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SOME SLAUGHTER TRAITS AND PHYSICOCHEMICAL CHARACTERISTICS OF MEAT IN BULGARIAN SCREW-HORNED LONGHAIRED KIDS AT WEANING AT 90-DAYS OF AGE

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Abstract

The Bulgarian Screw-horned longhaired goats are kept for milk, meat and skins. This native Bulgarian goats breed have a combined productivity. In all farms with Screw-horned goats, the meat obtained from kids at an early age, is the main income for the farmers. This requires a detailed study some slaughter parameters and physicochemical characteristics of meat from their kids, slaughtered at weaning at 90 days of age, without a period of intensive fattening, and the possibility for obtaining meat with high taste and dietary qualities. The dressing percentage for Bulgarian screw-horned longhaired kids, slaughtered at weaning at 90 days of age was 50.5%. The pH values measured at m. Longissimus were relatively stable stored under refrigerated conditions. At 24 hours after slaughter, the pH was 6.5, and after storage for 7 days it was 6.6. Instrumentally captured color characteristics of m. Longissimus were as follows: The degree of brightness (**L ***), 24 hours after slaughter was 42.47. The relative deviation to the red color (**a ***) was 18.02. The relative deviation to the yellow color (**b ***) was 3.55. The saturation index of meat color (**C**), measured 24 hours after slaughter, was 18.35. The chemical composition determined of samples from m. Longissimus was as follows: dry matter - 26.2%, protein - 23.01%, fat - 2.25%. The fatty acids with the highest concentration in samples of m. Longisimuss were respectively: monounsaturated oleic acid (18: 1) – 44.42%, and the saturated palmitic acid (16: 0) – 24.46%, and stearic acid (18: 0) – 9.57 %.

Keywords: Native goats kids, meat quality, chemical traits, physical properties, fatty acids.

INTRODUCTION

Traditionally in the Mediterranean countries and the South European production systems, the kids are kept together with their mothers. However, in this rearing technology the milk yield for cheese production has been reduced- a typical practice in these areas. In order to produce more milk, the goat breeders wean the kids from their mothers at a young age (15 days, 5-6 kg live weight), and they are slaughtered immediately after weaning. In some farms there is a practice in which the kids are reared to higher live weights and are fed with milk replacers. This significantly increases meat yield (Arguello et al 2005). The meat from young suckling kids is a highly valuable product with pronounced dietary and taste qualities (Arias and Alonso, 2002; De Gea et al, 2005; Zimerman et al, 2008; Bonvillani et al 2010). According to a number of studies, some physicochemical characteristics of meat, such as pH, color and chemical composition, are particularly important for the final assessment of its quality (Babiker et al, 1990; Todaro et al, 2002, 2004; Dhanda et al, 2003; Marichal et al, 2003; Argüello et al, 2005).

In the traditional technology for rearing of the Bulgarian screw-horned longhaired goats, the farmers combining milk and meat yields, such as kids, are slaughtered immediately after weaning (at about three months of age, without a period of intensive fattening after weaning), and followed by a milking period of 150-180 days. The physicochemical properties of meat in such young suckling kids are poorly studied in Bulgaria, and this fact initiates the present investigation.

