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THE EFFECT OF ADMINISTRATION OF A VITAMIN-MINERAL COMPLEX ON THE GROWTH PROCESS IN YOUNG KAKAKUL OF BOTOŞANI SHEEP

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Abstract

The objective of this research was to evaluate the effect of administering a vitamin and mineral supplement on the growth and body development of young sheep. The biological material consisted of two groups (L1 and L2) of young ewes, and the experimental factor was the supplementary administration of the vitamin-mineral complex (VM), given only to the L2 group. At the time of breeding, the live weight in L2 was 4.67% higher compared to L1 ($P \leq 0.001$). Evaluation of body condition showed that VM supplementation did not have a significant influence but directly contributed to better body development in L2. For croup height, chest circumference, body width, chest depth, and croup length, the statistical differences between the groups were highly significant ($P \leq 0.001$). In L1, the proportion of non-pregnant and aborted maiden ewes was higher (20% vs. 12%).

Key words*: body condition; body weight; Botoșani Karakul sheep breed; diet influence; reproductive traits.*

INTRODUCTION

The intervention and coordination in the growth process of young sheep from their first year of life can positively influence the profitability of sheep farming, contributing not only to the improvement of breeding but also to a reduction in the interval between generations. In sheep farming, regardless of the technology applied or the type of production pursued (meat, milk, wool, or pelts), productive performance is conditioned by the results obtained in the reproductive activity. Therefore, the introduction of young females into the reproductive circuit should be a primary concern of sheep farm management (Pascal, 2015). The foundation of this statement is supported by the fact that the proper management of the growth process of young ewes leads not only to an improvement in productivity levels but also to increased profitability throughout their entire productive life (Kenyon et al., 2022).

When farm activities are primarily focused on increasing economic efficiency, many farmers become proponents of early use of young females for reproduction, as they have observed that they can achieve superior performance compared to young ewes that do not produce lambs in their first year of life (Moise at al., 2012; Dyrmundson, 1981).

Regarding the biological characteristics specific to the growth process in the early part of life, some studies specify that there are considerable differences both between breeds and within breeds in terms of the optimal age and body weight required for introduction into the reproductive cycle (Dyrmundson, 1981; Pascal et al., 2023; Pascal et al., 2024; Bichard et al., 1974). To highlight the effect of nutrition on production performance, some studies confirm that when young ewes receive balanced nutrition, the growth intensity is high and is associated with optimal body condition (Pascal, 2015; Moise et al., 2012; Dyrmundson, 1981; Bichard et al., 1974). Therefore, the reproductive performance will record superior values for basic indicators (Haslin et al., 2021), there will be an improvement in puberty, estrus will be more intense, and the conception and lambing rates will be higher (Haslin et al., 2021). Results obtained from a larger study conducted on young Merino females indicate that selection applied for genetic growth potential can accelerate the onset of puberty, increase fertility,

as well as the reproduction rate of young females (Nieto et al., 2013). Other research conducted on young ewes used for reproduction between one and two years of age highlights that balanced nutrition ensures moderate growth of muscle mass and fat, facilitating positive results for both fertility and reproduction rate (Malau-Aduli et al., 2007).

In line with this information, the objective of this research was to evaluate the purpose of nutrition and the influence of administering the vitamin-mineral complex (VM) supplement on growth intensity and body condition at the onset of puberty. The results obtained allowed for an objective assessment of the effect generated by providing a balanced diet on both the growth process and an evaluation of the possibilities for utilizing young females for breeding starting from their first year of life.

MATERIALS AND METHODS

Ethical approval

The experimental protocol was approved by the Ethics Committee for Scientific Research, which authorizes all analyses and evaluations conducted on animals. Through the document "Statement of Bioethics No. 154," issued on February 6, 2023, by the Research and Development Station for Sheep and Goat Breeding in Popăuți-Botoșani, Romania, the Committee for Animal Ethics has favorably approved the activity program and the experimental protocol. Additionally, throughout the research period, all welfare standards were maintained when immobilizing animals for weighing or taking body measurements. Regarding animal handling, all ethical requirements were followed to ensure favorable conditions without causing any discomfort or pain.

