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# Effects of rearing type and slaughter age on some carcass quality traits of Saanen kids

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**Abstract**

In the study, it was aimed to compare certain carcass quality traits of Saanen kids reared naturally or artificially and slaughtered at 80 or 120 days of age. There was no significant difference between the carcass weight and dressing percentage of the naturally and artificially reared kids. On the other hand, kids slaughtered at 80d in the naturally reared group was lower real dressing percentage than other subgroups. The effect of rearing type on the kidney knob and channel fat (KKCF) and subcutaneous fat proportion in hind limb was found insignificant, while the intermuscular fat proportion in hind limb was higher in the naturally reared kids. Parallel to the increase in slaughter age; carcass weights, carcass and hind limb compactness indices and proportion of flank and neck increased. The effect of slaughter age on proportions of KKCF, subcutaneous and intermuscular fat in hind limb was not detected significant. Meat ratio in hind limb was found higher on kids that were slaughtered younger. Breeders who aim to get high milk yield can rear Saanen kids artificially, without causing any negative effect on carcass quality traits.

**Anahtar kelimeler:** Rearing type, slaughter age, dressing percentage, carcass joints, carcass composition

**Saanen oğlaklarda büyütme tipi ve kesim yaşının bazı karkas kalitesi özellikleri üzerine etkileri**

**Özet**

Çalışmada, analı ve yapay büyütülen Saanen ırkı erkek oğlakların 80 ve 120 günlük yaşlarda kesime sevk edildiği üretim modellerinde, oğlakların bazı karkas kalitesi özelliklerinin karşılaştırmalı olarak ortaya konulması amaçlanmıştır. Karkas ağırlığı ve karkas randımanı bakımından analı ve yapay büyütülen oğlaklar arasında önemli bir farklılık tespit edilmemiştir. Diğer yandan boş vücut ağırlığına göre hesaplanan gerçek karkas randımanının yapay büyütülen oğlaklarda analı büyütülenlere kıyasla daha yüksek olduğu görülmektedir. Büyütme tipinin böbrek-leğen yağı ve butta derialtı yağ oranı üzerine etkisi önemsizken, butta kaslararası yağ oranının analı büyütülen oğlaklarda daha yüksek olduğu sonucuna ulaşılmıştır. Kesim yaşı artışına paralel olarak karkas ağırlığı, karkas ve but kompaktlık indekslerinin, boyun ve kaburga oranlarının arttığı tespit edilmiştir. Kesim yaşının böbrek-leğen yağı, butta derialtı yağ ve kaslararası yağ oranları üzerine etkisi önemsiz bulunmuştur. Butta et oranının ise küçük yaşlarda kesime sevk edilen oğlaklarda daha fazla olduğu sonucuna ulaşılmıştır. Yüksek süt verimi elde etmeyi amaçlayan keçi yetiştiricileri, karkas kalite özelliklerinde herhangi bir olumsuzluğa neden olmaksızın Saanen oğlaklarını yapay besleme ile büyütebilirler.

**Keywords:** Büyütme tipi, kesim yaşı, karkas randımanı, karkas parçaları, karkas kompozisyonu

## Introduction

Despite the implemented inappropriate agricultural policies regarding goat breeding that intended to decline the goat population, goat breeding still maintains its importance to supply living cost and nutritional needs of the families who are living in the forestry and urban regions. In recent years, depending on the prominence of healthy living concept, an increase was observed for the tendency of consuming of the healthy and quality products. The demand for the goat milk and products supplied from the goat milk (cheese, ice-cream, and yogurt) increased due to being easier to digest comparing to cow milk and being less protein allergenic due to having less beta casein (Haenlein, 2004). Today the goat milk products can be marketed as niche products and consumers are willing to pay high prices. In Turkey, goat breeding is performed by indigenous breeds mostly in an extensive production system. However, in this production system, enough amount of quality goat milk cannot be obtained for the market. In order to fulfill the increased goat milk demand, intensive goat production systems have started to