MATERIALS AND METHODS

The object of the study were 6 Bulgarian screw-horned longhaired kids, from the native area of distribution for the breed - Southwestern Bulgaria, the town of Kresna. The experimental group was equalized by sex and type of birth - male, single born. During the mammalian period, the kids were kept with their mothers in agree with the traditional technology. The main food being breast milk, and after the 20th day after birth, the kids had free access to alfa alfa hay and concentrated fodder (corn, barley and sunflower meal). The goats-mothers were selected according to age - 2-4 years of age. Their daily ration were mainly of grazing. The determinant factor for the experiment was the age of the kids - 90 days old. The slaughter of the experimental animals was conducted in the experimental base of the Agricultural University – Plovdiv, after a 24-hours fasting diet, with a free access to water. The slaughter live weight of the kids was measured immediately before slaughter. After slaughter, the carcasses were cooled to 4˚C for 24 hours. The weight of the chilled carcass and the dressing percentage were determined by the method of Zahariev and Pinkas (1979). The data were processed by the variation-statistical method. The measurements of the physicochemical characteristics of the meat were made on a *m. Longissimus* (at the 12th rib of the left half for each carcass). Muscle pH was determined using a pH meter with a combined electrode, in case of double measurement at *m. Longissimus*. The first - after cooling (24 hours after slaughter), and the second - after 7 days, storage under refrigerated conditions at a temperature of 4˚C. The meat color was measured on the same muscle at an identical time interval, using a Minolta CR200 chromometer (where **L *** represents relative brightness; **a *** shows relative deviation to red; and **b *** represents relative deviation to yellow). The "color saturation index", or "Chroma" (**C**), was calculated using values **a *** and **b *** according to Wyszecki and Stiles (1982). The moisture content of the meat (*m. Longissimus*) was determined by air drying (AOAC, 1984, procedure 24003). The fat content was determined by the Soxhlet method - extraction in petroleum ether (AOAC, 1984, procedure 13032). The Kjeldahl method (AOAC, 1984; procedure 2057) was used to determine nitrogen, using a conversion factor of 6.25 to convert nitrogen to protein percentage. The determination of the ash was made according to AOAC 1984 (procedure 14066). To determine the fatty acid composition of the fatty extract from the meat (*m. Longissimus*) of Bulgarian screw-horned kids, esterification of the fatty acids obtained after hydrolysis was performed by the method of Hartman & Lago (1973). Extraction of myoglobin was performed as described by Pogorzelska et al., 2018). After meat (2 g) homogenization with 10 ml of phosphate buffer (pH 8.0, 0.01 M), the samples were placed in an ice bath for 1 h and centrifuged. After filtration the percentage of myoglobin forms at the meat surface was measured spectrophotometric: MetMbat 504 nm, DeoMbat 557 nm, OxyMbat 582 nm and isobestic point at 525 nm, using Camspec M 550 double-ray UV-VIS spectrophotometer

(Spectronic Camspec Ltd, Leeds, United Kingdom).

RESULTS AND DISCUSSION

From the results presented in table 1, it can be seen that the Bulgarian screw-horned kids, slaughtered at weaning at 90 days of age, has a relatively high live weight - 19.4 kg. The weight of the cooled carcass was 9.7 kg. The dressing percentage was relatively high - 50.5 %. Lower results are cited by Markovic et al. (2011) in 90 days old, male kids from the Balkan goat breed in the Republic of Montenegro. The Screw-horned longhaired kids have higher values for the signs weight of the chilled carcass and dressing percentage, than kids from some Turkish local goats breeds - Gokceada, Maltese, Hair Goats (Yalcintan et al. 2010). The results for some characteristics of the meat are presented in tables 1 and 2. The pH of the chilled meat is an important factor, affecting to the color, quality and shelf life. At the 24 hour post mortem, the pH values of chilled meat from Bulgarian screw-horned suckling kids, vary between 6.40 and 6.74. Average - 6,535. Our results are in line with those found by other authors (Snell, 1996, Kirton et al., 1989). Similar pH values 24 hours after slaughter are obtained by Solaiman et al. (2011), in crossed kids with the Boer breed. Close to our results indicate Pieniak-Lendzion et al. (2009) in 90-day-old kids from the White Improved dairy breed. Lower values for this sign are reported by Arguello et al. (2004) in chilled meat from local kids, slaughtered at significantly lower live weight. The average pH value in *m. Longissimus toracis* at 24 h post mortem was 6.53. However, the pH parameters obtained by us, were higher than the desired values from 5.5 to 5.8 at which the meat is considered as light and tender (Gardener et al., 1999). Similar higher values are cited by Webb et al. (2005), as well as by Simela et al. (2004) in meat from South African goats. One of the probable reasons is the higher live weight at slaughter, which statistically significantly increases the pH levels in the meat (Arguello et al. 2005). On the other hand, the age and the diet in the young ruminants also have an effect on the pH of their meat. Marichal et al. 2003, found that early weaning of the kids, and feeding with a milk replacer, leads to earlier and more effective adaptation to the specific type of feeding in ruminants. This provokes more carbohydrates intake, and the muscle glycogen accumulation, which causes lower pH values of meat. The traditional practice in our country - slaughter of kids at early age, explain the relatively higher pH levels of the meat from the 90 days old Screw-horned kids - 6.535. According to Warris et al. (1984), and Warner et al. (1998), this pH range (5.99 - 6.5) is usually associated with darker and firmer meat, with increased water retention, which contributes to the greater possibility for bacterial damage of the meat, and correspondingly shorter shelf life. However, our results showed that the pH of the meat from the screw-horned kids at 90 days of age has relative stability stored in refrigerated conditions. The pH values on day 7 of storage of meat at a temperature of 4˚ C, varied between 6.5 and 6.82, average value - 6.63.

