughter took place in May 2015 in a Slaughterhouse near Stara Zagora. The lambs were transported to the Slaughterhouse in the early hours of the day using specialized transportation vehicle, company's property.

After slaughtering, carcasses were divided into 3 groups:

- first group (reference group)- 3 lamb carcasses from the Bulgarian Dairy Synthetic Population;

- second group- 3 lamb carcasses F_1 crosses of the Bulgarian Dairy Synthetic Population with Ile de France;
- third group- 3 lamb carcasses F_1 crosses of the Bulgarian Dairy Synthetic Population with the Mutton Charolais.

Table 1. Lamb fattening concentrate mixture-composition

Ingredients	Content, %
Corn	63,5
Barley	18,0
Sunflower groats	15,0
Calcium carbonate $CaCO_3$	2,5
Salt	0,5
Premix (lambs)	0,5

The carcasses were chilled for 24 hours and then the linear dimensions of each carcass left half were measured. We used a linear measurement device and followed the methodics of *Zahariev and Pinkas (1979)*.

Carcass length (cm): determined was the distance from the front end of the pelvic symphysis to the middle of the first rib front side (Fig. 1, line A-B). *Chest width* (cm): measured at the level of the 5^{th} thoracic vertebrae. Determined was the distance from the 5^{th} thoracic vertebrae to the caudal end of the sternum (breastbone) from the ventral side (Fig. 1, line C-D).

Leg length (cm) measured was the distance from the carpal joint to the front end of the pelvic symphysis (Fig. 1, line A-E).

Leg circumference (cm): two measurements were made. The first measurement (large circumference) was made at the widest part of the leg (Fig. 1, line F-G). The second measurement (small circumference) (Fig. 1, line H-I) was made at the middle of the line determining the leg length (A-E).The carcasses were carved in accordance with *BDS 4348-78* into the following parts: lamb neck, lamb shoulder, cutlet, leg and loin (Fig. 2). Each cut of meat was then weighed using electronic scales.

Lamb neck (Fig. 2a): these are all cervical vertebrae (without the first cervical vertebra) and the adjoining muscle mass.

Lamb shoulder (Fig. 2b): this is the muscle mass in the front leg with the shin, the sides half of the thoracic vertebrae with the adjoining ribs and the sides half of the breastbone.

Cutlet (Fig. 2c): The front boundary of the cutlet coincides with the rear boundary of the shoulder. The cut outlining the rear boundary of the cutlet goes between the last and the last but one lumbar vertebrae. The cutlet contains the side halves of the lumbar vertebrae.

Leg (Fig. 2d) the front boundary of the leg coincides with the rear boundary of the cutlet. The rear boundary goes across the carpal joint.
Loin (Fig. 2e): containing the soft abdominal wall.
After weighing, the meat cuts were deboned in order to find out the weight of the meat and bones.
The results from our trial were processed by MY STAT and STATISTIKA AX.

Results and Discussion

The carcass linear measurement results are presented in Table 2. Data reveals that the lambs from the Bulgarian Dairy Synthetic Population stand out with the greatest carcass length (55.83 cm) in comparison to the animals from the other groups. Also, comparing the lambs from the second and the third group in terms of carcass length, there is a slight superiority of the Mutton Charolais crosses over Ile de France crosses (carcass length respectively 52.83 cm and 52.00 cm). Expressed as a percentage, the difference is 1.57%. Our results with regard to carcass length differ from the results obtained by *Yankov (2008).* The author has determined that the Ile de France crosses feature longer carcass in comparison with Mutton Charolais crosses. In terms of the leg length, the lambs from the first group show the greatest leg length (35.00 cm), followed by the Ile de France crosses (34.17 cm) and the Mutton Charolais crosses (33.83 cm). Similar are the results presented by *Yankov (2009).*
By measuring the leg circumference, it is possible to determine the muscle gain and the muscle development in lamb carcasses. The linear measurements based on this trait (leg circumference-large and small), showed that the lambs from both the second and the third group perform better than the animals from the Bulgarian Dairy Synthetic Population. The results from the leg small circumference measurement of the Ile de France crosses are 17.44% higher compared to the animals from the reference group. When measuring the leg large circumference, it can be seen that the Mutton Charolais crosses do better (38.50 cm) in comparison with the lambs from the Bulgarian Dairy Synthetic Population (34.50 cm). Expressed as a percentage, the difference is 10.39%. Similar results are presented by *Nedelchev* (*2005); Slavov et al. (2005); Laleva et al. (2007).*

