AGRICULTURAL SCIENCE AND TECHNOLOGY, VOL. 12, No 2, pp 124-129, 2020
Published by Faculty of Agriculture, Trakia University, Bulgaria
ISSN 1313-8820 (print)
ISSN 1314-412X (online)
http://www.agriscitech.eu
DOI: 10.15547/ast.2020.02.021

Effect of diets with whey powder on growth and development of Saanen Goat kids

A. Özdemir[1], M. Yilmaz[1]*, A. Çağli[1], G.S.E. Aşıcı[2], H. Akçay[1], K. Çelik[3]

[1]Department of Animal Science, Faculty of Agriculture, Adnan Menderes University, Aydin, Turkey
[2]Department of Biochemistry, Faculty of Veterinary Medicine, Adnan Menderes University, Aydin, Turkey
[3]Department of Animal Science, Faculty of Agriculture, Çanakkale Onsekiz Mart University, Çanakkale, Turkey

(Manuscript received 11 December 2019; accepted for publication 16 April 2020)

Abstract. *In this study, the effect of the diets enriched nutritionally with whey powder (WP) on the growth and development of weaned Saanen Goat kids was investigated. For the purpose, 24 kids born in March 2017 and weaned after 5 months and reared for 8 weeks in Adnan Menderes University Agricultural Faculty Research and Application Farm were used. The kids were divided into three groups according to the content of the ration. The kids whose beginning weights were recorded were distributed homogeneously to each group. These groups were labeled as the control group (CG) and the experimental groups which were formed by adding 5% (5%WP) and 10% whey powder (10%WP) to the ration by removing the same amount of feed. The following parameters of the experimental kids were controlled: live weight, body condition score (BCS), body length, chest girth, the height at the withers, and some blood serum indices (total protein, cholesterol, glucose and urea). The differences between the initial and final values of the growth performance parameters in the groups with the best improvement according to the results obtained from the experiment were found to be 2.57 kg in body weight and 6.25 cm in body length in 10%WP group and the body condition score was 0.26 points, wither height 6.06 cm, and chest girth 6.75 cm in the 5%WP group. When the groups in which the best results are observed in blood parameters are considered; in the 5% WP group, the difference between the initial and final values were found to be 4.19 mg/dL in glucose and 1.22 g/dL in total protein, while urea 41.06 mg/L and cholesterol were determined to be 58.53 mg/dL in the 10%WP group. In the light of the results obtained, it has been determined that the addition of WP in a certain amount to the ration has a positive effect on the growth and development of the kids. As a result of the study, the addition of 5%WP was recommended in the ration to be given during the kid growing period.*

Keywords: goat kids, whey powder, fattening performance, blood parameters

Introduction

Food consumption increases with the developing world population. Therefore, in the processed food sector, different new feed sources, sometimes called waste, and sometimes by-products, emerge. In animal husbandry, it is important to reduce feed costs. If these products obtained as waste are evaluated in animal husbandry, the cost of feed can be reduced (Degu et al., 2009).

Whey is one of the significant by-products of the milk technology, generally obtained during cheese production. Its total dry substance is around 6%, which meets the 85-95% of the milk volume and contains 55% of milk compounds. Whey is a significant by-product containing lactose, fat, mineral matter and vitamins at varying levels, together with serum proteins like milk compounds lacto albumin and lacto globulin (Şahin and Karaali, 2003; Dincoğlu and Ardiç, 2012). Whey proteins are high-quality proteins and they include all essential amino acids (Hoffman and Falvo, 2004). These all-essential amino acids are contained in whey at higher concentrations than herbal protein sources (Haraguchi et al., 2009). This product is used in many various ways in developed countries that are aware of the nutrients value in whey. However, it can not be used enough in Turkey (Şahin and Karaali, 2003).

In the studies conducted on ruminating animals, it was determined that the digestibility of the dry matter compounds in the forage increased when dry fodder was softened with whey, instead of water, and was given to the animals. In addition, it was also reported that the utilization rate of protein and phosphate also increased when 5% whey was added to forage (Yener et al., 1995).

In this study, the effect of the rations with whey powder (WP) on the growth performance and development of weaned Saanen Goat kids as well as it usability was investigated. It was aimed in the study to define the possibility of usage of whey at animal rations, which is regarded as a big problem and as a waste in the milk-cheese sector production.