be established especially in Marmara and Aegean Regions. Recently, while goat farms have been gaining modern structure which leads them to be less sufficient to the pasture, changes in the production systems provided the usage of high yielded genotypes (Savaş, 2008). In this context, Saanen or Saanen crossbreds come to the fore with their features in terms of the high milk and offspring yield for either family type or modern enterprises that aim milk production. In order to obtain more marketed goat milk, goat kids are separated from their dams at early ages and reared in artificial rearing systems in intensive goat breeding enterprises. While most of the female goat kids are added to the flock to sustain herd size and increase the capacity of milk production, except the breeder male goats, male goats are sold for the meat production and they form a secondary income source for the enterprise.

Carcass weight, dressing percentage, percentages of the carcass joints where valuable meat is obtained, carcass indexes and proportion of meat, bone, and fat are the primary features, which determine the quality of goat carcasses. Various researchers reported that quality of goat carcasses is affected by genotype (Ekiz et al., 2010; Koşum et al., 2003; Özcan et al., 2010), production system and slaughter weight/age (Marichal et al., 2003; Zimerman et al., 2008; Bonvillani et al., 2010), gender (Mahgoub et al., 2004) and goat rearing systems (Argüello et al., 2007; Panea et al., 2012).

For the enterprises, which are primarily aiming the milk production, however, selling male goat kids, which are not separated for the production purposes for the meat production, quality goat carcass production would contribute to increasing the income level. In this regard, presenting the quality of goat carcasses in existing production systems and knowing the effects of various environmental factors, have a great importance regarding to improve the carcass quality.

This study was produced from a project, which investigated the effect of rearing systems on certain carcass and meat quality characteristics of Saanen kids. This article includes growth performance and certain carcass quality results of the main project.

## Material and Methods

### *Animals and experimental design*

The Ethics Committee of Istanbul University approved the experimental protocol of the current study (Approval number: 2014/17).

The study was conducted in the private dairy goat farm in Catalca /Istanbul (Evla Goat Farm, Catalca, Istanbul, Turkey). The animal material of the study was formed by 42 male Saanen kids which were raised in natural rearing (NR) and artificial rearing (AR), and were slaughtered at 80 and 120 days of age. There were 4 experimental groups in the study; AR-80 (n=12), AR-120 (n=12), NR-80 (n=9) and NR-120 (n=9). Birth weight of the NR-80, NR-120, AR-80 and AR-120 kids were 3.56 kg, 3.33 kg, 3.19 kg and 2.99 kg, respectively. Immediately after kidding the researchers decided for the goat kids which would be in AR and NR groups. Goat kids in the subgroups were selected from the singleton reared ones.

According to the routine farm management practice, the farmer separated AR kids from their dams immediately after kidding and fed them with colostrum for the first two days by the nursing bottle. On the 3$^{rd}$ day, every 12 kids were placed into pens (0.70 $m^2$ / per animal) and they were fed with commercial milk replacer (95.5% dry matter, 23.13% crude protein, 15.46 MJ ME/kg DM) by using a milk feeder bucket until 83 days of age (Table 1). There were two milk feeder buckets in each pen and each kid had a chance to take one nipple at the feeding time. Besides the milk replacer, kids were fed *ad libitum* with concentrate feed (86.9% dry matter, 17.69% crude protein, 11.24 MJ ME/kg DM) and dry grass (88.5% dry matter, 7.13% crude protein, 8.81 MJ ME/kg DM) after 21 days of age.

