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# Growth performance and carcass characteristics of finishing Boer goats

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**Abstract.** In developing countries, goat kids are usually reared naturally under extensive conditions, but kids that are fed high concentrate diets generally have higher daily gains, dressing percentage and carcass quality then those produced in extensive system. Feeding of goat kids is the main factor affecting growth performance and carcass characteristics of finishing Boer goats. A study was carried out within the framework of the project 'Zootechnical and economic efficiency of feeding of fodder pulses to ruminant's meat production'. Eight kids of Boer breed were individually fattened for 60 days under an intensive management system, of which 4 kids received *ad libitum* concentrated feed of melted grain mix (GG) that was produced in farm and consisted of 25% oats, 25% barley and 50% fodder beans, but 4 kids received pelleted concentrated feed (CG) produced in feed company. Fattening performance, slaughter traits and carcass characteristics were evaluated. The carcasses were analyzed by weight and proportion of tissue: muscle, bone, fat. Daily live weight gain during 60 days of the fattening period was 235 g per day for CG kids, which is by 42.4% greater than for GG group kids (165 g per day ($P < 0.05$)). Feeding of GG kids by grain mix showed a lower growth rate of kids than feeding by pelleted concentrated feed (31.1 kg and 35.5 kg pre-slaughter, respectively), but had a higher dressing percentage (49.5% and 43.5%, respectively). Consequently, there was no significant difference in carcass weight (14.36 kg and 14.50 kg, respectively). GG carcasses had a higher fat content - 11.8% vs. 9.4%. In terms of the muscle-to-fat ratio, the carcasses of the kids of the two groups were significantly different ($P < 0.05$), where in the GG group there was 5.0 kg of muscle tissue per kg of fat and in the CG group there was 6.8 kg of muscle tissue. Total feed costs per day per animal and per kg live weight gain were higher in the CG group, as the feed price from a feed company was significantly higher than for farm-based grain meal. The results suggest that diet has an impact on the goat kid growth performance and carcass quality, and in intensive fattening systems it is more profitable to use a self-produced grain mix.

**Key words:** kids, fattening performance, carcass characteristics, meat quality.

## INTRODUCTION

Today, goats are spread throughout the world, with the exception of extremely cold areas. Goats are widely present in the countries with an extensive agricultural production, although their population is rising in richer countries, mainly due to intolerance of certain groups of people to cow's milk (Ivanovic, 2016). The world population of goats (1.05 billion in 2017) increased by 49% in the last 20 years, whereas that of sheep (1.20 billion in 2017) and cattle (1.49 billion in 2017) increased more slowly (FAOSTAT, 2019). According to FAO (FAO, 2017) the number of meat goats worldwide totals 464 million heads and the estimated goat meat production is 5.8 million tons. In spite of the numerical relevance of the stock, goat meat consumption is low, when compared to beef consumption. In Latvia the number of goats for meat production is 4 thousand heads, but there is no production of goat meat in the market (FAO, 2017). Demand for low-fat meats and meat products have increased in recent years to avoid the health risks associated with excessive fat intake. Goat is known to produce relatively lean meat. Information on the characteristics of goat meat and meat products in Latvia and the Baltic's remains limited and needs to be further investigated. The breeding of goat meat in Latvia started in 2005, when the German Cattle breed was purchased from a German farm. The most popular meat goat breed in the world is the Boer goat. Currently, the Latvian goat-rearing industry is at an early stage of development. Although there is a demand for goat meat in Latvia, the number of breed goats is decreasing. In order to successfully develop goat meat production, it is necessary to increase the number of animals and to continue to popularize goat meat production in Latvia (Report on Agriculture ...). With increasing of living standards and increasing of economy, requirements for the qualitative livestock products have increased (Ni et al., 2017).

According to Teixeira et al. (2017) the most popular goat meat in the world is chivo meat from goats aged 6 to 9 months with a carcass weight of more than 11 kg. Nutritionally, goat meat is a source of high quality protein and fat, low in calories, intramuscular fat, saturated fatty acids and sodium (Horcada et al., 2012). The goat carcass fat content is low and mostly all parts of carcass are consumed (Webb, 2014).