Research area

The research area is located in the Northeastern part of Romania, where sheep farming relies exclusively on traditional technologies. This region also represents the location where the Botoșani Karakul has originated; this breed is primarily raised for pelts and milk and holds a significant proportion of the current structure of local sheep populations in this area.

Since the pedoclimatic conditions in that area are specific to plateau regions, the climate is characterized by winters with low and cold precipitation, while summers are hot and dry. This fact affects not only the quality of pasture but also that of naturally obtained fodder. Therefore, also on the vegetation period, supplementary feeding becomes necessary to ensure the daily nutritional requirements according to the age category or physiological condition of the sheep flocks.

Animal material, general procedures and data management

The biological material was represented by young ewes of Botoșani Karakul breed retained for reproduction. In the spring of 2023, at the age of 90 days post-lambing (at the weaning moment), a total of 100 young ewes were selected. Selection criteria included body development, conformation, constitution, as well as the degree of expression of phenotypic traits characteristic of the Botoșani Karakul sheep breed.

Subsequently, the retained flock was divided into two groups (L1 and L2), each consisting of 50 young ewes (Figure 1). During the experimental period, the maintenance of both groups was done solely in stabling. Each group was housed in a different compartment, ensuring all welfare requirements were met. The provided nutrition during the research was based on an optimized diet designed to support an intense growth rate. The diets were provided from the group formation until lambing and were isoenergetic and isoproteic, with the difference being the varied vitamin and mineral content. Throughout the experimental period, the L2 group was additionally given a complex mixture consisting of vitamins (A, D, E) and some minerals (Zn, Fe, Mn, Cu, Co, I, Se) in the quantities presented in Table 1. The vitamins and minerals included in this VM complex are part of the group of bioactive factors, being essential as they fulfill specific metabolic functions and play a vital role in the development process of young animals. The diets were developed using the Hybrimin program, which ensures efficiency, economy, and optimization.

Water was provided ad libitum from wholesome sources. In each group, the salt blocks were provided.

The body condition score

The Body Condition Score (BCS) was assessed at the age of nine months based on palpation of muscle masses and fat deposits over the ribs (from the upper part of the trunk towards the lumbar area and croup).

Table 1. The structure of the diet administrated to the experimental batches

Dietary ingredients	**Quantity (kg/day/head)**
Alfalfa hay	0.500
Grass hay	0.824
Corn	0.057
Barley	0.300
Complex VM*	0.005
Nutritional value	
Dry matter (g)	1449
Crude protein (g)	217.78
Metabolic Energy-ruminants (Mj)	13.98
Net Energy for Milk production (Mj)	8.30
Ca (g)	9.000
P (g)	4.843
Na (g)	1.000
Mg (g)	2.000
***The structure of VM complex administered daily to the L2 batch:** **Vitamin** (IE): A 4960; D 496; E 37; **Minerals** (mg): Zn 29.76; Fe 39.68; Mg 3.97; Cu 2.48; Co 0.15; I 0.74; Se 0.15.	



(**L1**)



(**L2**)

Figure 1. The groups of young sheep at the beginning of research (original)

A scoring system ranging from 1 (thin young sheep) to 5 (fat young sheep) was used, with half-unit increments, following a method developed by Russel, 1991. The BCS was assessed by two experienced technicians who scored the sheep in consensus.

The assessment of body development of maiden ewes before breeding

This type of assessment is important because physiologically mature young animals are considered those with normal genital development and achieve over 70% of the specific body development of adults by the time of breeding. To identify the rate of body development at different age stages (3 months, 6 months, and 9 months), live weight (LW) was determined after a 12-hour fasting period using an electronic scale with a precision of ± 100 g. The average daily weight gain (kg/time period) was calculated based on data obtained from two successive weighing. To establish the effect of nutritional factors on the development of certain body segments or regions, some body measurements were taken at the time of breeding for L1 and L2.

The measurements were conducted using calipers, compasses, and measuring tapes, adhering to points associated with specific body dimensions, as follows:

- The height at the withers (WH): Vertical measurement from the highest point of the withers to the ground (cm).
- Croup height (CH): Distance from the point where the top line intersects with the line connecting the hip points to the ground (cm).
- Chest circumference (CC): Determined with the measuring tape around the chest, just behind the front limbs (cm).
- Body length (BL): Measurement from the sternum (*manubrium*) to the aitchbone (*tuber ischiadicum*) (cm).