The degree of brightness (**L ***) for the meat from 90-days old Screw-horned kids, 24 hours after slaughter was 42.47. Comparing to the other results, it can be seen that the goat meat has lower values for **L *** (darker) and **b *** (less pronounced yellowish tinge), and higher values for **a *** (more pronounced reddish tinge), compared to lamb meat (Babiker et al., 1990). Identical values for the brightness of the meat were found by Pieniak-Lendzion et al. (2009) in 90-days old kids. However, the authors cited that with increasing the age to 180 days, the

brightness decreases and the flesh becomes darker.

Our results for this indicator (table 2) were lower than those found by Arguello et al. (2005) in Majorera kids slaughtered at significantly lower live weight - 6 and 10 kg. There is an inverse relationship between the brightness of the meat and the live weight at slaughter. The meat in heavier kids is darker (lower **L *** values) than in animals with lower live weight at slaughter (Arguello et al. 2005). A similar relationship was observed by Marichal et al. (2003) in goat meat and also Sanudo et al. (1996) in lambs.

Tab. 1. Live body weight, dressing percentage of Bulgarian screw-horned longhaired kids, slaughtered at 90 days of age (n-6), and chemical composition of *m. Longissimus thoracis* at 24 h post mortem.

Signs	Mean ± SD (n = 6)
Live body weight at slaughtered, kg	19,400±1,799
Weight of cooled carcass, kg	9,799±0,960
Dressing, %	50,503±1,988
Dry matter %	26,236±0,676
Protein, %	23,014±0,551
Fat,%	2,256±0,207
Ash, %	0,966±0,001
Idex W/P	3,20±0,567

Tab. 2. pH and color characteristics (**L***, **a***, **b***, **C**) and percentage contribution of myoglobin forms in Longissimus thoracis from Bulgarian screw-horned longhaired kids during 7 days refrigerated storage at 0 +4°C.

Signs	Mean ± SD (n = 6)	
	1d post mortem	7 days post mortem
pH	6.535^{a}±0.095	6.650^{a}±0.081
L*	42.476^{a}±1.723	43.718^{a}±1.534
a*	18.020^{a}±0.345	18.858^{a}±0.813
b*	3.552^{a}±0.234	2.828^{b}±0.284
C	18.357^{a}±0.376	19.068^{a}±0.486
Deo Mb	1.343^{a}±0.029	1.318^{a}±0.105
Oxy Mb	0.785^{b}±0.064	0.506^{a}±0.147
Met Mb	0.166^{a}±0.037	0.493^{b}±0.055

$^{a, b}$–Means in the same row having different superscripts letters are significant at $P < 0.05$.

The values obtained by us for the brightness of the meat in 90-days old Screw-horned kids were identically to the cited values from Snell (1996) in kids with similar live weight at slaughter. Significantly lower values of the brightness index (**L ***) are reported in meat from fattened cross-breeds with Boer breed, slaughtered at a significantly higher live

weight (45 kg) - 29.91 (Solaiman et al., 2011). The same authors also reported significantly higher values of **b ***, associated with a stronger yellow color of the meat in fattened kids - 15.44. At 90-days old Bulgarian screw-horned kids **b *** was 3,552. At the same time, we reported higher values for the indicator **a *** - 18.02, reflecting the red color of the meat, compared to **a *** in crosses with the Boer breed, with a higher live weight - 45 kg (16.21). The saturation index or chroma (**C**) of the meat color for Bulgarian screw-horned kids, measured 24 hours after slaughter, was 18.35. The values obtained by us for this indicator were higher than those established by Arguello et al. (2005) in Majorera kids with a slaughter live weight of 10 kg. In table 2, it can be seen that the instrumentally measured color characteristics of the meat from 90-days old Bulgarian screw-horned kids were relatively stable when stored under refrigerated conditions. After 7 days of storage at 4˚C, the brightness (**L ***) slightly increased to 43.71. We also reported a minimal increase in the saturation index of meat color (**C**) – 19.06.

