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EFFECT OF CONTROLLED MILK FEEDING SYSTEMS ON GROWTH PERFORMANCE OF GOAT KIDS UNTIL WEANING

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Abstract

The duration of milk intake under artificial feeding conditions depends on the method of feeding, age, sex, and individual characteristics of the animals. The present study investigates the effect of artificial milk feeding using nipple buckets on goat kids reared in pens without their dams. The experiment was conducted under controlled feeding conditions and included goat kids from the Anglo-Nubian, Bulgarian White Dairy, and Toggenburg breeds.Throughout the study, the body weight development of the animals was monitored from birth until the weaning period (90 days). Key productive parameters were evaluated, including live body weight, average daily gain, growth rate, and related growth indicators. Differences in feeding behavior and adaptation to artificial milk feeding were identified depending on genotype and sex.The obtained results allow an objective assessment of the effectiveness of controlled artificial milk feeding systems and the degree of adaptation of goat kids to this feeding regime.

Key words: *breed, feeding, goat kids, growth, weight gain.*

INTRODUCTION

Globally, goat farming occupies a strategic position within the agricultural sector, providing high-quality dietary products and raw materials (Meza-Herrera et al., 2024). In the context of modern dairy goat farming, there is a clear trend toward increasing economic efficiency, which necessitates the implementation of various practices where the controlled feeding of kids is a fundamental element. This approach allows for the maximum utilization of produced milk for processing and provides an opportunity for reliable monitoring of the health and growth of young animals during the most critical period of their lives (Simonetti et al., 2019).

Controlled milk feeding systems (initially via nipple bottles and later using nipple buckets) are increasingly becoming the preferred method in Bulgaria, as they combine the physiological advantages of suckling with the technological discipline of rationed feeding (Delgado-Pertíñez et al., 2009; Ghibaudi & Simonetti, 2025). Despite the undeniable advantages, the adaptation of animals to this type of regime is often accompanied by stress, which varies depending on individual and breed characteristics (Toinon et al., 2022).

In Bulgaria, research on the comparative characteristics of different dairy breeds under identical artificial feeding conditions is limited. Breeds such as the Anglo-Nubian (AN), the Bulgarian White Dairy (BWD), and the Toggenburg (TG) possess different temperaments and feeding behaviors, which suggests a varying response to controlled milk intake systems.

The aim of the present study is to analyze the adaptation to controlled milk feeding, as well as its influence on the main growth parameters (live body weight and average daily gain) of goat kids from the specified genotypes. The evaluation of these parameters will allow for the optimization of technological solutions in rearing young animals, which is a key prerequisite for their development and future productivity.

MATERIALS AND METHODS

The study was carried out at the farm of the Experimental Base of the Research Institute of Mountain Stockbreeding and Agriculture in Troyan, Bulgaria. A total of 75 kids were included in the experiment: AN (n=19; 10 males and 9 females), BWD (n=36; 13 males and 23 females), and TG (n=20; 10 males and

10 females). The kids were born during the months of February and March in a herd controlled by the Association for Breeding Dairy Goats in Bulgaria. The animals were divided into three experimental groups, balanced by age.

Following birth and mandatory colostrum feeding, the kids were placed in group pens (5 animals per pen). An artificial milk feeding system was applied under the following conditions:

Feeding Method: Group feeding from buckets equipped with five individual nipples, allowing for simultaneous intake and reducing competitive stress.

Feeding Regime: Twice daily (morning and evening) with whole goat milk at a temperature of 38–39°C. After reaching 45 days of age, the kids were provided with free access (ad libitum) to alfalfa hay and a starter concentrate feed. The consumption of solid feeds was not recorded individually.

Growth Performance: The weight development of the animals was tracked from birth until weaning at 90 days of age: Live Body Weight (kg): Recorded individually at birth and every 10 days until the 90th day using an electronic scale. Average Daily Gain (g): Calculated for the specific periods.