Material and methods

Object of study

For the purpose of the study 24 female weaned Saanen kids, 5 months old were used and reared in the Faculty of Agriculture of Aydın Adnan Menderes University. The goats'

e-mail: myilmaz@adu.edu.tr

kids were divided into three homogenous groups with regard to their body weights and body condition score (BCS). Each animal was taken into individual divisions in groups. The first group was the Control Group (CG), fed ration without whey, and the second and the third groups were experimental groups, fed rations with powder whey added – 5% (5%WP) and 10% (10%WP), respectively (Table 1). The experiment lasted two months (8 weeks).

Table1. Feed rations given to kids

Ration composition, g	Control group (CG)	Second group (5%WP)	Third group (10%WP)
Kid growth forage	300	250	200
Dry clover	500	500	500
Wheat grass	200	200	200
Whey powder (WP)	-	50	100

All of the experiment kids were fed with a ration without whey addition in individual compartments for a week to make them get used to the experiment conditions just before they were included in the experiment. In the first two weeks of the experiment, the rations mentioned in Table 1 were given to kids as 500 g in the morning and 500 g in the evening, totally 1 kg a day during this trial period. After the first two weeks until the fifth week, the same amount of feed was given to kids once a day in the morning. During this period, some kids were observed not to have consumed their feed fully and the remaining amounts of feed were weighed and recorded. All of the kids were noticed to have finished all their feed starting with the beginning of the sixth week. At the end of the weighing done in the 6th week of the study, some falls in the live weight values were determined in the animals in all study groups, and so, the kid growth forage was increased as 100 g in all groups during the 7th and 8th weeks.

Kid's body parameters controlled

During the experimental period, some body parameters of the kids were controlled. The body condition score (BCS), the body length, the chest girth, the height at the withers and the live weight were measured every week. The parameters were determined according to the following definitions: Live weight - the animals were weighed individually with a precision of 1 g; Body Condition Score - back fat thickness was measured by hand (subjectively) and the scale was accepted as 1 meaning extremely weak and 5 meaning extremely fat (Russel et al., 1969); Withers height - the distance between the highest point of wither and the ground level was measured with a measurement strip; Body length - the distance between the articulation hummer and tuberischi was also taken by a measurement strip; Chest girth - the measurement passing on withers and sternum and turning fully around the chest was also determined with a measurement strip. Daily feed consumptions of the animals and their general health status were recorded.

Blood analyses

Blood samples (10 ml) were collected in the 1st (Initial), 4th (Middle) and 8th (Last) weeks of the experiment from *v. Jugularis* in tubes with EDTA and the tubes were transferred to the laboratory in cold chain by thermos containers. The samples coming to the laboratory were analyzed immediately. 1 hour after taking the blood samples, serum was centrifuged for 10 min at 3000 rpm. The serum samples were put into ependorf tubes and were stored in deep freeze at -20°C until they were analyzed. Total protein, cholesterol and glucose were measured by biochemistry auto analyzer (Rayto Chemray 120). The blood analyses were performed in the laboratories of Department of Biochemistry, Faculty of Veterinary Medicine, Aydın Adnan Menderes University.

Statistical analysis

The data were analyzed by using Friedman two-way analysis of variance and Kruskal-Wallis analysis of variance and SPSS 22 for inter-group comparisons. Statistical error level was taken as $p<0.05$

Results

As seen in Table 2, significant differences were determined in the live weights between the first and last measurements in all experimental groups at the end of the experimental period ($p<0.05$-0.01). When the live weight values between the first and the last measurements were evaluated, the differences were determined as 2.42 kg in CG, 1.44 kg in 5%WP group and 2.57 kg in 10%WP group. The biggest live weight difference and the best development were observed in the 10%WP group.

According to the findings obtained in the last evaluations, live weight values were seen to be slightly higher in the 5%WP and 10%WP groups than in the CG, which was found not significant statistically. When the measurements taken at the beginning and in the middle of the experiment were compared, it was seen that there was no significant difference ($p>0.05$) in the live weights among all of the groups (CG, 5%WP and 10%WP).

When we examined the difference between body condition score initial and final measurements, it was found 0.26 for 5%WP and 0.21 for 10%WP ($p<0.05$). Accordingly, the highest value of 5%WP was found to be 0.26, the group 5%WP was higher compared to all other groups (Table 3).