**Table 1.** Feeding programme for artificial rearing group

| **Age** | **Dams milk** | **Commercial Milk Replacer** | **Total Milk** (per kids) × **number of daily meal** |
|---|---|---|---|
| First 2 days | %100 (colostrum) | - | 350 ml × 3 |
| 3 – 7 d | %70 | %30 | 350 ml × 3 |
| 7 – 11 d | %50 | %50 | 400 ml × 3 |
| 11 – 15 d | - | %100 | 450 ml × 3 |
| 16 – 21 d | - | %100 | 550 ml × 3 |
| 22 – 27 d | - | %100 | 600 ml × 3 |
| 28 – 34 d | - | %100 | 700 ml × 2 |
| 35 – 41 d | - | %100 | 600 ml × 2 |
| 42 – 83 d | - | %100 | 500 ml × 1 |

Farmers kept kids with their dams and fed them by dam's milk until 45 days of age in NR groups. 2.3 $m^2$ indoor and 2.2 $m^2$ backyard area were supplied to each goat and their kids. In the second week after kidding, they started to put concentrate feed and dry grass in the box where only the kids had access. When kids reached the 45 days of age in NR groups, they were separated from their dams and were placed into pens (0.70 $m^2$ / per animal). Concentrate feed and dry grass was supplied *ad libitum* until the age of 83 days.

Kids reaching 83 days of age in AR and NR groups were sent to slaughter in the experimental abattoir of Istanbul University Veterinary Faculty. Kids which would be slaughtered at 120 days of age were fattened indoors (0.70 m2 / per animal) with ad libitum concentrate feed (87.5% dry matter, 14.31% crude protein, 11.09 MJ ME/kg DM) and dry grass after 83 days of age. The growth performance of kids was followed by weekly weightings.

***Slaughtering and carcass characteristics***

Kids which reached slaughter age were weighed at the farm in the morning without being fed and their weights were recorded as a final live weight. After 45 minutes of road transport, kids reached only clean water at a resting period for 30 minutes. Kids were electrically stunned and slaughtered after the recording of pre-slaughter weight. Carcass weights were recorded after 24h at 4°C chilling process. Cold carcasses included kidney and kidney knob and channel fat (KKCF). Dressing percentage was calculated using pre-slaughter live weight and real dressing percentage was estimated using empty body weight.

Cold carcasses firstly were divided into two halves, and then right halves were split into five joints (shoulder, flank, neck, ribs, and hind limb) according to the methodology of Colomer-Rocher et al. (1987). The weight of each carcass joints was recorded and proportion of each carcass joints were calculated based on half carcass weight. After carcass jointing, right hind limb was vacuum packed and put into deep freezer (-18°C) to estimate carcass composition. The day before dissection, hind limbs were thawed at 4°C for 24h. Each hind limb joint was dissected into muscle, bone, subcutaneous fat, intermuscular fat and other tissues by the dissection method described by Fisher and de Boer (1994). We used the formula that reported by Ekiz et al. (2010) to calculated conformation indices such as hind limb compactness, carcass compactness and chest roundness index.

***Data analyses***

In order to determine the effects of slaughter age and rearing type on growth and carcass quality traits, General Linear Model (GLM) procedure was applied by using SPSS 13.0 programme. In case of significant SA × RT interaction, One-way ANOVA and Duncan's multiple Range Tests for 4 subgroups were performed. The mathematical description of the GLM model was:

$\gamma_{ijk} = \mu + a_i + b_j + ab_{ij} + e_{ijk}$

Where;

$\gamma_{ijk}$ is the $ijk^{th}$ observation,

$\mu$ is the overall mean,

$a_i$ is the fixed effect of $i^{th}$ rearing type (i = Artificial and natural),

$b_j$ is the fixed effect of $j^{th}$ slaughter age (j = 80 and 120 days),

$ab_{ij}$ is the interaction between rearing type and slaughter age,

$e_{ijk}$ is random error.

## Results

The effect of slaughter age and rearing type on carcass traits are presented in Table 2. SA-120 kids had higher carcass weight, carcass and hind limb compactness than SA-80 kids. Rearing type and slaughter age had no significant effect on dressing percentage. On the other hand, SA × RT interaction was significant for real dressing percentage. Naturally reared SA-80 kids had lower real dressing percentages than artificial ones, while there were no significant differences between natural and artificial rearing kids with in SA-120 groups.