Ethological Observations: Upon the formation of the groups, the kids were presented with a nipple bucket, and their independent interest in it was recorded. In the absence of interest, the kid's head was manually guided toward one of the nipples on the bucket. The duration of human intervention was registered. The suckling duration and the rest intervals between individual feeding episodes were also recorded. Behavioral parameters were documented using the method of direct observation and chronometry.

Statistical analysis: Data were statistically evaluated by one-way ANOVA. The Fit modelprocedure of the JMP v.7 software package was used to perform the statistical analysis (JMP Version 7, SAS Institute Inc. Cary, NC). The effects were considered to be significant at $P<0.05$; $P<0.01$ and $P<0.001$. Significant differences among the means were determined using the Tukey test ($P<0.05$). All data were expressed as mean values with pooled standard errors.

RESULTS AND DISCUSSIONS

The analysis of the growth parameters of the kids under the controlled milk feeding system shows significant dynamics influenced by the breed factor and the individual adaptive capacity of the animals.

Dynamics of Live Body Weight and Growth Intensity

The results for live body weight from birth to 90 days of age are presented in Table 1. At birth, no statistically significant differences were established between the groups, with weights ranging from 3.45 kg (AN) to 3.90 kg (TG). These baseline data are essential for objectively tracking the influence of the artificial feeding system on further development.

During the first month of life, no statistically significant differences in live body weight were observed among the kids. However, the growth rate indicates future divergences. At 10 days of age, the BWD kids showed a weight gain of 1.41 kg, which is higher than the gain in AN (1.19 kg) and TG (1.22 kg). This indicator suggests that BWD kids adapt quickly to the artificial nipple, allowing them to maintain their growth momentum after separation from the dam. At 30 days of age, the weight of the BWD reached 8.09 kg, followed by the TG at 7.98 kg, and the AN at 7.31 kg (Table 1).

After the 40th day, a clearly pronounced difference in live body weight was observed between the BWD (9.98 kg) and the AN (8.79 kg) ($P<0.05$). At 60 days of age, the superiority of the BWD increased, with their weight reaching 14.21 kg, while the TG showed values of 13.68 kg. McManus et al. (2008) reported an average daily gain for Toggenburg kids up to the 60th day of 0.112 kg, which is lower than the values established in our study for the same period. The lowest weight gain at 60 days was recorded in the AN (1.75 kg), which is nearly 30% less than the gain in the BWD (2.29 kg). In the final stage of the milk period (between the 70th and 90th day), a more pronounced differentiation in the parameters of the groups is observed. By the time of weaning at 90 days, the BWD kids reach an average weight of 20.95 kg.

Table 1. Dynamics of live weight (kg) by breed and age

Age (Days)	Indicators (kg)	AN n=19		BWD n= 36		TG n=20		Sig.
		Mean	SD	Mean	SD	Mean	SD	
Birth weight		3.45	0.59	3.69	0.91	3.90	0.44	NS
10	Weight	4.64	0.96	5.1	1.07	5.12	0.55	NS
	Weight gain	1.19	0.58	1.41	0.64	1.22	0.33	NS
20	Weight	5.92	1.03	6.49	1.24	6.43	0.61	NS
	Weight gain	1.28	0.38	1.39	0.64	1.31	0.68	NS
30	Weight	7.31	1.14	8.09	1.55	7.98	1.72	NS
	Weight gain	1.39	0.27	1.59	0.53	1.55	0.79	NS
40	Weight	8.79 ^{b}	1.22	9.98 ^{a}	1.87	9.78 $^{a, b}$	1.90	*
	Weight gain	1.48 ^{b}	0.28	1.88 ^{a}	0.71	1.81 $^{a, b}$	0.31	*
50	Weight	10.43 ^{b}	1.57	11.91 ^{a}	2.22	11.67 $^{a, b}$	1.89	*
	Weight gain	1.63	0.46	1.93	0.53	1.89	0.67	NS
60	Weight	12.18 ^{b}	1.72	14.21 ^{a}	2.52	13.68 $^{a, b}$	1.88	**
	Weight gain	1.75 ^{b}	0.22	2.29 ^{a}	0.6	1.98 ^{b}	0.80	***
70	Weight	14.01 ^{b}	1.71	16.58 ^{a}	2.68	15.89 ^{a}	1.96	***
	Weight gain	1.83 ^{b}	0.15	2.37 ^{a}	0.35	2.22 ^{a}	0.22	***
80	Weight	15.98 ^{b}	1.75	18.7 ^{a}	2.75	17.93 ^{a}	1.97	***
	Weight gain	1.97 ^{c}	0.12	2.12 ^{a}	0.17	2.04^{b}	0.18	***
90	Weight	18,00^{b}	1.73	20.95 ^{a}	2.75	20.01 ^{a}	1.96	***
	Weight gain	2.02 ^{b}	0.50	2.25 ^{a}	0.24	2.08 ^{a}	0.31	***
Absolute gain		14.55^{b}	1.37	17.26 ^{a}	2.34	16.11 ^{a}	1.78	***