The results of the chemical analysis of the meat from 90-days old Bulgarian screw-horned kids are presented in table 1. The percentage of moisture was relatively high - 73.7%. The higher water content is characteristic of meat obtained from animals slaughtered at an early age and fed mainly with milk. Impressive was the relatively high percentage of protein - 23.01%. For comparison, in 90-days old Egyptian kids from Baladi breed, the protein in *m. Longissimus* accounted for 19.97% (Moawad et al. (2013). Our values for dry matter and protein content were higher than those established by Pieniak-Lendzion et al. (2005; 2009) in White Improved (dairy goat breed), slaughtered at the same age (21.62% and 19.71%, respectively). Lower values of these signs has been cited in kids of Alpine and Saane breeds (23.74 and 19.64%; 21.96 and 20.65% respectively) (Mioč et al. 2001). The fat content in the meat from 90-days old Screw-horned kids was relatively low at 2.26%. Similar fat content were found by Moawad et al. (2013), in 90-days old kids from the local Egyptian breed Baladi. Lower fat content in *m. Longissimus* has been reported in kids of specialized milk breeds (Peňa et al. 2009; Pieniak-Lendzion et al. 2009).

The W / P index is directly related to the maturity of the meat. The values established by Kesava Rao et al. (2003) vary in the range of 3.10 to 3.87 according to the protein content in the food. The higher protein content in the food, leads to the higher value of the W / P index for meat. The W/P index established by us for meat from 90-days old Screw-horned kids was 3.20. Pieniak-Lendzion et al. (2009) reported higher values of this index in dairy goats, slaughtered at the same age (3.98). The value of the W / P index was also higher (4.18) in the meat from Alpine kids and its crosses with the Boer breed, than our results (Brzostowski et al. 2008).

The increasing of metmyoglobin content during seven days refrigerated storage (0+4°C) in overall pigment content is the indicator of discoloration of meat (Pogorzelska et al., 2018).

The metmyoglobin measured at 7-th day in meat from Bulgarian screw-horned kids was three times greater than 1st day post mortem (table 2), and simultaneously OxyMb decreased by 1.5 times ($p<0.05$). These results are a consequence for on growing oxymyoglobin oxidation process during meat storage (0 +4°C). The MetMb formation observed in m. *Longissimus thoracis* from Bulgarian screw-horned longhaired kids storage 7 d at 0 +4°C in lower than reported by Adeyemi et al., (2016) five times increasing of MetMbin the same stored goat meat.

Attractive meat color is the most important quality parameter for the consumers (Adeyemi et al., 2016). Color redness and lightness are assessed with meat oxidation (Sabow e tal., 2016). For the studied period (7d, 0 +4°C), no significant differences between colour lightness and redness in goat m. *Longissimus thoracis* was found. Only slightly decrease by 1.25 times in color yellowness was established.

The fatty acid composition of the meat from 90-days old Bulgarian screw-horned kids is presented in table 3. From the presented fatty acids with the highest concentration in samples of m. Longisimuss were monounsaturated oleic (18:1), and saturated palmitic (16:0) and stearic acids (18:0). The monounsaturated oleic fatty acid lowers blood cholesterol in human blood, and the fact that it has the highest relative content in the meat of Screw-horned kids emphasizes its dietary qualities. The degree of fat saturation is one of the most important characteristics affecting the quality of meat. The longchains saturated fatty acids harden easily on cooling and affecting to the taste of meat. The relatively high content of stearic fatty acid (18:0) in the meat of Screw-horned kids was decisive for its good dietary qualities. This fatty acid belongs to the group of "desirable" fatty acids related to human dietetics. The "desirable fatty acids" are stearic (C18:0) and all unsaturated fatty acids (Banskalieva et al., 2000). The total percentage of "desirable fatty acids" in the meat of Bulgarian screw-horned kids slaughtered at 90 days of age was 64.7%. A higher percentage was found by Solaiman et al. (2011) in fattened crossbred Boer kids - 75%.