Major goat rearing and feeding systems for kid meat production are extensive grazing and intensive rearing systems (Joy et al., 2008). Therefore, it is necessary to optimize productivity of goats with naturally available feed resources, and goat producers have to adopt new technologies and better feeding practices to improve the performance and yield of goats (Webb, 2014). The feeding system affects the animal's growth rate, carcass weight, dressing percentage, fat content, muscle / fat ratio, organoleptic properties of meat (Carrasco et al., 2009; 2010; Toplu et al., 2013). Feed rations with concentrates can affect various carcass characteristics as well as internal and carcass fat levels (Goetsch et al., 2011). The level of concentrate has few effects on meat quality, but the total level of fat in meat tissues is greater for the highest vs. intermediate dietary concentrate level. The level of subcutaneous fat is greater among diets with higher level of concentrated feed (Ryan et al., 2007). Including of protein crops into the goat compound feed results in a greater live weight gain, but also a greater accumulation of adipose tissue in the carcass (Aplocina et al., 2019). Limited nutrient intake increases lean meat yield and reduces fat deposition, regardless of animal sex.

All goat breeds, ages and genders have similar requirements for the main nutrients - protein, energy, minerals, vitamins and water. The diet should contain sufficient protein, as no other nutrient can replace it. Energy is provided by dietary carbohydrates (starch and crude fiber), fat and protein surplus. If the forage is low in protein, additional protein supplements should be provided. It has been found that the cheapest source of protein is high quality forage. If necessary, the feed for fattening may be supplemented with additional protein sources - soya beans, peas or beans, gluten feed, urea or other feedstuffs, but the effectiveness and economy of these feedstuffs must be evaluated (Feeding programs ...).

The objective of our study was to assess the efficiency of feeding different concentrated feed to the growth performance and carcass quality of Boer goat kids.

## MATERIALS AND METHODS

The groups of kids were formed by selecting for each group kids that were born as twins (Table 1) with similar live weight after weaning and transferring them to the study site. Goat kids were given *ad libitum* access to water, salt block, hay and concentrated feed. Every day were accounted consumed feedstuffs. Four animals were housed together in pens equipped with elevated slatted floors, automatic waterers, grain mix and hay feeders.

**Table 1.** The research scheme

| Group | Concentrated feed | Fattening period, days | Number of kids per pen |
|---|---|---|---|
| 1st trial | Melted fodder beans (50%), barley (25%), oats (25%) | 60 | 4 |
| 2nd trial | Pelleted commercial feed | 60 | 4 |

The goat kids were weighed regularly with electronic scales and the depth of the dorsal muscle and adipose tissue was measured with the Mindray ultrasonograph at 13 ribs.

The following feed nutrient chemical parameters were established before the start of the trial according to generally accepted methods of analysis: dry matter (DM) according to ISO 6496:1999 method; neutral detergent fibre (NDF) according to LVS EN ISO 16472:2006; acid detergent fibre (ADF) according to LVS EN ISO 13906:2008; crude protein (CP) according to LVS EN ISO 5983-2:2009; fat (EE) according to ISO 6492:1999; starch according to LVS EN ISO 10520:2001, calcium (Ca) according to LVS EN ISO 6869:2002; phosphorus (P) according to ISO 6491:1998; but the net energy for lactation (NEL) was calculated based on the results of the analysis performed (Moe et al., 1976). The quality indicators for nutrients were determined by the accredited scientific laboratory of Biotechnologies of the Latvia University of Life Sciences and Technologies.

In the trial period goat kids were weighed at birth and at the age of 50 days and also at the beginning (91–92 days of age) and at the end (152–153 days of age) of fattening with electronic scales (accuracy of 0.01 kg). The absolute live weight gain per day of the period for the kids subject to the analysis was calculated by using the following formula (1):

$$a = \frac{W_t - W_0}{t} \tag{1}$$

where $a$ – live weight gain per day, g; $W_t$ – live weight at the end of the period, g; $W_0$ – live weight at the beginning of the period, g; $t$ – the period, days.

At the end of the feeding period kids were held overnight without feed before slaughtering. Each goat kid was weighed before slaughtering to determine the slaughter live weight. Hot carcass weights were taken immediately after slaughtering and removal of non-carcass components. Carcasses were chilled for 24 h at 4°C. In 24 h *post mortem*, the carcasses were reweighed. Dressing percentage was computed as a proportion of the cold carcass weight to the slaughter live weight by using the following formula (2).

$$K = \frac{K_m}{W_k} \times 100 \tag{2}$$

where $K$ – dressing, %; $W_k$ – live weight before slaughter, kg; $K_m$ – carcass weight, kg

Each carcass was evaluated for conformation and fatness according to the SEUROP carcass classification system for lambs (Commission Regulation (EC) No. 1249/2008). Carcass was classified for conformation (scale from S = Superior (0) to P = poor (5)) and fatness (scale from 1 = traces of or no fat visible to 5 = very thick fat cover) according to the visual scores in the SEUROP system. After the evaluation of conformation and fatness, the length of the carcass and the circumference of hips were measured using a tape measure. The neck was then separated and the carcass was split lengthwise by a saw. The left side of the carcass was also separated into five prime cuts: shoulder blade with shoulder, hip with leg, ribs, flank, sirloin.