Note: *- P < 0.05; **- P < 0.01; ***- P < 0.001.
^{a,b}The same letters on the same row indicate values with significant reliability.

The Toggenburg kids reach 20.01 kg. Our results are close to the values of Galina et al. (1995), who report that kids fed with whole goat milk achieve a weight gain of approximately 0.167-0.170 kg/day. At the same time, a lower live body weight is recorded for the Anglo-Nubian kids at the end of the period - 18.00 kg, which places them in a different position compared to the previous two groups. These values significantly exceed the data of Hammoud & Salem (2019), who report a birth weight of 2.54 kg and a weaning weight of only 13.12 kg for the same genotype. This superiority in our study can be attributed to the optimized feeding regime and the higher genetic potential of the animals used.

Our results regarding the weight development of the Anglo-Nubian kids (18.00 kg at 90 days of age) are similar to recent studies by Ghibaudi & Simonetti (2025), who, using a similar artificial rearing system, reported a live body weight of approximately 14 kg at 70 days of age (10 weeks). The identical levels of average daily gain in both studies (150-160 g/ day) confirm that despite the more challenging adaptation period for this genotype, under intensive management and proper technology (such as the use of nipple buckets), the kids manage to realize their genetic growth potential.

The absolute gain for the entire 90-day period reflects the final effect of the applied feeding system. For the BWD kids, a total accumulated mass of 17.26 kg was recorded, which is approximately 2.71 kg more compared to the AN group. These data indicate that controlled milk feeding from a nipple bucket has a more favorable effect on the growth of the Bulgarian White Dairy breed, while for the Anglo-Nubian breed, the same system leads to more moderate results.