**Table 2.** Certain carcass quality characteristics of kids according to slaughter age and rearing type (data expressed as mean ± SE).

| Characteristics | Natural Rearing | | Artificial Rearing | | SA | RT | SA × RT |
|---|---|---|---|---|---|---|---|
| | SA-80 | SA-120 | SA-80 | SA-120 | | | |
| Weaning weight, kg | 8.23±0.58 | 10.66±0.58 | 10.95±0.50 | 12.58±0.50 | *** | *** | NS |
| Final live weight, kg | 10.13±0.87 | 13.40±0.87 | 11.15±0.76 | 13.59±0.76 | * | NS | NS |
| Carcass weight, kg | 3.49±0.37 | 4.71±0.37 | 3.85±0.32 | 4.43±0.32 | * | NS | NS |
| Dressing perc.[1], % | 34.32±1.06 | 35.34±1.053 | 34.98±0.91 | 33.17±0.91 | NS | NS | NS |
| Real dressing perc.[2], % | $42.68^{b}$±0.75 | $45.11^{a}$±0.75 | $45.89^{a}$±0.65 | $45.23^{a}$±0.65 | NS | * | * |
| Chilling losses, % | 8.13±0.60 | 6.65±0.60 | 7.23±0.52 | 5.86±0.52 | * | NS | NS |
| Carcass comp.[3], g/cm | 77.39±6.26 | 98.38±0.39 | 82.90±5.43 | 89.64±5.43 | * | NS | NS |
| Hind limb com.[4], g/cm | 20.80±1.91 | 26.52±1.91 | 21.50±1.66 | 24.15±1.66 | * | NS | NS |
| Chest roundness index | 0.61±0.03 | 0.69±0.03 | 0.66±0.03 | 0.61±0.03 | NS | NS | * |

NS, not significant (P>0.05); * P<0.05, *** P<0.001.

[a, b] For characteristics, where SA × RT interaction was significant, means with different superscript letters following them are significantly different (P<0.05).
[1] Dressing percentage was calculated based on slaughter weigh.
[2] Dressing percentage was calculated based on empty body weight.
[3] Carcass compactness.
[4] Hind limb compactness.

It was seen that, SA-120 kids had higher flank and neck proportion than SA-80 kids, while artificial kids had higher hind limb proportion than natural ones (Table 3). Slaughter age had a significant effect on lean proportion, while rearing type had a significant effect on intermuscular fat proportion and lean/fat ratio. Natural reared kids had higher intermuscular fat proportion and lower lean/fat ratio than artificial ones (Table 4).

**Table 3.** Proportion of carcass joints in Saanen kids according to slaughter age and rearing type (data expressed as mean ± SE).

| Characteristics | Natural Rearing | | Artificial Rearing | | SA | RT | SA × RT |
|---|---|---|---|---|---|---|---|
| | SA-80 | SA-120 | SA-80 | SA-120 | | | |
| Shoulder | 22.70±0.45 | 22.54±0.45 | 22.24±0.39 | 22.75±0.39 | NS | NS | NS |
| Flank | 6.44±0.39 | 7.98±0.39 | 6.81±0.34 | 7.31±0.34 | * | NS | NS |
| Neck | 9.51±0.43 | 8.89±0.43 | 9.31±0.37 | 8.11±0.37 | * | NS | NS |
| Ribs | 25.32±0.71 | 24.93±0.71 | 25.10±0.62 | 24.69±0.62 | NS | NS | NS |
| Sirloin | 17.95±0.75 | 17.87±0.75 | 17.82±0.65 | 18.25±0.65 | NS | NS | NS |
| Loin | 7.38±0.36 | 7.05±0.36 | 7.27±0.31 | 6.45±0.31 | NS | NS | NS |
| Hind limb | 33.48±0.41 | 33.08±0.41 | 34.48±0.35 | 34.65±0.35 | NS | ** | NS |
| Tail | 0.29±0.03 | 0.30±0.03 | 0.25±0.02 | 0.32±0.02 | NS | NS | NS |
| Kidney | 1.27±0.05 | 1.21±0.05 | 1.19±0.05 | 1.26±0.05 | NS | NS | NS |
| KKCF[f] | 0.99±0.20 | 1.08±0.20 | 0.62±0.17 | 0.92±0.17 | NS | NS | NS |

NS, not significant (P>0.05); * P<0.05; ** P<0.01.
[f] Kidney knob and channel fat.