Table 2. Linear Carcass Measurements for the three groups

Carcass characteristics	Animal Groups											
	1st group- Bulgarian Dairy Synthetic Population				2nd group- Bulgarian Dairy Synthetic Population x Ile de France				3rd group- Bulgarian Dairy Synthetic Population x Mutton Charolais			
	n	$\bar{x}$	$S_{\bar{x}}$	V_c	n	$\bar{x}$	$S_{\bar{x}}$	V_c	n	$\bar{x}$	$S_{\bar{x}}$	V_c
Carcass length, cm	3	55.83	1.44	3.00	3	52.00	0.87	2.00	3	52.83	0.58	1.00
Leg length, cm	3	35.00	0.87	3.00	3	34.17	0.58	2.00	3	33.83	0.58	2.00
Leg circumference, cm	3	26.03	0.46	2.00	3	31.53	0.81	3.00	3	30.60	0.00	0.00
small circumference, cm	3	34.50	0.00	0.00	3	38.00	0.87	2.00	3	38.50	0.00	0.00
large circumference, cm												
Chest width, cm	3	15.87	1.44	9.00	3	15.90	0.69	4.00	3	15.90	0.69	4.00

The father's breed (Table 3) has a high proven effect onto the small and large leg circumference ($P \leq 0.001$) and a proven effect onto the carcass length ($P \leq 0.01$).

Table 3. Variance components of the characteristics studied according to the group

Characteristics	F
Carcass length, cm	11.553**
Leg length, cm	ns
Leg small circumference, cm	89.958***
Leg large circumference, cm	57.000***
Chest width, cm	ns

ns- not significant
**- $P \leq 0.01$
***- $P \leq 0.001$

Carcass characteristics for all three groups of lambs are presented in Table 4. It is seen that the Mutton Charolais crosses come first in terms of weight of the chilled carcass (11.03 kg), while the lambs from the first group come last (9.50 kg). There is only a slight difference between the two trial groups in terms of carcass weight. Expressed as a percentage, this difference is 2.36% and it is in favour of the Mutton Charolais crosses. *Laleva et al. (2007*) have found out that the F_1 crosses with Mutton Charolais stand out with bigger weight of the chilled carcass in comparison with the source breed (Trakian merino lambs). In his study *Yankov (2008;2009)* has found out that the Ile de France crosses have bigger weight of the chilled carcass in comparison with the Mutton Charolais crosses. The carcass yield

for both trial groups is significantly higher in comparison with that of the reference group. The Ile de France crosses have up to 8.42%, and Mutton Charolais - 5,86% better carcass yield in comparison with the lambs from the Bulgarian Dairy Synthetic Population. The better carcass yield in crosses with the meat sheep breeds in comparison with the source breeds is also confirmed by a number of other authors (*Slavov et al., 2005; Laleva et al., 2007; Anev, 2009*). Comparing the animals from the trial groups we have found out that the Ile de France crosses have higher carcass yield than the Mutton Charolais crosses. With regard to the weight of the various meat cuts, it is seen that the two trial groups feature better performance than the reference group. The weight of the neck cut in Mutton Charolais crosses is 26.14% higher compared to that of the Bulgarian Dairy Synthetic Population. In Ile de France crosses the weight of the neck cut is 16.67% higher than the weight of the neck cut in the Bulgarian Dairy Synthetic Population. In terms of meat cuts, the leg in the Mutton Charolais crosses weighs the heaviest (1.99 kg), Ile de France crosses coming second (1.97 kg), followed by the Bulgarian Dairy Synthetic Population (1.57 kg). In their study *Cividini et al. (2005)* and *Pajor et al. (2009)* have found out that the Mutton Charolais and Ile de France crosses feature heavier leg, shoulder and cutlet compared with the source breed. With regard to the weight of the different meat cuts, there are no significant differences between the two trial groups.

Table 4. Carcass characteristics of the lambs from the three groups

Carcass Characteristics	Animal Groups											
	1st group- Bulgarian Dairy Synthetic Population				2nd group- Bulgarian Dairy Synthetic population x Ile de France				3rd group- Bulgarian Dairy Synthetic population xMutton Charolais			
	n	$\bar{x}$	$S_{\bar{x}}$	Vc	n	$\bar{x}$	$S_{\bar{x}}$	Vc	n	$\bar{x}$	$S_{\bar{x}}$	Vc
Weight of the chilled carcass, kg	3	9.50	0.00	0.00	3	10.77	0.40	4.00	3	11.03	0.65	6.00
Carcass yield, %	3	43.85	0.58	1.00	3	47.88	1.79	4.00	3	46.58	1.91	4.00
Lamb neck, kg	3	0.65	0.08	12.00	3	0.78	0.09	12.00	3	0.88	0.12	14.00
Lamb shoulder, kg	3	2.11	0.05	2.00	3	2.28	0.28	12.00	3	2.33	0.18	8.00
Cutlet, kg	3	0.62	0.11	18.00	3	0.62	0.06	10.00	3	0.67	0.03	4.00
Leg, kg	3	1.57	0.07	5.00	3	1.97	0.09	5.00	3	1.99	0.10	5.00

The cross type has a high proven effect onto the weight of the leg cut (Table 5) (P≤ 0.001), proven effect onto the weight of the chilled carcass (P≤ 0.01) and there is a trend for proving the effect onto the carcass yield (P≤ 0.05).