The cuts were weighed and expressed as a percentage of the total weight of the carcass. The *M. longissimus dorsi* (MLD) were carefully dissected from the left side sampled, weighted and the ribeye area (REA) was measured on a transparent plastic grid. The guidance for grid assessment of REA was based on a mathematical theorem for determining the area of a polygonal object located on a grid of equally spaced points, Pick's Theorem (Pick, 1899).

For the calculations of REA we used Pick (1899) theorem (3).

$$A = ID + \frac{BD}{2} - 1 \tag{3}$$

where $A$ – area, cm$^2$; $ID$ – interior dots; $BD$ – boundary dots.

Each cut was dissected into the components of meat, bone and fat. The dissection technique used for measuring muscle, bone, and fat composition was described by Colomer-Rocher et al. (1987). First, the muscle was individually removed from their attachment and then the external fat was removed. Then, muscle, fat, and bone were separated and weighed individually. After boning the carcasses, the tissue ratios were calculated: meat (muscle tissue + adipose tissue) and bone tissue, muscle tissue and bone tissue, muscle tissue and adipose tissue.

Using the data on the consumed feed and the obtained live weight gain, the economic efficiency of the use of concentrated feed was calculated.

Fattening performance and carcass parameters were analyzed with mathematical data processing methods using Microsoft Excel software. In all analyses, statistical significance was declared at $P < 0.05$. The physical data were subjected to analysis of variance (ANOVA). The results are reported as least square means (LSM) and the standard error of the mean (SEM).

## RESULTS AND DISCUSSION

The evaluation of the results of the research was started with the analysis of the composition of the concentrated feed.

During the study, the 1st trial group kids were fed a cereal mix containing 50% beans, 25% oats and 25% barley as an energy source, whereas 2nd group kids received concentrated feed of pelleted commercial feed. The grain mix and pelleted feed were fed without restriction from loose troughs and hay was freely accessible throughout the fattening period.

The cereal mix has a higher content of net energy for lactation (NEL), protein, starch and Ca compared to commercially produced concentrated feed, while lower total crude fiber, neutral detergent fibre (NDF), acid detergent fibre (ADF) and total fats, but the difference isn't significant. The quality of hay is low, which is evidenced by the low protein (10.71%) and energy (5.55 MJ $kg^{-1}$ DM) content and the very high NDF content (62.64%), which signifies that the grass forage consists mainly of perrenial grasses that have already been overgrown. In Table 2 we can see the feed nutrient intake per goat kid per day.

**Table 2.** Average feed nutrient intake per head per day

| Indices | 1st trial group | | | 2nd trial group | | |
|---|---|---|---|---|---|---|
| | Hay | Concentr. feed | Total | Hay | Concentr. feed | Total |
| The amount, kg | 0.605 | 1.289 | 1.894 | 0.580 | 1.359 | 1.939 |
| Dry matter (DM), kg | 0.501 | 1.084 | 1.585 | 0.481 | 1.177 | 1.658 |
| Crude protein (CP), g | 53.7 | 206.3 | 260.0 | 51.5 | 232.1 | 283.6 |
| NDF, g | 314.1 | 185.9 | 500.0 | 301.3 | 331.6 | 632.9 |
| ADF, g | 195.5 | 104.8 | 300.3 | 184.2 | 226.6 | 401.8 |
| NEL, MJ | 2.8 | 8.5 | 11.3 | 2.7 | 8.3 | 11.0 |
| Fats, g | - | 23.5 | 23.5 | - | 29.6 | 29.6 |
| Starch, g | - | 485.7 | 485.7 | - | 311.6 | 311.6 |
| Ca, g | 2.7 | 24.9 | 27.6 | 2.5 | 13.5 | 16.0 |
| P, g | 1.2 | 5.0 | 6.2 | 1.15 | 5.7 | 6.85 |

Because of the unrestricted access to food, we can see that, during the entire fattening period, the animals in the 1st trial group ate slightly less concentrated feed than in group 2. Kids in the 2nd trial group consumed more protein (by 9.08%), fat (by 25.9%) and P (10.5%), while they consumed less starch (by 35.9%) and Ca (by 42.0%).