- Body width (BW): Measurement of the distance between the outline line of the sheep and the central line of symmetry (cm).
- Chest depth (CD): Measured from the spine process to the xyphoid process of the sternum.
- Croup length (CL): Determined by measuring the distance between the hip points and the ischial points (cm).

Measurements applied at the pelvic level, such as pelvic width (PW), pelvic height (PH), and pelvic area (PA), were conducted using a method adapted from the model described by Walker et al. (1992), Kilgour et al. (1993), and Johnson et al. (1988).

To eliminate the experimental errors and determinate the live weight and body development, the applied evaluation also relied on a comparative analysis with the mean values of live weight and the same body dimensions specific to adult sheep. In this regard, a group of 100 adult ewes aged between two and six years was also weighed and measured. The adult ewes were randomly selected from the livestock of the Botoșani Karakul breed, located in the base flock of the same research and development unit.

Statistical data processing

The experimental data were entered into a column-type database and processed using GraphPad Prism 9 software (Palo Alto, CA, USA) to obtain statistical descriptor values (mean, standard deviation) and to compare the performances of the two groups. The unpaired "t" test followed by Welch correction was employed, assuming that the standard deviations of the groups were not equal.

RESULTS AND DISCUSSIONS

Effect of feed on body development and body condition score of young ewes

At the beginning of the research, the average body weight of the young ewes in the two groups was similar, being 19.742 ± 0.89 kg in L1 and 19.824 ± 0.71 kg in L2 (Table 2). The data obtained from weighing at six months of age highlight distinct and significant differences ($P \leq 0.01$), as L2 achieved a higher LW by 1.95% compared to L1. Regarding the data obtained from weighing at nine months of age, it is observed that the difference in LW increases. At this age, under the influence of experimental factors, the LW determined in L2 exceeds by 4.67% the average value determined in L1, with the recorded difference being highly significant ($P \leq 0.001$).

The total live weight gain accumulated from the moment of weaning until the age of nine months indicates that the average values obtained are lower in the L1 group. Over this age interval, the young ewes in L1 achieve approximately 50.76% of the live weight recorded at the time they reach nine months of age. In contrast, under the influence of the experimental treatment, the young ewes in L2 achieve 52.87% of the live weight determined at the time they reach nine months of age (Figure 2).

Since L2 achieved approximately 69.60% of the LW determined in adult ewes at the time of breeding, while L1 achieved only 66.35%, it can be stated that the daily supplementation with that VM complex was useful and effective as it supported a more intense LW growth rate in L2. Regarding the average LW values determined at the time of breeding between L1 and L2, very significant differences were found ($P \leq 0.001$).

Considering that reproductive performance is influenced by body condition, this trait was assessed at the time of breeding by awarding scores according to the evaluation system used. In both groups, most of the ewes obtained a BCS between 2.0 and 3.0 points, suggesting that the provided diet was balanced and facilitated the achievement of a favorable body condition. Based on the evaluation applied to the L1 group, it was found that approximately 76% of the young ewes achieved a BCS between 2.0 and 3.0 points. In contrast, in the L2 group, the proportion of young ewes with a BCS between 2.0 and 3.0 points increased to 78% (Figure 3).

Under these conditions, it is observed that the body condition was not significantly influenced by the additional administration of the VM complex, as the average score was similar, being 2.29 ± 0.61 points in batch L1 and 2.38 ± 0.60 points in L2. Although the average score was 3.78% higher in L2, statistical processing of the data does not indicate significant differences between the two groups.

The live weight (LW) represents a major indicator because it negatively influences the future performances of the individuals from the livestock. This is the reason why the average values of LW are important – they cand facilitate

real evaluation of growth rate and provide data regarding the response on different dietary plans, treatments, and environmental factors. In certain cases, the data obtained from periodic LW determinations can also be used to establish dietary requirements (Lukuyu et al., 2016). Knowing the weight of the animals and changes in this direction are also important in determining responses to genetic selection (they represent a vital tool for implementing effective management practices) (Simeanu et al., 2023). In sheep farming, optimal LW for use in reproduction in young ewes represents a highly important internal factor, as it is a trait that benefits from an asymptotic approach concerning specific values for adult ewes. If certain requirements regarding body weight are not met at the time of introduction to breeding in young ewes, there can be negative consequences later on (Simeanu et al., 2023).