Table 5. Variance components of the characteristics studied according to the group

Characteristics	F
Weight of the chilled carcass, kg	10.295**
Carcass yield, %	5.382*
Neck, kg	ns
Shoulder, kg	ns
Cutlet, kg	ns
Leg, kg	21,277***

ns- not significant
*- P≤ 0.05
**- P≤ 0.01
***- P≤ 0.001

After carving and deboning of the left half of the carcasses, we found out that with regard to the meat yield, the Mutton Charolais crosses perform better (3.98 kg) while the lambs from the Bulgarian Dairy Synthetic Population have the smallest meat yield (3.21 kg) (fig. 3).The difference in the meat yield between the Ile de France and the Mutton Charolais crosses is 3.44%. With regard to the weight of bones, after deboning the carcass halves, the animals from the first and the second group show nearly the same values. The weight of the bones in the animals from the reference group is 1.32 kg, while in the Ile de France crosses, it is 1.32 kg. More significant is the difference in the weight of the bones between the Ile de France and the Mutton Charolais crosses. Expresses as a percentage, it is 10.70% and it is in favour of the Ile de France crosses. The differences in the weight of the bones from the left half of the carcass determined by us is supported by *Yankov (2009).* The author has found out that the weight of the bones in the Mutton Charolais crosses is higher.

Conclusion

The father's breed has a high proven effect onto the leg's weight (P≤ 0.001), proven effect onto the weight of the chilled carcass (P≤ 0.01) and a trend for proving the effect onto the carcass yield (P≤ 0.05). The Mutton Charolais crosses feature the biggest weight of the chilled carcass (11.03 kg), the Ile de France crosses coming second (10.77 kg), followed by the lambs from the reference group (9,50 kg).

Ile de France and Mutton Charolais breeds have a high proven effect onto the linear measurements of the leg circumference (both large and small circumference) (P≤

0.001) and a proven effect onto the carcass length (P≤ 0.01). With regard to the small leg circumference, the Ile de France crosses show 17.44%, and the Mutton Charolais crosses 14.93% higher values than those of the Bulgarian Dairy Synthetic Population.

After deboning the carcass halves, we have found out that the Mutton Charolais crosses produced the higher amount of deboned meat (3.98 kg), followed by the Ile de France crosses (3.84 kg), and the Bulgarian Dairy Synthetic Population (3.21 kg).