The analysis of the results of the study continued with growth rates, i.e. changes in the kids' live weight during the fattening.

The 1st trial group kids started fattening at the mean age of 92.7 days and mean live weight of 21.3 kg, while the 2nd group kids were on average by 1.2 days younger and 0.1 kg heavier, indicating that groups were very similar in terms of live weight and the age of the kid (Table 3).

**Table 3.** The age and live weight of kids at the beginning of fattening

| Group | Age at beginning of fattening, days | | | | Live weihgt at beginning of fattening, kg | | | |
|---|---|---|---|---|---|---|---|---|
| | $\bar{x} \pm S_{\bar{x}}$ | min. | max. | V,% | $\bar{x} \pm S_{\bar{x}}$ | min. | max. | V, % |
| $1^{st}$ trial | 92.7 ± 0.75 | 92 | 95 | 1.6 | 21.3 ± 1.33 | 18.0 | 24.5 | 12.5 |
| $2^{nd}$ trial | 91.5 ± 1.65 | 87 | 95 | 3.6 | 21.4 ± 0.98 | 18.5 | 23.0 | 9.2 |

Where V, % – coefficient of variation; $s_x$ – standard error of the mean.

The results in Table 3 show that the kids in both groups were age-adjusted and weight-adjusted at the start of the study - the coefficient of variation is 1.6–12.5%. At the start of the trial, the adaptation period of 10 days was provided to allow the kids to get used to the new housing and feeding conditions.

Kid's age and live weight before slaughter are summarized in Table 4.

**Table 4.** The age and live weight of kids before slaughter

| Group | Age before slaughter, days | | | | Live weihgt before slaughter, kg | | | |
|---|---|---|---|---|---|---|---|---|
| | $\bar{x} \pm S_{\bar{x}}$ | min. | max. | V,% | $\bar{x} \pm S_{\bar{x}}$ | min. | max. | V, % |
| 1st trial | 152.8 ± 0.75 | 152 | 155 | 1.0 | 31.1 ± 2.07 | 25 | 34 | 13.3 |
| 2nd trial | 151.5 ± 1.66 | 147 | 155 | 2.2 | 35.5 ± 1.54 | 31 | 37 | 8.7 |

Where V, % – coefficient of variation; $s_x$ – standard error of the mean.

The first group kids were by 1 day older and 4.38 kg lighter than kids in the 2nd group. At the begginning of the trial, goat kids in both groups had nearly the same live weight, but after fattening with a supplement of commercial concentrated feed, the body weight in group 2 was by 14.1% higher than in cases when fattening was achieved with grain mix, but there was no significant difference ($P > 0.05$).

The fattening period of goat kids in both groups was 60 days, during which the daily live weight gain was 165 and 235 g, respectively (Table 4). Daily live weight gain for 60 days of the fattening period was by 42.4% greater in the 2nd group kids than in the 1st group kids, and this difference was significant ($P < 0.05$).

**Table 5.** Average kid's live weight and live weight gain (± $s_x$)

| Group | Birth live weight, kg | Live weight at 50th day, kg | Live weight gain from birth till 50th day., g per day | Live weight gain until the end of fattening, g per day | Live weight gain during fattening, g per day |
|---|---|---|---|---|---|
| 1st group | 3.7 ± 0.25 | 13.0 ± 0.72 | 186 ± 15.3 | 179 ± 14.3 | $165^a$ ± 21.3 |
| 2nd group | 3.9 ± 0.36 | 13.3 ± 0.78 | 186 ± 10.6 | 208 ± 9.5 | $235^b$ ± 13.3 |

Where $s_x$ – standard error of the mean; a, b – signifficant differences ($P < 0.05$).

According to Table 5 the first group kids had a 0.22 kg lower birth weight than the kids of the 2nd group. In the 1st group, one kid was born alone, but all other kids in both groups were born as twins. Goat kids for the trial were purchased from a farm that is engaged in breeding of meat goats, but as this is a relatively new livestock breeding sector in Latvia, the farm has Boer goats with different crossing level. In Latvia, only 10 male goats and 34 female goats are pure-bred animals (https://www.ldc.gov.lv/upload/doc/BK_15112019_K.PDF).