Table 2. Live weight development related to body condition score at breeding

Age and age interval	L1			L2			*P value*
	Mean	± St. Dev.	CV %	Mean	± St. Dev.	CV %	
Live Weight (kg)							
at 3 months	19.742	0.89	4.53	19.824	0.71	3.57	0.612^{ns}
at 6 months	29.548^{a}	0.91	3.10	30.135^{c}	0.85	2.81	0.001
at 9 months	40.096^{a}	0.82	2.05	42.064^{d}	0.58	1.39	$9.61x10^{-25}$
Accumulated live weight (kg)							
from 3-6 mounts	9.806^{a}	1.27	12.95	10.311^{b}	0.96	9.39	0.048
from 6-9 mounts	10.548^{a}	1.22	11.62	11.929^{d}	0.67	5.60	$4.01x10^{-3}$
The LW achieved in relation to adult ewes							
Live weight for ewes adult = 60.43 ± 1.10 kg							
LW of young sheep at breeding compared to LW of adult sheep (%)	66.354^{a}	1.60	2.41	69.607^{d}	1.41	2.02	$1.90x10^{-18}$
Body Condition Score (points)							
At breeding	2.29	0.61	16.05	2.38	0.60	12.04	0.804^{ns}

Statistical significance of differences for means with different superscripts within row: ns = not significant differences for $P > 0.05$; ^{ab}for $P < 0.05$; ^{ac}for $P < 0.01$; ^{ad}for $P < 0.001$.

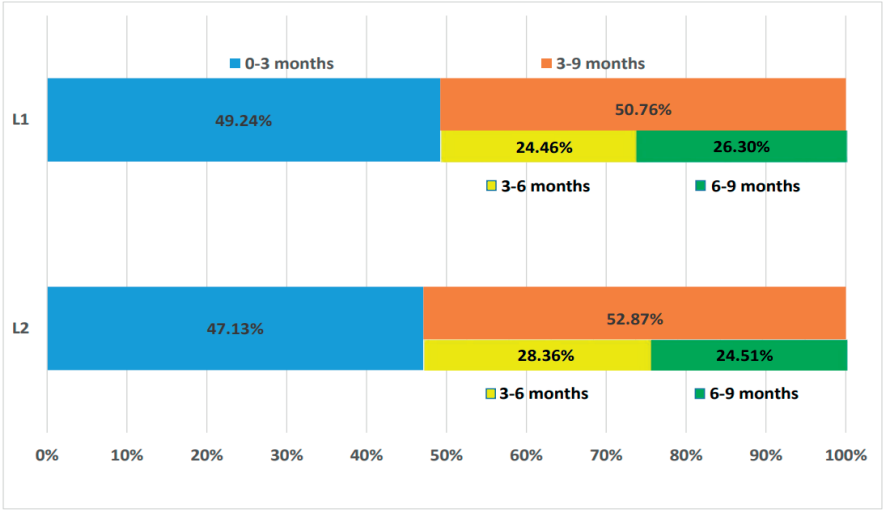


Figure 2. The proportion of body mass accumulation over different growth intervals in relation to the live weight at the time of breeding

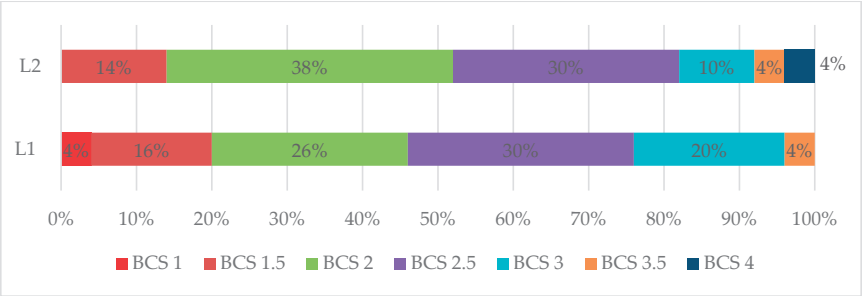


Figure 3. The distribution of maiden ewes related with the BCS determined at breeding