**Table 4.** Hind limb composition of Saanen kids according to slaughter age and rearing type (data expressed as mean ± SE).

| Characteristics | Natural Rearing | | Artificial Rearing | | SA | RT | SA × RT |
|---|---|---|---|---|---|---|---|
| | SA-80 | SA-120 | SA-80 | SA-120 | | | |
| Lean, % | 57.90±1.69 | 55.97±1.69 | 62.66±1.46 | 57.53±1.46 | * | NS | NS |
| Bone, % | 31.96±1.77 | 31.61±1.77 | 28.58±1.54 | 31.98±1.54 | NS | NS | NS |
| Subcutaneous fat, % | 0.64±0.26 | 0.92±0.26 | 0.53±0.23 | 0.91±0.23 | NS | NS | NS |
| Intermuscular fat, % | 5.55±0.53 | 5.08±0.53 | 4.00±0.46 | 4.50±0.46 | NS | * | NS |
| Total fat, % | 6.20±0.64 | 6.00±0.64 | 4.53±0.55 | 5.40±0.55 | NS | NS | NS |
| Other tissues[g], % | $2.26^{b}$±0.37 | $4.35^{a}$±0.37 | $1.95^{b}$±0.32 | $2.46^{b}$±0.32 | *** | ** | * |
| Evaporation loss, % | 1.69±0.24 | 2.08±2.24 | 2.28±0.21 | 2.62±0.21 | NS | * | NS |
| Lean/Bone ratio | 1.86±0.16 | 1.85±0.16 | 2.25±0.14 | 1.90±0.14 | NS | NS | NS |
| Lean/Fat ratio | 9.86±1.18 | 11.24±1.18 | 14.46±1.03 | 11.69±1.03 | NS | * | NS |

NS, not significant (P>0.05); * P<0.05; ** P<0.01; *** P<0.001.
[a, b] For characteristics, where SA × RT interaction was significant, means with different superscript letters following them are significantly different (P<0.05).
[g] Major blood vessels, tendons, larger nerves and lymph nodes.

## Discussion

Naturally reared kids had lower weaning weight than artificially ones, while the final live weight of kids was not affected by rearing type. The differences between rearing type groups for weaning weight in the present study could be the result of weaning age. Naturally reared kids were weaned at 45 days of age, while artificially reared kids were weaned at 83 days of age. Similarly, Delgado-Pertíñez et al. (2009) observed no significant effect on the live weight for natural suckling and artificially rearing kids.

In the current study, higher final live weight was obtained in older lambs as expected. Increasing carcass weight, carcass compactness, and hind limb compactness and decreasing chilling losses with increasing slaughter age might be caused by high final weight in SA-120 kids. Various authors also reported high carcass weight, carcass indices and low chilling losses with increasing slaughter weight (Peña et al., 2007; Bonvillani et al., 2010). Peña et al. (2007) attributed low chilling losses at the higher slaughter weight to a decrease in the body surface/body weight ratio. Dressing percentages did not change with slaughter age in this study. Supporting the current results, several authors (Kaić et al., 2012; Panea et al., 2012; Peña et al., 2007) also pointed out that the effect of slaughter age/weight on dressing percentage was insignificant. Moreover, Teixeira et al. (2011) found out that dressing percentage did not change in light kids, which had 3.8 - 6 kg carcass weight. Dressing percentage values (34.07 –

34.83%) in the current study were lower than reports in the previous studies. Fehr et al. (1976) reported lower dressing percentage of kids slaughtered at lower live weights and explained this results by inadequate growth rate in kids. Lower dressing percentage obtained in the present study might be related to the low growth rate of kids under the conditions of the study.