For both goups kids crossing level is 66.02–90.6%. The daily increase in live weight up to the age of 50 days is 186 g per day. Boer goat fertility should be 180–200%, and live weight gain till 50 days of age should be 160–220 g per day (https://www.ldc.gov.lv/upload/doc/BK_15112019_K.PDF). As can be seen from the data in Table 5, the farm should focus on feeding mother goats in order to achieve a better fasting of kids during the first 50 days. During the fattening period the weight gain reached 165 to 235 g per day ($P < 0.05$). These results are higher compared to other reported research where average daily gain for Boer goats during *ad libitum* feeding reached only 147 g per day per animal (Solaiman et al., 2011).

After slaughtering, the resulting carcass weight and dressing was calculated (Table 6).

**Table 6.** Means (± S.E.) of carcass measurements

| Group | Dressing, % | Carcass length, cm | Hip circumference cm | Body fat thickness, mm | Thickness of dorsal muscle, mm | Ribeye area, $cm^2$ |
|---|---|---|---|---|---|---|
| 1st group | 49.5 ± 6.61 | 68.0 ± 2.33 | 54.0 ± 1.92 | 1.9 ± 0.21 | 24.3 ± 1.19 | 12.3 ± 1.09 |
| 2nd group | 43.1 ± 4.20 | 70.0 ± 1.52 | 55.0 ± 0.41 | 2.4 ± 0.16 | 25.5 ± 0.71 | 13.1 ± 0.97 |

Dressing percentage can be calculated as the ratio between hot carcass weight and live weight (McGregor, 2012). For the 1st group kids dressing percentage ranged from 32.0 to 64.0%, while for the second study group it was from 38.5 to 55.7%. The results showed lower dressing percentage by 13.0% for the 2nd group kids, but the differences were not significant. Although there were differences in the thickness of the adipose tissue, in the thickness of the muscle tissue and in the size of the ribeye muscle area, no significant differences were found ($P > 0.05$). McMillin et al. (2013) found that the average dressing percentage of goats is 48%, but other researchers found it in the range of 44.2–57.0% (Gurung et al., 2009; Kadim et al., 2003). Dressing percentage can have a large variation due to many factors including muscling, fat thickness, mud or debris on the hide, gut fill, amount of bone and horns (Schweihofer, 2011). According to Ruvuna et al. (1992) dressing percentage can increase with age. Intensive feeding can also increase the dressing percentage (Ryan et al., 2007). In our research carcasses weighing on average 14.36 kg (1st group) to 14.50 kg (2nd group) were obtained, and this difference isn't significant.

Overall, three carcasses in each group were graded O class and one carcass in each group was graded P class. The fat cover is a very important indicator for kid carcasses, because the quality of meat during storage depends on how much subcutaneous fat is present. If the fat in carcasses is low, storing and freezing may be difficult as the carcasses are damaged by dehydration. In the present study values of fat thickness and *Longissimus* muscle area are higher than in the studies of other researchers (Owen & Norman, 1977; Solamain et al., 2011). The carcass fat content is quite varying and depends on goat breed, age, sex, nutrition, live weight, physiological condition (Kirton, 1988). Visually the whole carcasses did not show differences to fat cover, but it should be noted that the carcass fat in the 1st group were notably yellow, and any tint could influence the consumers' choice when buying meat.

In view of the interests of consumers, in the market most carcasses are cut into cuts and then sold at a different price. The most valuable carcass cuts are hips, sirloin and ribs, which are classified by meat consumers in the 'Extra' category, while less valuable parts are either in category 1 – shoulder blade and shoulder or category 2 – flank and neck (Colomer-Rocher et al., 1987, Table 7).

According to previous findings (Aplocina et al., 2019), half carcass weight is quite similar despite the fact that kids in the present trial were by 57–62 days younger. The proportion of the most valuable and expensive parts is basically the same for the carcasses of kids in both groups, representing 70.9% to 71.4% of the weight of a half carcass. The least valuable part - flank - formed a bigger part in the carcass in the 1st group.