Table 2. The least squares mean and standard errors of live weight (kg) change in Saanen kids

Experimental groups	n	Body live weight, kg			p
		Initial	Middle	Last	
Control	8	23.16 ± 1.58^{b}	23.50 ± 1.61^{b}	25.58 ± 1.51^{a}	**
5% WP	8	24.48 ± 1.13^{b}	24.40 ± 1.04^{b}	25.92 ± 1.16^{a}	*
10% WP	8	23.13 ± 1.92^{b}	23.38 ± 1.70^{b}	25.70 ± 1.63^{a}	**
p	24	ns	ns	ns	

WP- Whey powder; a,b- The differences between the averages with different letters in the same row are statistically significant; *= $p<0.05$; **= $p<0.01$; ns- not significant.

Table 3. Least squares mean and standard errors of Body Condition Score (BCS) values in Saanen kids

Experimental groups	n	Body condition score (BCS)			p
		Initial	Middle	Last	
Control	8	1.85±0.11	1.90±0.08	1.97±0.10	ns
5% WP	8	1.81±0.08^{b}	2.04±0.12^{a}	2.07±0.12^{a}	*
10% WP	8	1.81±0.21^{b}	1.82±0.10^{bc}	2.02±0.09^{ac}	*
P	24	ns	ns	ns	

WP- Whey powder; a,b- The differences between the averages with different letters in the same row are statistically significant; *=p<0.05; **= p<0.01; ns- not significant.

When the difference was examined between the initial and final measurements of the height at the withers, we found 6.06 cm for 5%WP, 6.00 cm for 10%WP and 4.5 cm for CG. According to that, the highest value was found to be 6.06 cm in the 5%WP group compared to the other groups, and the 5%WP group was the one to show the best development (Table 4).

When the difference between body length initial and final measurements was examined, it was found to be 4.88 cm for 5%WP, 6.25 cm for 10%WP and 4.0 cm for CG. The differences were statistically significant for all groups (p<0.01). Accordingly, the highest value of body length increase was found to be 6.25 cm in the 10%WP group when compared to the other groups (CG and 5%WR), (Table 5).

When the difference between chest girth start and final measurements was examined, we found 6.75 cm for 5%WP, 5.00 cm for 10%WP and 2.75 cm for CG. The differences were statistically significant in all groups (p<0.05 - CG and 10%WP; p<0.01 - 5%WP). The highest value of Chest girth increase was found to be 6.75 cm in the 5%WP group when compared to other groups and the 5%WP group was found to be the one presenting the best improvement (Table 6).

According to the data in Table 7, no statistically significant differences were determined between glucose values of all measurements at 5%WP and 10%WP group (p>0.05). On the other hand, the difference between the first and the second glucose values in the CG was found statistically significant (p<0.05)

Table 4. The least squares mean and standard errors of the height at the withers (cm) values in Saanen kids

Experimental groups	n	Height at the withers, cm			p
		Initial	Middle	Last	
Control	8	59.00±1,38^{b}	60.87±1.23^{a}	63.50±1.46^{a}	**
5% WP	8	58.56±0.72^{b}	61.00±0.68^{b}	64.62±0.88^{a}	***
10% WP	8	57.25±1.52^{b}	58.62±1.10^{b}	63.25±1.08^{a}	**
p	24	ns	ns	ns	

WP- Whey powder; a,b- The differences between the averages with different letters in the same row are statistically significant; *= p<0.05; **= p<0.01; ***= p<0.001; ns- not significant.

Table 5. The least squares mean and standard errors of body length (cm) values in Saanen kids

Experimental groups	n	Body length, cm			p
		Initial	Middle	Last	
Control	8	60.75±1.25^{b}	61.62±1.32^{b}	64.75±1.27^{a}	**
5% WP	8	61.12±1.56^{b}	61.75±1.58^{a}	66.00±1.43^{a}	**
10% WP	8	60.00±2.07^{b}	60.75±1.91^{b}	66.25±1.50^{a}	**
p	24	ns	ns	ns	

WP- Whey powder; a,b- The differences between the averages with different letters in the same row are statistically significant; *= p<0.05; **= p<0.01; ns- not significant.