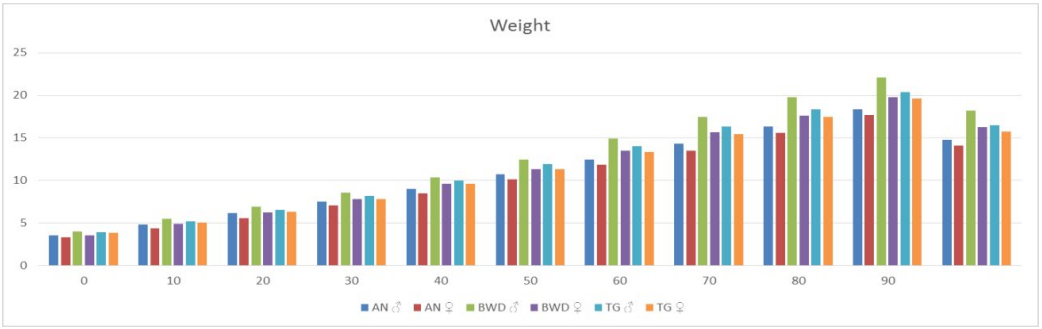


Figure 1. Dynamics of live weight (kg) in kids by breed and age

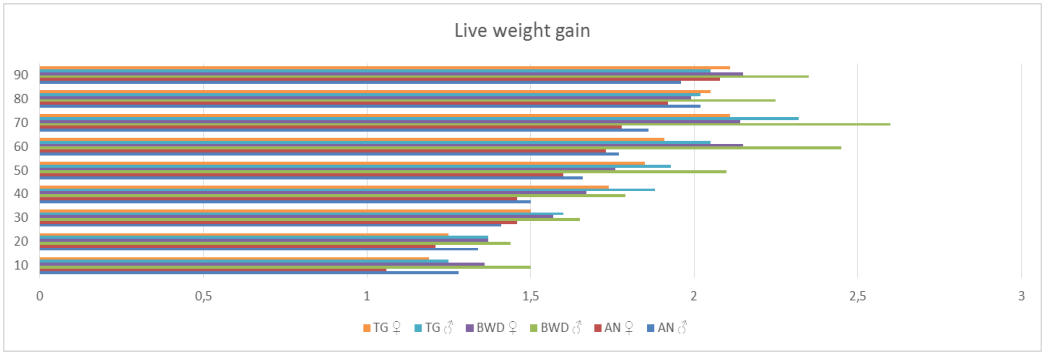


Figure 2. Dynamics of weight gain (kg) in kids by breed and age

The graphical representation of the data in Figure 1 allows for a detailed analysis of the influence of sex on the efficiency of the controlled milk feeding system.

The observed differences in weight between the sexes indicate that the conditions of pen housing and the feeding method eliminate stress factors and allow for a differentiated expression of the animals' growth capabilities.

The data analysis reveals that in all studied breeds, male kids maintain higher live body weight levels compared to females. This superiority is most pronounced in the Bulgarian White Dairy breed. In this group, male individuals reach peak values of nearly 22.00 kg by the end of the 90-day period, while females reach approximately 20.00 kg. This difference of approximately 10% in favor of the males is attributed to natural anabolic hormones, which stimulate higher feed conversion efficiency and faster muscle tissue accumulation compared to females (summarized by Never, 2015).

Figure 1 illustrates that in the early stages (up to the 20th day), the difference between the sexes is minimal. As age progresses, the divergence between male and female individuals increases progressively. Regarding the Anglo-Nubian breed, it is noteworthy that although the overall weight is lower, male kids show a better response to the feeding system after the 60th day, managing to compensate for the initial growth lag more effectively than their female counterparts. Simonetti et al. (2019) report an average weight of 14.6 ± 0.26 kg for female Anglo-Nubian kids at 12 weeks of age fed with milk replacer.

In the Toggenburg breed, male individuals reach an average live body weight of 20.01 kg, compared to their female peers (18.50 kg), which establishes this genotype as highly adaptive to the artificial milk feeding system. Our results for the Toggenburg breed are close to the values reported by Galina et al. (1995) during intensive rearing of the same breed in Mexico, confirming the genetic stability of weight gain under controlled milk intake, regardless of geographical conditions.

In the early stage (up to the 20th day) (Figure 2), the weight gain is almost uniform across all

groups, with differences in intensity based on sex and breed becoming clearly visible only after the 40th day.

The Bulgarian White Dairy kids exhibit the highest growth intensity, with male individuals reaching a gain of 2.6 kg in the interval between the 60th and 70th day. The difference in weight gain between the two sexes is most distinct here, with males outperforming females by approximately 10% at the end of the study period. Our findings correspond with our previous study (Mondeshka & Stoycheva, 2024) regarding both sex and different ages.

In the Toggenburg breed, stability and consistency are observed throughout the entire 90-day period. The males maintain a steady pace, and the females show values very close to theirs, which is an indicator of uniform weight gain within the genotype.