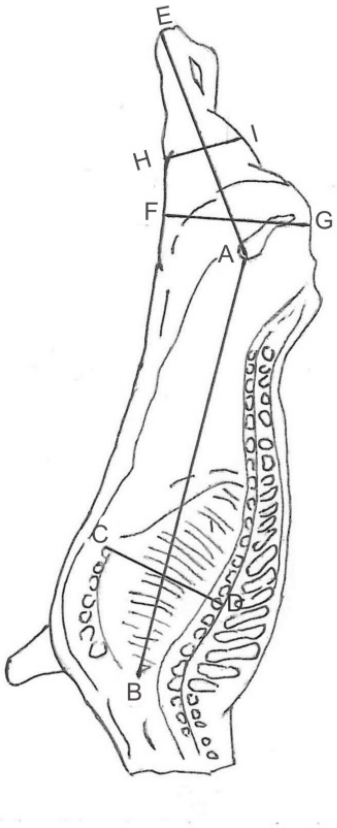

Fig. 1. Linear carcass measurements (*Zahariev and Pinkas, 1979)*

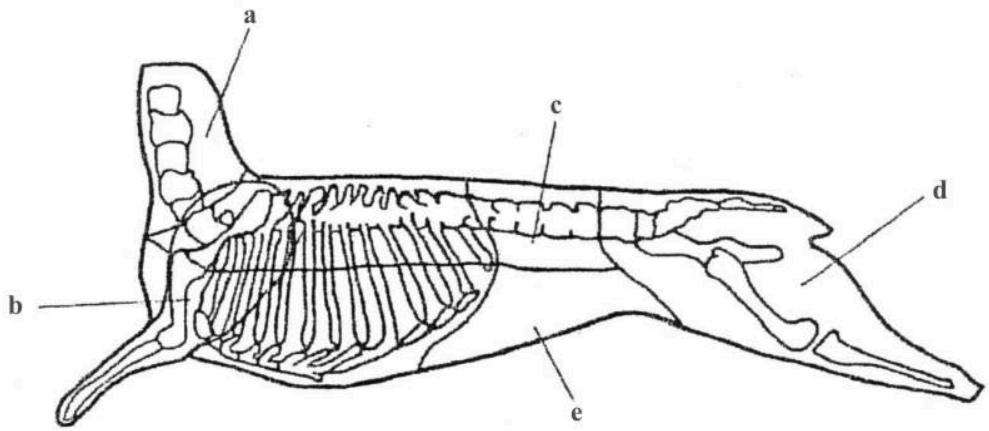

Fig. 2. Lamb cuts chart ***(Marinova and Popova, 2011)***

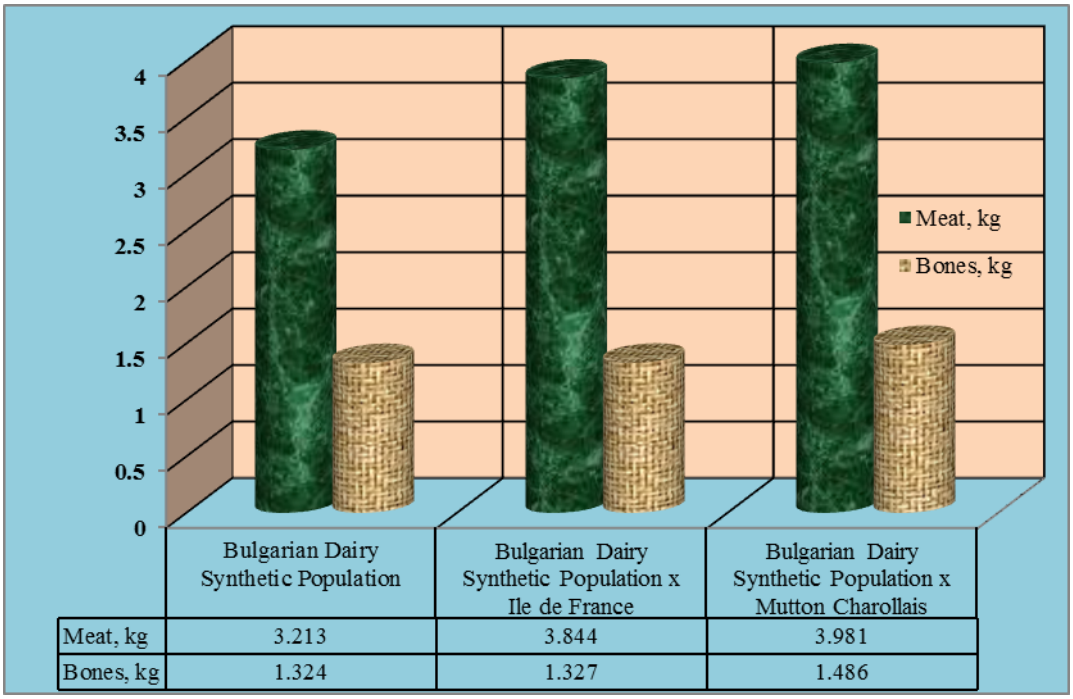

Fig. 3. Weight of the meat and bones after deboning carcass left halves for the lambs from all three groups

Uporedna analiza osobina trupa jagnjadi bugarske mlečne sintetičke populacije i F_1 meleza sa rasom Ile de France i Charollais

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Rezime

Cilj ovog istraživanja je bio da se utvrdi uticaj rase oca na osobine trupa jagnjadi bugarske mlečne sintetičke populacije i njenih F_1 meleza sa Ile de France i Charollais rasama. Istraživanje je sprovedeno na farmi ovaca Poljoprivrednog instituta u Staroj Zagori u Bugarskoj. Predmet istraživanja su bila jagnjad bugarske mlečne sintentičke populacije i njeni melezi sa Ile de France i Charollais rasama. Nakon dostizanja težine grla od 21-24 kg, 9 muških jagnjadi različitih kombinacija ukrštanja su zaklani. Klanje je sprovedeno u licenciranoj klanici. Trupovi jagnjadi su hlađeni 24 sata. Nakon toga, linearna merenja su izvršena na levim polutkama.
Rasa oca ima dokazano značajan uticaj na obim noge ($P \leq 0{,}001$) i dokazani uticaj na dužinu trupa ($P \leq 0{,}01$). Ile de France melezi imaju 17,44% veći obim nogu u poređenju sa životinjama iz referentne grupe. Slična je situacija sa Charollais melezima gde imamo 14,93% veći obim nogu u poredjenju sa referentnom grupom.
Utvrđen je takođe efekat na težinu ohlađenog trupa i prinos trupa. Jagnjad iz oglednih grupa su imali dokazano veću težinu nogu ($P \leq 0{,}001$), dokazano veću težinu ohlađenih trupova ($P \leq 0{,}01$) i pokazuju trend kojim se dokazuje i efekat na prinos trupa ($P \leq 0{,}05$).

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