Table 6. The least squares mean and standard errors of chest girth (cm) values in Saanen kids

Experimental groups	n	Chest girth, cm			p
		Initial	Middle	Last	
Control	8	63.12±1.56^{b}	63.62±1.62^{bc}	65.87±1.15^{ac}	*
5% WP	8	63.75±1.17^{b}	63.87±1.12^{b}	70.50±2.20^{a}	**
10% WP	8	62.62±1.96^{b}	62.62±1.96^{b}	67.62±2.65^{a}	*
p	24	ns	ns	ns	

WP- Whey powder; a,b- The differences between the averages with different letters in the same row are statistically significant; *= p<0.05; **= p<0.01; ns- not significant.

The falls between the glucose values taken in the first and final measurements were seen as 9.03 mg/dL for CG (p<0.05), 4.19 mg/dL for 5%WP and 2.17 mg/dL for 10%WP (p>0.05). Accordingly, the highest value was found to be 9.03 mg/dL in the CG when compared to the other groups, and the CG was found to be the one providing the best improvement (Table 7).

Total protein values increase during the experimental period in all groups. The differences in the mean total protein values between the first and last measurements were the greatest at 5%WP (1.36 g/dL, p>0.05) followed by CG (1.34 g/dL, p<0.05) and 10%WP (1.22 g/dL, p>0.05). The results showed that the 5%WP group was found to be the one presenting the best improvement (Table 8).

Table 7. The least squares mean and standard errors of glucose (mg/dL) values in Saanen kids

Experimental groups	n	Glucose, mg/dL			p
		Initial	Middle	Last	
Control	8	73.25±11.36^{b}	103.59±7.50^{a}	64.22±3.76^{b}	*
5% WP	8	65.37±3.72	86.31±5.73	61.18±2.27	ns
10% WP	8	74.64±10.63	81.28±10.82	72.47±5.66	ns
p	24	ns	ns	ns	

WP- Whey powder; a, b- The differences between the averages with different letters in the same row are statistically significant; *= p<0.05; **= p<0.01; ns- not significant.

Table 8. The least squares mean and standard errors of total protein (g/dL) values in Saanen kids

Experimental groups	n	Total protein, g/dL			p
		Initial	Middle	Last	
Control	8	5.17±0.27^{b}	6.44±0.47^{a}	6.51±0.41^{a}	*
5% WP	8	4.35±0.56	5.29±0.57	5.71±0.44	ns
10% WP	8	4.78 ±0.48	6.09±0.31	6.00±0.52	ns
p	24	ns	ns	ns	

WP- Whey powder; a,b- The differences between the averages with different letters in the same row are statistically significant; *= p<0.05; **= p<0.01; ns- not significant.

With regard to cholesterol levels, the values recorded in the first measurement were seen to be higher than the ones taken in the middle and final measurements for all groups. While there were no statistically significant differences between the first and last cholesterol values in CG and in 5%WP groups, a statistically significant decrease in the cholesterol levels was found in the 10%WP group between the first (130.62 mg/dL) and the last (72.06 mg/dL) measurement values (Table 9). In this study, as a result of blood analysis, the difference of cholesterol reduction values initial, middle and final measurements was examined. A similar trend of change in cholesterol content in all groups of kids was observed. Cholesterol levels were the highest in the first measurement, drastically decreased in the second measurement at week 4, and then increased again in the last measurement at week 8. The biggest difference between the first and last cholesterol determination was found at 10%WP (58.53 mg/dL) followed by CG (28.19 mg/dL) and 5%WP (12.36 mg/dL). At the end of the experiment, the cholesterol amount was higher in the test groups (5%WP and 10%WP) compared to the control group. It can be thought that those higher values are due to the lipids in whey.

The statistical analysis showed a significant difference ($p<0.01$) in the urea concentration between the initial and final measurement in all experimental groups of kids (Table 10). In the urea analysis, it is thought that the grazing of the animals in the pasture before the experiment was the reason for the high initial values obtained. With almost the same urea values in all groups at the beginning of the experiment, at week 4 and week 8 the differences in values between the groups were well expressed, but not significant ($p>0.05$).