The Anglo-Nubian breed maintains the lowest levels of weight gain compared to the others. It is noteworthy that after the 60th day, the male kids begin to realize their capacity more effectively and improve their gain compared to their female peers, although they remains below the levels of the other two breeds.

For comparison, Simonetti et al. (2019) report an average daily gain over a 12-week period for female AN kids of 0.137 kg.

Analysis of Ethological Parameters and Adaptive Capacity

The ethological observations (Figures 3, 4 and 5) provide fundamental information on how each breed interacts with the controlled milk feeding system. The behavior of the animals during milk intake is the direct mechanism through which the growth parameters presented earlier are modulated. The observations were conducted during the adaptation of the animals to the studied system.

The most significant indicator determining milk intake is the total suckling duration. A comparison between the three figures shows that the BWD kids (Figure 3) achieve the longest period of active suckling - 178 s. This is nearly 30% more compared to the AN kids (Figure 4), whose duration is only 138 s. This greater time resource allows the BWD kids to consume a larger volume of milk per feeding, which likely underlies their higher daily gain. The Toggenburg kids (Figure 5) occupy an intermediate position with 155 s, which corresponds to their stable, yet slightly lower than BWD, growth parameters.

The time to first suckling is an indicator of the innate reflex and the animal's resilience in the external environment (Bélanger-Naud & Vasseur, 2021; Toinon et al., 2022). In the AN breed (Figure 4), this time is the longest - 60 s. In combination with the highest requirement for human help (40 s), these data indicate that Anglo-Nubian kids experience the strongest adaptive stress upon separation from the dam and transitioning to bucket feeding. This longer orientation period and dependence on staff delay the start of intensive growth, which is evident from the curve in Figure 1. Our results highlight the significance of the human factor during the initial adaptation of the kids. While Ghibaudi & Simonetti (2025) state that the success of artificial rearing depends on the "intense dedication of the operators", our study concretizes this assertion by recording the time required for assistance during the first suckling. The data show that this need for support is breed-specific. For this genotype, staff involvement is of key importance for the successful adoption of the technology.

In the AN breed, the duration of "Interruptions during suckling" is 62 s, whereas for the BWD, it is only 50 s. This indicates that kids from the BWD and TG breeds exhibit more focused and sustained feeding behavior. Their ability to consume their ration with fewer interruptions minimizes stress signals in the digestive system and optimizes the functioning of the esophageal groove, ensuring that the milk passes directly into the abomasum (Bélanger-Naud & Vasseur, 2021).

The lower ethological performance of the AN kids in our study corresponds with the findings of Ghibaudi & Simonetti (2025) regarding the difficulties in adapting this genotype to artificial feeding systems.

In conclusion, the ethological analysis proves that the controlled feeding system from a nipple bucket is most effective for breeds with a high stress-resistance threshold and a strong feeding instinct, such as the BWD and TG. The AN breed, while highly productive, requires more intensive attention from staff during the early stages of the milk period.

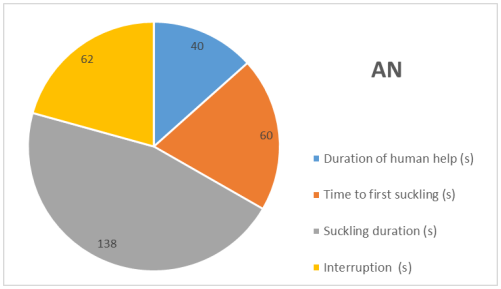


Figure 3. Ethological parameters of AN kids during feeding (s)

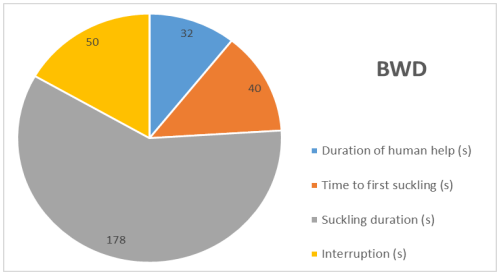


Figure 4. Ethological parameters of BWD kids during feeding (s)