The results and ratios of the parts of the carcass tissue are shown in Figure 1. In respect of muscle tissue that is highly demanded by customers the highest carcass yield was obtained from the 2nd group carcasses, 55.8% on average, indicating an increased tendency for muscle formation in kids that are fed with commercially produced feed. This concentrated feed has a high fat content that gives a kid more nutritional energy during fattening, which is beneficial for the kid's growth and fattening performance. The largest proportion of low-value bone tissue - 32.4% - was obtained from the 1st group carcasses. Values reported for the proportion of muscles in the carcass in the present study are slightly lower (Aplocina et al., 2019) or consistent with the findings of other researchers, but the proportion of fats is significantly lower than in the studies of other researchers (Solamain et al., 2011; Aplocina et al., 2019).

**Table 7.** Carcass parts

| Carcass parts | 1st group | | 2nd group | |
|---|---|---|---|---|
| | kg | % | kg | % |
| Half carcass | 7.12 | 100 | 6.85 | 100 |
| Hip + leg | 2.14 | 30.2 | 2.25 | 32.9 |
| Flank | 0.57 | 7.8 | 0.45 | 6.5 |
| Sirloin | 0.42 | 5.9 | 0.41 | 6.0 |
| Ribs + chest vertebrae + back vertebrae | 2.48 | 34.8 | 2.23 | 32.5 |
| Shoulder blade + shoulder | 1.51 | 21.3 | 1.51 | 22.1 |

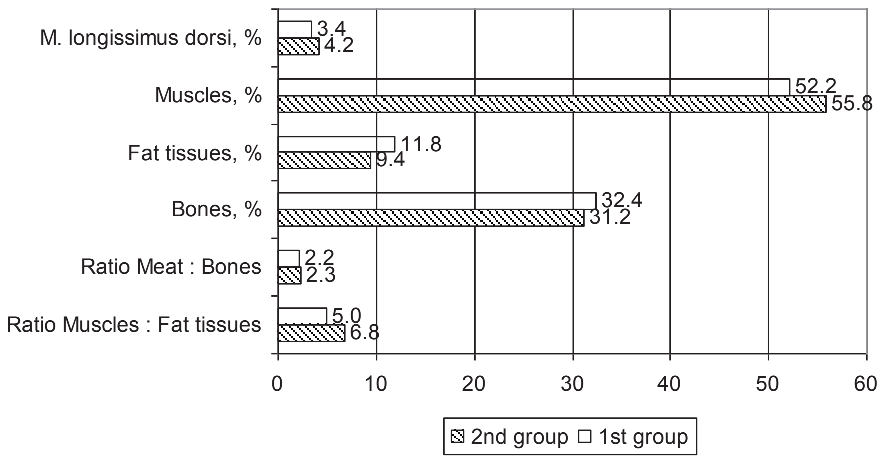


**Figure 1.** Carcass tissue parts and the ratio.

The meat-to-bone ratio was the same for both groups of kids, with 2.2 to 2.3 kg of meat per kg of bone. However, in terms of the muscle-to-fat ratio, the carcasses of both groups were significantly different ($P < 0.05$). Compared to our previous research, where goat kids received restricted amount of concentrated feed (Aplocina et al., 2019), the meat-to-fat ratio in the present study is significantly higher, which means that carcasses had less fat and much more lean meat. It is the result of *ad libitum* feeding of concentrated feed at the fattening period.

During the fattening of kids, the consumed concentrated feed and hay were recorded. The amount and economical effect of feeding during the fattening is summarized in Table 8.

**Table 8.** Feedstuffs consumed during the study

| Indices | 1st group | | 2nd group | |
|---|---|---|---|---|
| | Amount, kg | Cost, EUR | Amount, kg | Cost, EUR |
| Concentrated feed per day per animal | 1.289 | 0.31 | 1.359 | 0.49 |
| Concentrated feed per 1kg of ADG | 7.83 | 1.88 | 5.77 | 2.08 |
| Hay per day per animal | 0.605 | 0.04 | 0.580 | 0.03 |
| Hay per 1kg of ADG | 3.67 | 0.22 | 2.46 | 0.15 |
| Total daily feed costs per animal, EUR | 0.35 | | 0.52 | |
| Total feed costs per 1 kg ADG, EUR | 2.10 | | 2.23 | |

Where ADG – Average daily gain.

The results show that the kids in the 2nd group used more concentrated feed per day per kid than the kids in the 1st group, and the cost of consumed concentrated feed per day by one kid was 58.1% higher than in the 1st group. Conversely, the amount of concentrated feed consumed per kg of live weight gain was lower in the 2nd group kids, but also in this case the cost of feed per kg of live weight gain was by 0.20 euros or 10.6% higher than in the 1st group group animals. The amount of hay consumed per animal per day did not differ between groups. The total feed costs per animal per day and per kg of live weight gain were higher in the 2nd group, as it is known that commercially produced feed has higher price than that of grain mix.