Table 9. The least squares mean and standard errors of cholesterol (mg/dL) values in Saanen kids

Experimental groups	n	Cholesterol, mg/dL			p
		Initial	Middle	Last	
Control	8	80.05±15.47	45.82±7.24	52.31±4.04	ns
5% WP	8	79.42±16.08	54.04±7.44	67.06±4.03	ns
10% WP	8	130.62±18.38^{a}	54.90±4.55^{b}	72.09±4.12^{ab}	**
p	24	ns	ns	**	

WP- Whey powder; a,b- The differences between the averages with different letters in the same row are statistically significant; *= $p<0.05$; **= $p<0.01$; ns- not significant.

Table 10. The least squares mean and standard errors of urea (mg/dL) values in Saanen kids

Experimental groups	n	Urea, mg/dL			p
		Initial	Middle	Last	
Control	8	61.91±1.29^{a}	36.95±5.34^{ac}	14.33±4.29^{bc}	**
5% WP	8	62.00±0.86^{a}	49.03±12.36^{ac}	22.48±5.122^{bc}	**
10% WP	8	61.41±1.83^{a}	42.36±12.15^{b}	20.35±2.55^{b}	**
p	24	ns	ns	ns	

WP- Whey powder; a,b- The differences between the averages with different letters in the same row are statistically significant; *= $p<0.05$; **= $p<0.01$; ns - not significant.

Discussion

It was found that the administration of whey as 5% and 10% levels had significant effect ($p<0.05$-0.01) on the body live weight of the experimental kids (Table 2). In a study of Swiatecka et al. (2017), the whey reduced the body weight by reducing fat mass in dietary obesity animals. In another study, whey had an acute effect on weight gain (Tranberg et al., 2013). It was observed that the administration of whey as 5% and 10% levels had significant effect on BCS ($p<0.05$), the withers height values ($p<0.01$-0.001), the body length ($p<0.01$) and chest girth ($p<0.05$-0.01) of the experimental kids (Tables 3, 4, 5, 6).

Bolacalı and Kuçuk (2012) determined the height at the withers and body length for the Saanen kids weaned at 90 days old as 48.8 and 50 cm, respectively. Şimşek et al. (2007) found the height at the withers, the body length and the chest girth at 60 days old Saanen x Hair Goat F1 as 45.18 cm, 43.46 cm and 54.14 cm, respectively. Uludağ (2007) found the height at the withers, the body length and the chest girth for 60 days old Akkeci (Saanen x Kilis goat crossbreed) at male kids: 44.7 cm, 37.4 cm and 49.6 cm, and for female kids as 43.9 cm, 39.1 cm and 50.8 cm, respectively.The values found by Şimşek et al. (2007), by Uludağ (2007) and by Bolacalı and Kuçuk (2012) were lower than the findings in this study.

In terms of glucose values, the results obtained were lower than the range of the normal values for glucose in the blood in small ruminant animals - 80-120 mg/dl, reported by Çotelioglu et al. (2012). An exception was the glucose levels measured in the middle of the experiment, which in all animal groups fall within these limits (81.28-103.59 g/dL) (Table 7). It is noteworthy that the glucose content varies with different dynamics during the experimental period. At the beginning of the experiment, the glucose levels were relatively low, in the middle of the period (at week 4), they were the highest and at the end of the experiment they were the lowest. This is due to the reality that there were some kids that did not consume all the feed they were given during the first weeks as well as that metabolic needs of the kids also increased continuously with every passing day. During the last period, in parallel with growing, due to the increase of the feed need of the growing kids, the falls in the glucose levels were regarded to be within an acceptable range. However, the reduction in glucose levels was observed in all experimental groups between the first and the last measurement, statistically significant only at CG ($p<0.05$). Similar to the results obtained were also the results reported by Veldhorst et al. (2009), who found a decrease in blood glucose levels as a result of whey consumption in healthy individuals. Barnett et al. (2008) established a 55-65% reduction in insulin secretion in adult life of the offsprings of the rats consuming low amounts of WP during pregnancy.

The cholesterol concentrations strongly reduced in all kids groups from the first to the last measurement, but statistically proved only at 10%WP group ($p<0.01$) (Table 9). According to Kaneko et al. (1997), the cholesterol is not affected by the feeding system and it shows an increasing trend after puberty.

Various cholesterol levels have been found in various goat breeds towards the determination of biochemical values. As determined by various researchers, the reference range of total cholesterol is 53.00 mg/dl in wild goats (Perez et al. (2003); 80-130 mg/dl in domestic goat (Kaneko et al., 2008); 59.50 mg/dL in Kanni goats (Ramprabhu et al., 2010); 55.28 mg/dL in 1-4 months old Saanen goats (Elitok, 2012); 71.18 mg/dl in Saanen goats (Al-Bulushi et al., 2017) and 69.98 mg/dl in Persian goats (Omidi et al., 2018).

