

## **QUALITY TRAITS OF MEAT FROM GOAT KIDS FED A DIET WITH 10% FLAXSEEDS**

Krystyna Pieniak-Lendzion, Roman Niedziółka,  
Elżbieta Horoszewicz, Magdalena Łukasiewicz

Department of Breeding Methods and Poultry and Small Ruminant Breeding, University of Podlasie,  
Prusa 14, 08-110 Siedlce, Poland

### **Abstract**

The objective of the study was to analyse the slaughter value and physicochemical attributes of muscle tissue from goat kids slaughtered at 150 days of age. After weaning, animals were fed a diet with 10% flaxseed from 60 days of age. Significant ( $P \leq 0.05$ ) differences were found for slaughter yield (45.80%) and primal cuts (leg, saddle) in the experimental group. In the same group, carcass fatness was found to be 1% lower. In contrast, the proportion of muscle tissue in leg (70.60%) and carcass (60.71%) was non-significantly higher in the group receiving flaxseed. The muscle tissue of male kids fed flaxseed was darker ( $L^* 42.60$ ) ( $P \leq 0.01$ ) and contained significantly more ( $P \leq 0.01$ ) dry matter (24.32%) and protein (20.97%) but significantly less ( $P \leq 0.05$ ) fat (1.92%). Sensory values of meat were similar in both groups, with no statistically significant differences between the groups.

**Key words; goat kids, flax, slaughter value, carcass cuts, quality of meat**

The meat of goat kids is characterized by excellent properties as far as its nutritional value is concerned because intramuscular fat content in the meat is low whereas protein and mineral content is high (Kędzior et al., 1997; Pieniak-Lendzion et al., 2006; Sen et al., 2004).

Studies on slaughter value of goat kids slaughtered at different body weights have yielded varying results. In general, they found a higher proportion of primal cuts and meat tissue in the carcass of animals slaughtered at higher weight standards, as well as more beneficial physicochemical properties of meat (Kasprzyk and Krupa, 2000; Kuźnicka et al., 2004; Mioč et al., 2001; Peña et al., 2007). The addition of oilseeds to a ration has a beneficial influence on the slaughter value of the meat obtained, as well as basic quality attributes of the meat of slaughtered lambs and kids (Borys and Pająk, 2005; Kesava Rao et al., 2003; Pieniak-Lendzion et al., 2006; Szymanowska et al., 2006).

The objective of the study was to determine the effect of using a balanced feed mixture with 10% flaxseed in goat kid feeding on basic meat quality attributes.

### Material and methods

An experiment was carried out on White Improved goat kids (8 animals per group) fattened in confinement to 150 days of age. After weaning at 60 days of age, a balanced feed mixture and meadow hay were fed. The goat kids were fed *ad libitum* during the fattening period. The diet of the experimental group contained 37% barley, 17% oats, 25% wheat bran, 10% soybean meal, 10% flaxseed, and 1% mineral mixture. The control group diet contained 36% barley, 22% oats, 18% wheat bran, 13% bean, 10% soybean meal, and 1% mineral mixture. One kg of pelleted feed contained 87.0–87.2% dry matter, 156.4–158.4 g crude protein, and 5.94–6.04 MJ net energy (Ryś, 1998). The animals were castrated and kept in confinement on deep bedding throughout the feeding period.

Slaughter and slaughter analysis were performed according to the methodology for small ruminants developed by the National Research Institute of Animal Production (Nawara, 1963). After 24-h chilling at 4°C, carcasses were separated into cuts which were subjected to detailed dissection into meat, fat and bone tissues.

Samples of the longest back muscle (*m. longissimus dorsi*) were subjected to chemical analysis to determine the content of dry matter, total protein, fat, and mineral compounds (in the form of ash). The respective methods of determination were: oven-drying at 105°C, Kjeldahl, Soxhlet, and combustion methods. The adductor muscle (*m. adductor*) was used to determine meat water holding capacity by the Grau-Hamm method, pH after 45 min and 24 h by means of a CP-315 integrated electrode pH-meter, and muscle tissue (*m. semimembranosus*) darkening using a Minolta Chroma Meter CR-300.

Statistical analysis was carried out using the ANOVA procedure by means of the Stat. 6.0 PL package (Stat., 2002) and it included calculation of means ( $\bar{x}$ ) and coefficients of variation (V). Significance of differences between means was determined by Tukey's test.