An important point in the analysis of the results was the consideration of the average values of caprylic (C8) and capric (C10) fatty acids. In the meat of the Bulgarian screw-horned longhaired kids these values were as follows - 0.21% (C8) and 0.88% (C10). According to some authors (Voyvodova and Mihailova, 2001), these fatty acids are crucial for the taste and smell of both milk and meat in small ruminants. Namely the relatively low content of caprylic and capric fatty acids in the meat of 90-days old Screw-horned longhaired kids can explain the fact that there is no strong species-specific odor. This is defined as a positive characteristic for the taste of the meat from Screw-horned longhaired suckling kids. In order to more fully characterization of the dietary properties of meat of Bulgarian screw-horned kids, it was necessary to note the content of essential linoleic Ω6 (C18:2) and linolenic Ω3 (C18:3) fatty acids, as well as the ratio between them.

Tab. 3. Intramuscular fatty acids (%) of *m. Longissimus thoracis*, 24 h post mortem, of Bulgarian screw-horned longhaired kids, slaughtered at 90 days of age (n-6).

Fatty acids	Mean ± SD
Caprylic fatty acid C 8:0	0,42±0,026
Capric fatty acid C 10:0	0,74±0,045
Lauric fatty acid C 12:0	7,19±0,017
Myristic fatty acid C 14:0	0,70±0,025
Palmitic fatty acid C 16:0	24,46±0,225
Palmitoleic fatty acid C 16:1	3,31±0,015
Margarine fatty acid C 17:0	0,75±0,064

Margarinoleic fatty acid C 17:1	0,79±0,020
Stearic fatty acid C 18:0	9,57±0,075
Oleic fatty acid C 18:1	44,42±0,226
Linoleic fatty acid C 18:2	3,67±0,030
Linolenic fatty acid C 18:3	0,51±0,030
Saturated fatty acids (%)	44.876±0.188
Polyunsaturated fatty acids (%)	48.096±0.228
Monounsaturated fatty acids (%)	7.013±0.025
Polyunsaturated / Saturated fatty acids	1.071±0.478
Desirable fatty acids % (C 18:0 + total unsaturated)	64.679±0.109

A number of authors has determined the dietary qualities of the meat from ruminants, based on the content of conjugated linoleic acid, emphasizing its anticancer and antiatherosclerotic effect (Belury, 2003; Kritchevski, 2003; Khanal & Olson, 2004). In our study, linoleic acid was relatively high. In the fatty extract from the meat of Bulgarian screw-horned longhaired kids, at weaning at 90 days of age, linoleic acid has a relative content of 3.67% and linolenic - 0.51%. When compared with the content of linoleic acid in the meat of fattened Strandzha kids (1.41%, according to Stankov et al. (1999), it can be seen that it is almost twice higher in the meat from 90-days old Screw-horned longhaired kids. This emphasizes the higher dietary qualities of the meat from young suckling kids, compared to the intensively fattened ones. The ratio of polyunsaturated to saturated fatty acids is also crucial for the dietary qualities of meat. Some authors define as desirable the values of this ratio close to 1, and lower than 5 (Enser et al., 1998; Raes et al., 2004). In our investigation the ratio of polyunsaturated to saturated fatty acids in the meat of 90-days old Screw-horned kids was close to the desirable values - 1.07, which corresponds to its dietary characteristics.

CON**CLUSIONS**

The dressing percentage in Bulgarian screw-horned longhaired kids, slaughtered at weaning at 90 days of age was 50.5%. The pH values measured at *m. Longissimus* from Bulgarian screw-horned longhaired kids showed relatively stable values when stored under refrigerated conditions. At 24 hours after slaughter, the pH was 6.5, and after storage for 7 days it was 6.6. The instrumentally measured color characteristics of *m. Longissimus* from Bulgarian screw-horned longhaired kids, slaughtered at weaning at 90 days of age, were as follows: The degree of brightness (**L ***), 24 hours after slaughter was 42.47. The relative deviation to the red color (**a ***) was 18.02. The relative deviation to the yellow color (**b ***) was 3.55. The saturation index of the meat color (**C**), measured 24 hours after slaughter, was 18.35. The chemical composition, determined on samples of *m. Longissimus* from Bulgarian screw-horned longhaired kids, slaughtered at weaning at 90 days of age was: dry matter - 26.2%, protein - 23.01%, fat - 2.25%. The fatty acids with the highest concentration in samples of *m. Longisimuss* were monounsaturated oleic (18:1) – 44.42 %, and saturated palmitic (16:0) – 24.46 %, and stearic (18:0) – 9.57 %.

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