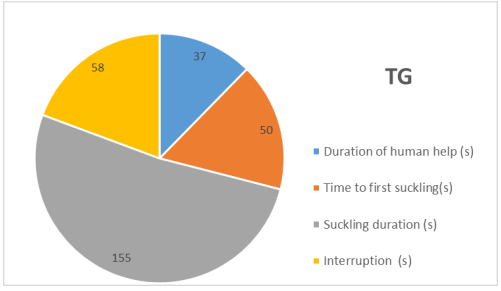


Figure 5. Ethological parameters of TG kids during feeding (s)

The study conducted highlights the role of early adaptation to the studied controlled milk feeding system as a determining factor for the future development of kids. The results demonstrate that the transition to artificial feeding is not merely a technological act, but a complex ethological process that occurs differently across individuals and genotypes (Bélanger-Naud & Vasseur, 2021; Toinon et al., 2022; Ghibaudi & Simonetti, 2025).

While in combined systems (suckling combined with milking), the growth of kids slows down by 20-33% (Hernandez et al., 2007), the system described in our study allows the kids to realize their high potential, as they receive a rationed, full-value amount of milk without competition from the milking installation.

The Bulgarian White Dairy breed demonstrates the highest technological suitability, combining stable feeding behavior with intensive growth. The Toggenburg breed proves to be adaptive and balanced, showing uniform development, which makes it suitable for the studied system with minimal human intervention. On the other hand, the Anglo-Nubian kids, despite their high genetic potential, show greater sensitivity to stress upon separation from the dam, necessitating more precise management during the first weeks of life.

Strengths and Limitations

Strengths: The study covers breeds with diverse temperaments and origins, reared under identical environmental conditions. The inclusion of measurable parameters (time to first suckling, suckling duration) allows for an understanding of the underlying causes of weight differences, rather than merely stating them. The results offer specific guidelines for farmers regarding the necessity of individual attention to different breeds during the critical adaptation period.

Limitations: Since the kids were group-housed, individual consumption of starter feed and hay was not tracked; therefore, the focus of the study is placed on the adaptation to milk feeding and the influence of the genetic factor, rather than on the efficiency of solid feed intake. The study is limited to 90 days of age. Tracking the animals at a later stage (post-weaning) would reveal whether slower-adapting kids compensate for their growth lag later on. Other behavioral reactions outside of the feeding act, which are also indicators of adaptive stress, were not recorded.

Future Directions: The current study outlines the need for follow-up research to expand the scope by including a control group (natural suckling) to compare the potential of artificial systems against the biological standard. Furthermore, systematic monitoring of health status and tracking the frequency of dietary disorders across different breeds is recommended.

CONCLUSIONS

The implementation of a controlled milk feeding system using a nipple bucket affects growth performance depending on the genotype, with the Bulgarian White Dairy kids exhibiting the highest adaptability and growth intensity.

Clearly pronounced differences in growth capacity based on sex were established; male individuals from all breeds achieved a higher live body weight, with the difference being most significant in the BWD (approximately 10% superiority for males).

Ethological analysis indicates that the Anglo-Nubian kids experience the strongest adaptive stress (the longest time to first suckling - 60 s), which requires a greater commitment from the attending staff.

The Toggenburg breed demonstrates uniformity of parameters between the sexes and stability in feeding behavior, making it highly suitable for the studied feeding system.