### Results

Goat kids offered a diet containing 10% flaxseed had 1.34 kg higher body weight prior to slaughter compared with the control group (31.66 kg) (Table 1). Also the chilled carcass weight in the experimental group was on average 1 kg higher and amounted to 15.01 kg. Higher dressing percentage (45.80%) was obtained for the group of goat kids fed the flaxseed diet. The differences were statistically significant. Carcass weight losses during chilling were similar in both groups and averaged 3.66 and 3.85%.

Table 1. Body weight and slaughter value

Traits	Experimental group		Control group	
	$\bar{x}$	V	$\bar{x}$	V
Body weight at slaughter (kg)	33.00	6.63	31.66	10.52
Chilled carcass weight (kg)	15.01	6.20	14.00	10.36
Cooling loss (%)	3.66	4.76	3.85	6.03
Cold dressing percentage	45.80a	2.16	44.25b	2.44

a, b – values in rows with different letters differ significantly ( $P \leq 0.05$ ).

Table 2. Weight of primal half-carcass cuts (kg)

Traits	Experimental group		Control group	
	$\bar{x}$	V	$\bar{x}$	V
Right half-carcass	7.50	6.00	6.90	9.42
front	3.00	7.00	2.80	11.07
middle	2.07 a	5.80	1.92b	5.21
rump	2.18	6.88	2.01	9.95
Weight of kidney	0.058	4.22	0.056	6.42
Kidney fat	0.192 A	6.28	0.114 B	7.60
<b>Weight of half-carcass cuts</b>				
Neck	0.40	11.69	0.48	15.70
Middle neck	0.83 a	6.80	0.67 b	35.63
Shoulder	1.02 a	6.72	0.86 b	9.25
Flank with ribs	0.94	12.31	0.95	9.50
Cutlet	0.53	10.51	0.47	10.16
Leg	1.76 a	7.27	1.62 b	10.91
Loin	0.52 a	6.67	0.42 b	11.34
Sternum	0.38	8.06	0.39	15.53
Fore shank	0.37	14.88	0.40	17.44
Hind shank	0.42	14.42	0.39	15.91
Tenderloin	0.08	4.99	0.08	14.09
Valuable cuts in half-carcass (%)	37.47	8.21	36.38	9.53

a, b – values in rows with different letters differ significantly ( $P \leq 0.05$ ).

A, B – values in rows with different letters differ significantly ( $P \leq 0.01$ ).

In the experimental group there was observed a higher weight of the right side, including the fore, central and hind parts, compared with the control group. There were statistically significant ( $P \leq 0.05$ ) differences in the weight of the following cuts: middle neck, shoulder, leg and loin, in favour of the goat kids fed the mixture containing flaxseed (Table 2). The same goat kid group was characterized by a 0.30 kg higher weight of primal cuts, that is leg, loin and cutlet (by 0.14, 0.10 and 0.06 kg, respectively). In total, the weight of primal cuts was 1.09% lower in the control group (control group 2.51 kg, experimental group 2.81 kg). The amount of kidney fat may be an indicator of the carcass fatness level. The type of feed and flaxseed proportion in the ration may indirectly influence the fatness level, which

resulted in a higher fat weight (0.192 kg) in the experimental group. The differences proved to be statistically significant at  $P \leq 0.01$ .

Feeding did not significantly influence meat and bone tissues in the leg and carcass. Significantly ( $P \leq 0.05$ ) lower fat tissue content, by 1% on average, was obtained in the carcass of goat kids fattened with the mixture containing flaxseed. As far as meat and bone tissues were concerned, the experimental group was characterized by slightly higher values compared with the control group. Analysis of the leg tissue composition showed that the proportion of saleable meat was over 70% (Table 3).

Table 3. Tissue composition of leg and half-carcass (%)

Traits	Experimental group		Control group	
	$\bar{x}$	V	$\bar{x}$	V
<b>Tissue structure of leg</b>				
Muscle tissue	70.60	6.53	70.26	11.03
Fat tissue	9.29	15.51	9.48	18.38
Bone tissue	20.11	13.33	20.26	12.25
<b>Estimated contents in carcass</b>				
Muscle tissue	60.71	11.69	59.84	12.17
Fat tissue	12.33 a	4.98	13.33 b	8.91
Bone tissue	26.96	4.98	26.83	8.81

a, b – values in rows with different letters differ significantly ( $P \leq 0.05$ ).