According to the urea evaluation in the blood, drastically and statistically significant reduction ($p<0.01$) was observed in all experimental groups between the first and last measurement (Table 10). At the end of the trial period the urea values of the 5%WP and 10%WP groups were higher compared to the control group (CG). The amount of urea in the blood gives clues about the need of the animal for protein. As the kids grew, the amount of protein usage increased as well, and so, the urea levels, which were the highest in all three groups at the beginning, decreased in the later periods. Normal values for the urea in blood in small ruminant animals ranged between 8-20 mg/dl (Çotelioglu et al., 2012). In our study, the last values for urea in the CG, 5%WP and 10%WP groups were 14.33, 22.48 and 20.35 mg/dL, respectively. Since these values are between the normal values, defined as 8-20 mg/dL, no comment was made about them.

When the findings of the present study are evaluated, it is possible to say that the use of whey brought more positive effect in terms of the kids' fattening performance. Furthermore, the fact that no difference between 5% and 10% whey used in the rations of kids was observed in most of the parameters supports the conclusion that 5% ration added whey use could be sufficient and positive. As a result of a study conducted in different goat breeds it has been found that liquid whey can be used as a diet supplement for dairy goats (Rapettia et al., 1995).

Conclusion

Based on the results obtained, the use of whey powder (WP) was determined to have affected positively and statistically significant ($p<0.05$-0.01) the Saanen kids' body weight gain in the experimental groups (5%WP and 10%WP). In addition, the rations with 5% and 10% whey powder had similar effects on the kids' growth. Besides, body condition scores (BCS) in WP groups increased compared to the control group (concerning the height at the withers). BCS values at 5%WP group were better than the values in the 10%WP group; however, there were no significant differences between the 5%WP and 10%WP groups in the body length and chest girth values. On the other hand, the data obtained from the last value measurements in the 5%WP group have provided more positive results. Regarding the protein content, no statistically significant differences were found between 5%WP and 10%WP groups. Another determination was that the cholesterol values were negatively affected in 5%WP and 10%WP applications compared to the control group and the blood parameters of the animals (total protein, glucose, cholesterol, and urea) were determined to have remained within the acceptable limits at the end of the experiment. As an overall conclusion, it can be claimed that the use of whey powder provided more positive results in terms of fattening performances, such as the body weight, the body condition score, the height at the withers, the body length and the chest girth in Saanen kids. In addition, the fact that 5%WP and 10%WP usage did not differ in most parameters supports the conclusion that 5%WP in kid's rations could be used sufficiently and positively.

Acknowledgments

The authors would like to thank the Scientific Research Projects Unit of Adnan Menderes University and the Department of Biochemistry, Faculty of Veterinary Medicine, Adnan Menderes University.

References

Al-Bulushi S, Shawaf T and Al-Hasani A, 2017. Some hematological and biochemical parameters of different goat breeds in Sultanate of Oman (A preliminary study). Veterinary World, 10, 461-466. 10.14202/vetworld.2017.461-466.

Barnett MP, Phillips AR, Harris PM and Cooper GJ, 2008. Impaired insulin secretion in perfused pancreases isolated from offspring of female rats fed a low protein whey-based diet. Journal of the Pancreas, 9, 477-488.

Bolacalı M and Kuçuk M, 2012, Various body measurements of Saanen kids. YYU Vet. Fak. Derg., 23, 23-28.

Çotelioglu U, Ozcan M and Reece OW, 2012. Functional anatomy and physiology of domestic animals (4. Printed translation), 354-27. ASBN: 978-605-133-256-7.

Dinçoğlu A and Ardıç S, 2012. Peynir altı suyunun beslenmemizdeki önemi ve kullanım olanakları. Harran University Journal of the Faculty of Veterinary Medicine, 1, 54-60 (Tr).

Degu A, Melaku S and Berhane G, 2009. Supplementation of isonitrogenous oil seed cakes in cactus (*Opuntia ficusindica*)-tef straw (Eragrostis tef) based feeding of Tigray Highland sheep. Animal Feed Science and Technology, 148, 214-226.