## CONCLUSIONS

Feed rations with *ad libitum* concentrates affected various carcass characteristics as well as carcass fat level. During the whole fattening period, the feed intake was slightly less in the 1st group. The 2nd group kids consumed more protein (9.08%), fat (25.9%) and P (10.5%), while they consumed less starch (by 35.9%) and Ca (by 42.0%). Daily live weight gain of the 60 days fattening period was by 42.4% higher for the kids of the 2nd group that consumed commercially produced concentrated feed ($P < 0.05$). Feeding of grain mix resulted in a lower growth rate in the 1st group kids (31.1 kg and 35.5 kg pre-slaughter live weight, respectively), but kids of the 1st group have a higher dressing rate (49.5% and 43.5%, respectively). Consequently, there is no significant difference in carcass weight (14.36 kg and 14.50 kg, respectively). Carcasses in the 1st group had a higher fat content. In terms of muscle-to-fat ratio, the carcasses of kids in both groups were significantly different ($P < 0.05$), with 5.0 kg of muscle tissue per 1 kg of fats in the 1st group and 6.8 kg muscles in the 2nd group. Total feed costs per animal per day and per 1 kg of live weight gain were higher in the 2nd group, as commercially produced concentrated feed has a significantly higher price than grain mix feed. As there is no difference in obtained carcass weight and consumers ultimately pay for the amount of meat, not quality of meat, farmers can decide which feedstuffs are more suitable and profitable for fattening of goat kids.

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## REFERENCES


Aplocina, E. & Degola, L. 2019. Effect of concentrate supplementation on fattening performance and carcass composition of finished meat–goat kids. *Agronomy Research* **17** (S2), 1273–1286.

Carrasco, S., Ripoll, G., Sanz, A., Alvarez-Rodriquez, J., Panea, B., Revilla, R. & Joy, M. 2009. Effect of feeding system on growth and carcass characteristics of Churra Tensina light lambs. *Livestock Science*. **121**, 56–63.

Colomer-Rocher, E., Morand-Fehr, P. & Kirton, A.H. 1987. Standard methods and procedures for goat carcass evaluation, jointing and tissue separation. *Livestock Production Science* **17**, 149–159.

Commission Regulation (EC) No 1249/2008. Available https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:337:0003:0030:EN:PDF

FAOSTAT. 2019. Available http://www.fao.org/faostat/en/#home

Feeding programs for meat goats. By Pinkerton F. and Pinkerton B. http://www.goatworld.com/articles/nutrition/feedingprograms.shtml.

Food and Agriculture Organization of the United Nations (FAO), 2017. Available: http://www.fao.org/faostat/en/#data/QL

Goetsch, A.L., Merkel, R.C. & Gipson, T.A. 2011. Factors affecting goat meat production and quality. *Small Ruminant Research* **101**, 173–181.

Gurung, N.K., Solaiman, S.G., Rankins, D.L. & McElhenney, W.H. 2009. Effects of distillers dried grains with solubles on feed intake, growth performance, gain efficiency and carcass quality of growing Kiko x Spanish male goats. *J. Anim. Vet. Adv.* **8**(10), 2087–2093.

Horcada, A., Ripoll, G., Alcalde, M.J., Sanudo, C., Teixeira, A. & Panea, B. 2012. Fatty acid profile of three adipose depots in seven Spanish breeds of suckling kids. *Meat Science* **92**, 89–96.

ISO 10520:2001. Native starch. Determination of starch content. ISO/TC93, 8 pp.

ISO 13906:2008. Animal feeding stuffs. Determination of acid detergent fibre (ADF) and acid detergent lignin (ADL) contents. ISO/TC34/SC10, 17 pp.

ISO 16472:2006. Animal feeding stuffs. Determination of amylase-treated neutral detergent fibre content. ISO/TC34/SC10, 15 pp.

ISO 5983-2:2009. Animal feeding stuffs. Determination of nitrogen content and calculation of crude protein content. ISO/TC34/SC10, ICS: 65.120, ed. 2. part 2, 15 pp.

ISO 6491:1998. Animal feeding stuffs. Determination of phosphorus content. ISO/TC34/SC10, 7 pp.

ISO 6492:1999. Animal feeding stuffs. Determination of fat content. ISO/TC34/SC10, 9 pp.