Table 4. Chemical composition and physical properties of muscles

Traits	Muscle	Experimental group		Control group	
		$\bar{x}$	V	$\bar{x}$	V
pH <sub>1</sub>	<i>m. adductor</i>	6.32	11.67	6.39	1.88
pH <sub>2</sub>	<i>m. adductor</i>	5.55	2.16	5.67	2.65
Colour brightness L*	<i>m. semimembranosus</i>	42.60 A	3.31	45.65 B	3.61
Water holding capacity (%)	<i>m. adductor</i>	26.28	3.96	25.18	3.18
Dry matter (%)	<i>m. longissimus dorsi</i>	24.32 A	2.90	23.75 B	7.20
Crude protein (%)	<i>m. longissimus dorsi</i>	20.97 A	5.71	20.12 B	2.44
Fat (%)	<i>m. longissimus dorsi</i>	1.92a	5.73	2.12b	5.19
Ash (%)	<i>m. longissimus dorsi</i>	1.11	8.10	1.09	7.30

a, b – values in rows with different letters differ significantly ( $P \leq 0.05$ ).

A, B – values in rows with different letters differ significantly ( $P \leq 0.01$ ).

Analysis of meat chemical composition (Table 4) indicated statistically significant differences between kid groups. Significantly ( $P \leq 0.01$ ) higher dry matter and protein contents, by 0.57 and 0.85% respectively, and 0.20% lower fat content were found in the experimental group of kid goats. As far as the physical meat attributes are concerned, significant ( $P \leq 0.01$ ) differences were found in meat darkness. The L\* value indicated a darker colour of meat from male kids offered a mixture containing flaxseed.

Table 5. Sensory evaluation of the kid meat (5-point scale)

Traits	Experimental group		Control group	
	$\bar{x}$	V	$\bar{x}$	V
Flavour	4.25	4.7	4.27	4.68
Juiciness	4.20	2.38	4.19	2.39
Tenderness	4.25	2.35	4.20	4.76
Palatability	4.28	2.34	4.22	2.37

Sensory analysis results showed good culinary utility of meat of both kid groups studied, which was reflected in scores exceeding 4 points for each characteristic (Table 5). There was no significant effect on sensory evaluation of meat in the examined goat kids. What seems interesting is the fact that the meat aroma of kid goats fed the mixture containing flaxseed was almost the same as in the control group (4.25 pts).

## Discussion

The addition of flaxseed to the ration allowed obtaining better parameters for most slaughter value properties analysed. Kasprzyk and Krupa (2005) obtained a higher index of cold dressing percentage (47.39%). In turn, in their studies on goat kids and lambs, Szymanowska et al. (2006) and Korniewicz et al. (1999) obtained a dressing percentage of 45%. Higher values for the weight of the right (7.74 kg), fore (3.10 kg) and hind parts (2.34 kg) were obtained in an earlier study (Pieniak-Lendzion et al., 2005). Additionally, lower weights of the fore, central and hind parts in the carcass of lambs slaughtered at 30–35 kg body weight were reported by Grześkowiak et al. (2004). The proportion of leg in the side was slightly higher than 24%, irrespective of the group, and was about 4% lower than the proportion obtained by Sen et al. (2004). By contrast, Stanisiz et al. (2005) investigated 5-month-old goat kids (crossbreeds with the Boer breed) and obtained 38.65% proportion of primal cuts and 23.14% proportion of leg. The proportion of kidney fat in the experimental sides was 2.56% and was similar to the value (2.49%) obtained by Kuźnicka et al. (2004). Carcasses of kids of the Florida breed were characterized by different content of cuts according to the slaughtering weight (Peña et al., 2007). The slaughtering weight did not significantly affect the long leg content (30–33%), back content (18–19%) and neck content (8–10%), but it affected rib content (23–25%).

Similar values for the proportion of meat tissue (60.22%) in lambs were reported by other authors (Strzelecki et al., 2001). Tshabalala et al. (2003) obtained similar results for the meat tissue content in half-carcasses of goat kids, but higher values of meat tissue (76.19–78.06%) and bone tissue (20.16–22.74%) in legs of castrated kids in relation to breed than in the present study.