Elitok B, 2012. Reference Values for Hematological and Biochemical Parameters in Saanen Goats Breeding in Afyonkarahisar Province. Kocatepe Veterinary Journal, 5, 7-11.

Haraguchi FK, Pedrosa ML, De Paula H, Dos Santos RC and Silva ME, 2009. Influência das proteínas do soro sobre enzimas hapáticas, perfillipídico e formação óssea de ratos hipercolesterolêmicos. Revista de Nutrição, 22, 517-525 (Pt).

Hoffman JR and Falvo MJ, 2004. Protein-which is best? Journal of Sports Science Medicine, 3, 118-130.

Kaneko JJ, Harvey JW and Bruss ML, 1997. Clinical Biochemistry of Domestic Animals. 5th Edition, Academic Press, Inc., San Diego, London, Boston, New York, Sydney, eBook ISBN: 9780080529196.

Kaneko JJ, Harvey JW and Bruss ML, 2008 Clinical Biochemistry of Domestic Animals. 6th Edition, Academic press, eBook ISBN: 9780080568829.

Omidi A, Nik HA, and Nazifi S, 2018. Biochemical reference values for healthy captive Persian wild goat (*Capra aegagrus*). Comparative Clinical Pathology, 27, 483-491.

Perez JM, González FJ, Granados JE, Pérez MC, Fandos P, Soriguer RC and Serrano E, 2003. Hematologic and biochemical reference intervals for Spanish ibex. Journal of Wildlife Diseases, 39, 209-215. https://doi.org/10. 7589/0090-3558-39.1.209

Ramprabhu R, Chellapandian M, Balachandran S and Rajeswar JJ, 2010. Influence of age and sex on blood parameters of Kanni goats in Tamil Nadu. Indian J. Small Ruminants, 16, 249-251.

Rapettia L, Falaschi U, Lodi R, Vezzoli F, Tamburini A, Greppi GF and Enne G, 1995. The effect of liquid whey fed to dairy goats on milk yield and quality. Small Ruminant Research, 16, 215-220.

Russel AJF, Doney JM and Gunn RG, 1969. Subjective assessment of body fat in live sheep. The Journal of Agricultural Science, 72, 451-454.

Swiatecka D, Zlotkowska D, Markiewicz LH, Szyc AM and Wroblewska B, 2017. Impact of whey proteins on the systemic and local intestinal level of mice with diet induced obesity. Food Function, 8,1708-1717.

Şahin N and Karaali A, 2003. Peyniraltı Suyundan Laktoz Eldesi ve Gıda Sanayiinde Kullanım Olanakları. Süt Endüstrisinde Yeni Eğilimler Sempozyumu. 22-23 May 2004, 319-324. Bornova, İzmir, Turkey (Tr).

Şimşek UG, Bayraktar M and Gürses M, 2007. Saanen X Kıl Keçisi F1 ve G1 Melezlerinde büyüme ve yaşama gücü özelliklerinin araştırılması. F.Ü. Sağlık Bilimleri Dergisi, 21, 21-26 (Tr).

Tranberg B, Hellgren LI, Lykkesfeldt J, Sejrsen K, Jeamet A, Rune I, Ellekilde M, Nielsen DS and Hansen AK, 2013. Whey protein reduces early life weight gain in mice fed a high-fat diet. PLoS One, 8, e71439.

Uludağ D, 2007. Süt emme döneminde krep yemlemenin Akkeçi erkek oğlaklarında büyümeye etkisi. Yüksek Lisans Tezi, Ankara Üniv., Ziraat Fak. Zootekni, Anabilim Dalı, Ankara, Turkey (Tr).

Veldhorst MA, Nieuwenhuizen AG, Hochstenbach-Waelen A, van Vught AJ, Westerterp KR, Engelen MP, Brummer RJ, Deutz NE and Westerterp-Plantenga MS, 2009. Dose-dependent satiating effect of whey relative to casein or soy. Physiology & Behavior,96, 675-682.

Yener SM, Akman N, Kumlu S, Özder M, Çakmak N and Fidan H, 1995. Cattle animal products consumption projections and production targets. Turkey Agricultural Engineering IV. Technical Congress, pp. 773-751, Ziraat Bank Cultural Publications, Ankara, Turkey (Tr).