REFERENCES

Bélanger-Naud, S., & Vasseur, E. (2021). Literature Review: Current recommendations and scientific knowledge on dairy goat kid rearing practices in intensive production systems in Canada, the United States, and France. *Journal of Dairy Science, 104*(6), 7323-7333. https://doi.org/10.3168/jds.2020-19262

Delgado-Pertíñez, M., Guzmán-Guerrero, J. L., Caravaca, F. P., Castel, J. M., Ruiz, F. A., González-Redondo, P., & Alcalde, M. J. (2009). Effect of artificial vs. natural rearing on milk yield, kid growth and cost in Payoya autochthonous dairy goats. *Small Ruminant Research, 84*(1-3), 108–115. https://doi.org/10.1016/j.smallrumres.2009.06.014

Galina, M. A., Palma, J. M., Pacheco, D., & Morales, R. (1995). Effect of goat milk, cow milk, cow milk replacer and partial substitution of the replacer mixture with whey on artificial feeding of female kids. *Small Ruminant Research, 17*(2), 153–158. https://doi.org/10.1016/0921-4488(95)00662-D

Gautam, L., Kumar Nagda, R. A., & Waiz, A. H. (2019). Growth modeling and genetic analysis on growth traits of Sirohi goat under field conditions. *Iranian Journal of Applied Animal Science, 9*(1), 115–124.

Ghibaudi, M., & Simonetti, L. (2025). Evaluation of two milk replacers in the artificial rearing of Anglo-Nubian female goat kids. *Revista Facultad Nacional de Agronomía Medellín, 78*(1), 11025-11035. https://doi.org/10.15446/rfnam.v78n1.111475.

Hammoud, M. H., & Salem, M. M. I. (2019). Genetic analysis of pre-weaning growth traits of Anglo-Nubian and Baladi kids. *Journal of Animal and Poultry Production, Mansoura University, 10*(8), 243–249. - https://doi.org/10.21608/jappmu.2019.54146

Hernández, H., Delgadillo, J. A., Flores, J. A., Rodríguez, A. D., Serafín, N., Kann, G., Marnet, P. G., & Poindron, P. (2007). Effects of restricted nursing on milk production and collection, kid growth and plasma prolactin and growth hormone concentrations in dairy goats. *Animal, 1*(2), 233–240.

McManus, C., Filho, G. S., Louvandini, H., Dias, L. T., Teixeira, R. A., & Murata, L. S. (2008). Growth of Saanen, Alpine and Toggenburg goats in the Federal District, Brazil: genetic and environmental factors. Ciência Animal Brasileira, *9*(1), 68–75.

Meza-Herrera, C. A., Navarrete-Molina, C., Macias-Cruz, U., Arellano-Rodriguez, G., De Santiago-Miramontes, A., Sariñana-Navarrete, M. A., Marin-Tinoco, R. I., & Perez-Marin, C. C. (2024). Dairy Goat Production Systems: A Comprehensive Analysis to Reframe Their Global Diversity. *Animals, 14*(24), 3717. https://doi.org/10.3390/ani14243717

Mondeshka, L., & Stoycheva, S. (2024). A study on the growth and development of goat kids of the Bulgarian White Dairy breed until weaning. *AgroLife Scientific Journal, 13*(1), 155–160.

Never, A. (2015). Effect of sex and castration on growth performance and carcass characteristics of kids: A review. *Scientific Journal of Animal Science, 4*(7), 81–88.

Shi, Y., Liu, Y., Qi, Y., Rong, Y., Ao, X., Zhang, M., Xia, Q., Zhang, Y., & Wang, R. (2025). Estimation of Genetic Parameters of Growth Traits in the Inner Mongolia White Cashmere Goat (Erlangshan Type). *Animals, 15*(11), 1652. https://doi.org/10.3390/ani15111652

Simonetti, L., Valverde, C., & Ghibaudi, M. (2019). Crianza artificial de cabritas Anglo Nubian: comparación de dos lacto-reemplazantes. *Livestock Research for Rural Development, 31*(187). Retrieved February 23, 2026, from http://www.lrrd.org/lrrd31/12/simon31187.html

Toinon, C., Waiblinger, S., & Rault, J. L. (2022). Maternal deprivation affects goat kids' social behavior before and after weaning. *Developmental Psychobiology, 64*(4), e22269. https://doi.org/10.1002/dev.22269

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