It was seen that slaughter age did not affect significantly on proportions of carcass joints, except flank and neck proportions. Similarly, insignificant effects of slaughter age/weight on proportions of carcass joints were reported by Bonvillani et al. (2010) for Criollo Cordobés kids and Marichal et al. (2003) for Canarian Caprine genotype kids. Proportions for first quality carcass joints, which were hind limb and ribs (33.87-33.98% and 24.81-25.21% respectively) in the current study were in accordance with the reports by Zimerman et al. (2008) for Criollo Neuguino kids (32.13-34.05% and 23.89-25.43%); Peña et al. (2007) for Florida kids (31.3-32.8% and 22.1-24.3%) and Dhanda et al. (2003) for six different goat genotypes (33% and 24%).

Goat tends to store more fat internally, rather than intermuscular and subcutaneous sites (Dhanda et al., 1999a). Moreover, it is generally known that subcutaneous fat is slightly stored in goats. Slaughter age had no significant effect on the subcutaneous fat ratio, intermuscular fat ratio, total fat ratio as well as proportions of KKCF in the current study. Similarly, Marichal et al. (2003) reported that there were no significant differences between 6, 10 and 25 kg kids in the subcutaneous and total fat ratio. On the contrary, numerous authors (Dhanda et al., 1999a; Peña et al., 2007; Zimerman et al., 2008) reported increasing carcass fatness with slaughter age. These differences between researchers' findings might be caused by differences in diet or slaughter age. Furthermore, kids in the current study had low carcass fatness, which might be due to their not being developed enough to be fattened.

Carcass composition is one of the main criteria for carcass quality. Argüello et al. (2001) reported that, hind limb is a good predictor of carcass muscle, bone and intermuscular fat. Proportions of bone, subcutaneous fat, intermuscular fat as well as total fat did not change with slaughter age, when lean proportion decreased with slaughter age in the present study. Marichal et al. (2003) obtained insignificant differences in terms of subcutaneous fat, total fat, lean and bone proportions for 6, 10 and 25 kg kids. On the contrary, Panea et al. (2012), Dhanda et al. (1999b) and Zimerman et al. (2008) who used shoulder joint to determine the carcass composition reported increasing lean and fat proportions and decreasing bone proportion with slaughter age. Total fat proportion (4.87-4.9%) obtained from the hind limb dissection for both slaughter age groups (SA-80 and SA-120) were in accordance with the report by Bonvillani et al. (2010) for Criollo Cordobes kids (3.9-4.7).

Rearing type had no significant effect on final live weight, carcass weight, dressing percentage, carcass compactness, hind limb compactness, chest roundness index as well as proportions of carcass joints except hind limb ratio. On the other hand, real dressing percentage and proportion of hind limb showed higher results in artificially reared kids compared to naturally reared kids (Table 2 and Table 3). Argüello et al. (2007) also observed no significant differences in live weight at slaughter, carcass weight, dressing percentages, carcass indexes and proportions of primal cuts in kids reared with their dams and milk-replacer kids. Moreover, Panea et al. (2012) reported that the effects of milk diet (naturally and artificially) on live weight, carcass weight, and dressing percentages were not significant for Malagueña and Murciano-Granadina dairy goat breeds. Intermuscular fat and total fat proportions in hind limb were higher in the naturally reared kids (Table 4). Argüello et al. (2007) obtained similar results for Canary Caprine kids and they explained this difference with a higher amount of fat fed in kids reared with their dams and milk-replacer kids. Panea et al. (2012) also observed high intermuscular fat proportion in shoulder dissection for naturally reared kids compared to artificially ones.

## Conclusion

As a conclusion, final live weight, carcass weight, carcass compactness, hind limb compactness, flank and neck proportions were higher in SA-120 kids. On the other hand, lean proportion was higher in SA-80 kids. There was no significant difference in final live weight for rearing groups. However, artificially reared kids had higher real dressing percentage and hind limb proportion, while naturally reared kids had higher intermuscular fat proportion. The results obtained in the current study indicate that effect of slaughter age on carcass quality characteristics was more evident than rearing type. Breeders who aim to get high milk yield can rear Saanen kids artificially without, causing any negative effects on carcass quality traits.

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