ISO 6496:1999. Animal feeding stuffs. Determination of moisture and other volatile matter content. ISO/TC34/SC10, 7 pp.

ISO 6869:2002. Animal feeding stuffs. Determination of calcium, magnesium and sodium. ISO/TC34/SC10, ed.1,15 pp.

Ivanovic, S., Pavlovic, I. & Pisinov, B. 2016. The quality of goat meat and it's impact on human health. *Biotechnology in Animal Husbandry* **32**(2), 111–122.

Joy, M., Ripoll, G. & Delfa, R. 2008. Effects of feeding system on carcass and non-carcass composition of Churra Tensina light lambs. *Small Ruminant Research* **78**, 123–133.

Kadim, I.T., Mahgoub, O., Al-Ajmi, D.S., Al-Maqbaly, R.S., Al-Saqri, N.M. & Ritchie, A. 2003. An evaluation of the growth, carcass, and meat quality characteristics of Omani goat breeds. *Meat Sci.* **66**, 203–210.

Kirton, H. 1988. Characteristics of goat meat, including carcass quality and methods of slaughter. In: *Goat Meat Production in Asia. Proc. of a Meat Workshop.* Tando Jam, Pakistan, pp. 13–18.

McGregor, B.A. 2012. The role of objective and subjective evaluation in the production and marketing of goats for meat. In: Mahgoub, O.I.T. & Kadim, E.C. Webb (eds): *Goat Meat Production and Quality*. CAP international, Cambridge, MA. p 212.

McMillin, K., Gregorie, J., Braden, K., Cope, R. & Pinkerton, F. 2013. Live animal and carcass measurements of meat goats: A USDA National Institute of Food and Agriculture project. *Proc 28th Ann. Goat Field Day*. Langston University. Langton, OK. pp. 14–16.

Moe, P.W. & Turrell, H.F. 1976. Estimating metabolizable and net energy of feeds. In: *Proc. 1st Intern. Symp. on Feed Composition, Animal Nutrient Requirement and Computerization of Diets.* Utah State University, pp. 232–237.

Ni, K.K., Wang, F.F., Zhu, B.G., Yang, J.X., Zhou, G.A., Pan, Y. & Zhong, J. 2017. Effects of lactic acid bacteria and molasses additives on the microbial community and fermentation quality of soybean silage. *Bio resource Technology* **238**, 706–715.

Owen, J.E. & Norman, G.A. 1977. Studies on the meat production characteristics of Botswana goats and sheep – Part II: General body composition, carcass measurement sand joint composition. *Meat Sci*. **1**, 283–306.

*Report on Agriculture 2014.* https://www.zm.gov.lv/public/files/CMS_Static_Page_Doc/00/00/00/63/66/LS_gadazinojums_2015.pdf (in Latvian).

Ruvuna, F., Taylor, J.F., Okeyo, M., Wanyoike, M. & Ahuya, C. 1992. Effects of breed and castration on slaughter weight and carcass composition of goats. *Small Rumin. Res.* **7**, 175–183.

Ryan, S.M., Unruh, J.A., Corrigan, M.E., Drouillard, J.S. & Seyfert, M. 2007. Effects of concentrate level on carcas traits o fBoer crossbred goats. *Small Ruminant Research* **73**, 67–76.

Solaiman, S., Min, B.R., Gurung, N., Behrends, J. & Taha, E. 2011. Assessing feed intake, growth performance, organ growth, and carcass characteristics of purebred Boer and Kiko male kids fed high concentrate diet. *Small Ruminant research* **98**, 98–101.

Schweihofer, J.P. 2011. Carcass dressing percentage and cooler shrink. Native Plants and Ecosystem Services. https://www.canr.msu.edu/news/carcass_dressing_percentage_and_cooler_shrink.

Teixeira, A., Fernandes, A., Pereira, E., Manuel, A. & Rodrigues, S. 2017. Effect of salting and ripening on the physicochemical and sensory quality of goat and sheep cured legs. *Meat Science* **134**, 163–169.

Toplu, H.D.O., Goksov, E.O., Nazligul, A. & Kahraman, T. 2013. Meat quality characteristics of Turkish indigenous Hair goat kids reared under traditional extensive production system: effects of slaughter age and gender. *Tropical Animal Health and Production* **45**(6), 1297–1304.

Webb, E.C. 2014. Goat meat production, composition and quality. *Animal Frontiers* **4**(4), 33–37