Analysis of the leg tissue composition showed that the proportion of saleable meat was over 70% and was similar to the results of other workers (Kędzior et al., 1997) as well as our previous results. Szymanowska et al. (2006) found a similar

meat tissue content in the leg (70.4%) for goat kids fed mixtures containing flaxseed. Conversely, the results obtained by Borys and Pająk (2005) indicated higher meat and fat proportions (73.08 and 9.60%, respectively) and a lower bone proportion (17.33%) in the carcass of lambs offered a mixture containing flaxseed. An even higher meat tissue content in the leg (76.77%) was found by Sen et al. (2004).

The appropriate physicochemical composition of kid goat meat underlines its dietary and culinary value. Male kid feeding was found to have a significant influence on the dry matter, protein and fat contents as well as meat colour. Stanisiz et al. (2004) obtained 0.99% higher dry matter content and 2.42% lower protein content compared with our study. The results obtained for dry matter and protein were similar to the results of studies on Polish White Improved (23.53 and 20.21%, respectively), Alpine (23.74 and 19.64%) and Saanen breeds (21.96 and 20.65%) (Mioć et al., 2001; Pieniak-Lendzion et al., 2005). The darker meat colour may have resulted from lower intramuscular fat content, which was also mentioned in another study (Kalinowska et al., 1997). In turn, Stanisiz et al. (2004) obtained a darker colour in the group of Boer crossbred male kids, which also had a higher intramuscular fat content. The values were similar to our results and ranged from  $L^*$  45.7 to 46.3. Values of  $pH_1$  and  $pH_2$  measurements were slightly higher in the meat of the control group and amounted to 6.39 and 5.67, respectively. Similar  $pH_1$  and  $pH_2$  values in the meat of kids slaughtered at different ages were obtained in other studies (Kalinowska et al., 1997; Kesava Rao et al., 2003; Sen et al., 2004; Stanisiz and Gut, 2005).

Feeding flaxseed mixtures to goat kids did not result in significant differences in sensory results between the groups. Other studies indicated that meat tenderness and juiciness was especially influenced by the proportion of intramuscular fat (Borys and Pająk, 2005; Kalinowska et al., 1997; Stanisiz et al., 2004). It had previously been observed that the content of unsaturated fatty acids, which is in general higher in the meat of animals fed plant seeds, can negatively influence meat aroma (Borys and Pająk, 2005; Pieniak-Lendzion et al., 2006).

In conclusion, the addition of flaxseeds to the ration allowed obtaining better parameters of slaughter performance and weight of primal cuts, in particular leg and saddle. The carcasses of experimental kid goats contained significantly ( $P \leq 0.05$ ) less fat tissue. Male kid feeding had a significant influence on the dry matter, protein and fat contents as well as meat colour.

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KRYSTYNA PIENIAK-LENDZION, ROMAN NIEDZIÓŁKA, ELŻBIETA HOROSZEWCZ,  
MAGDALENA ŁUKASIEWICZ

### Cechy jakościowe mięsa koziołków żywionych mieszanką z 10% udziałem nasion lnu

#### STRESZCZENIE

Celem badań była analiza wartości rzeźnej i właściwości fizykochemicznych tkanki mięśniowej koziołków ubijanych w wieku 150 dni życia. Po odsadzeniu w wieku 60 dni rozpoczęto tuczyć mieszanką z 10% udziałem nasion lnu. Stwierdzono istotne różnice ( $P \leq 0,05$ ) w przypadku wydajności rzeźnej (45,80%) i wyrębów (udziec, comber) w grupie doświadczalnej. W tej samej grupie wykazano niższe

(o 1%) otłuszczenie tuszy. Udział procentowy tkanki mięśniowej w udźcu (70,6%) i tuszy (60,71%) był statystycznie nieistotny, ale wyższy w grupie żywionej z udziałem nasion lnu. Tkanka mięśniowa koźląt żywionych z mieszanką z udziałem nasion lnu była ciemniejsza ( $L^* 42,60$ ) ( $P \leq 0,01$ ) i zawierała istotnie więcej ( $P \leq 0,01$ ) suchej masy (24,32%) i białka (20,97%) oraz istotnie mniej ( $P \leq 0,05$ ) tłuszczu (1,92 %). Wartości oceny sensorycznej mięsa były w obu grupach zbliżone i nie zostały potwierdzone statystycznie.