In sheep rearing, the age at which minimum requirements for breeding are met varies significantly between breeds. This variability arises because the age at which optimal live weight is achieved is controlled by genetic factors and is also influenced by certain environmental factors, especially nutrition (Pascal et al., 2019). In this experiment, specific diets for small ruminants were utilized. These plans provided identical levels of energy and protein and consisted of forages (alfalfa and grass hay) and concentrates (corn and barley). Additionally, for batch L2, a VM complex was added at a rate of 0.005 kg/day/individual. The experimental factor contained biologically active substances such as fat-soluble vitamins (A, D, E) and some minerals (Zn, Fe, Mn, Cu, Co, I, Se). The purpose of the additional administration of the VM complex was to determine if the biologically active substances had a positive influence on the productive and reproductive performances of the studied young sheep. When choosing the VM complex, the attention was given to how different minerals interact with each other and how this affects their absorption and utilization by the body. Additionally, it was ensured that these substances complemented the intake of minerals and vitamins provided by the used supplements. Macro-minerals are required in relatively large quantities in the diet of sheep and are vital for bone development and nervous system health (Haslin et al., 2021; Dyrmundson, 1973). All micro and macro minerals included in that VM complex fulfill specific metabolic functions and play a vital role in the organism's development process.

When forming the batches, it was considered that when retaining the breeding youth, most farmers aim for a live weight of more than 18 kg at the time of weaning and the age of approximately 90 days (Pascal, 2015; Florea et al., 2020). At the beginning of the research, the average LW values were close, with a difference of only 0.082 kg and statistically insignificant for $P \geq 0.05$. Additionally, the low values of the coefficient of variation suggest good homogeneity of individuals for this trait (Table 2). To analyze the trend in growth and body development, a new weighing was conducted at the age of 6 months. Based on the obtained data, it is observed that in Lot L2, the rate of live body mass accumulation was more intense. Statistical data analysis indicates that the difference in LW between L1 and L2 was 0.587 kg, which was distinctly significant ($P \leq 0.01$).

Subsequently, the weighing conducted at the age of nine months, revealed that L2 had a higher live weight by 4.67% compared to L1, a difference that had a high level of statistical significance ($P \leq 0.001$). Due to the fact that the accumulation of body mass realized between six and nine months was higher by 8.49% in L2, it can be said that the administration of the VM complex was beneficial and positively influenced the total weight gain. Additionally, it was observed that during the same time interval, the highest values of LW growth occurred in L2. Under these circumstances, it can be affirmed that the appearance of these differences between lots is mainly due to the experimental treatment. The consistent consumption of the VM complex in optimal quantities provided a physiological and metabolic balance that facilitated obtaining higher growth rates in L2.

The results obtained correlate with other data published in the relevant literature, highlighting the fact that supplementation with both coated and uncoated trace elements in the diet of young sheep plays a role in improving growth performance, apparent digestibility, and intestinal

development (Zhou et al., 2022). Essentially, adding certain vitamins and trace minerals to the diet regulated the expression of certain genes related to intestinal function and modified the structure of the intestinal microflora, represented by gut bacteria, in young ewes. This aspect has also been highlighted by other findings conducted in this field (Vigh et al., 2023). All the data obtained from weighing performed at the age of nine months support that the diet was adequate, meeting the specific requirements for growth and body development. This is further evidenced by the favorable progression of body weight for each age interval (Figure 2).

One of the essential conditions that maiden ewes must meet to be used for reproduction is related to body weight. This objective is easily achievable in early-maturing breeds, and with correlated management and biological potential, young ewes can be used for breeding starting at age of 8 months. In a comprehensive study conducted on Romney breed young stock weighing approximately 47.5 kg at breeding, reproductive activity-specific traits and many of the measured variables did not significantly differ from those of ewes aged two or three years ($P > 0.10$). This suggests that farmers can raise Romney lambs to an average weight of 48 kg without any negative impacts on reproductive performance at two or three years of age, nor on their progeny's live weight or growth to weaning (Haslin et al., 2021). For young ewes, the minimum weights accepted at first breeding for many sheep breeds within the same area as Botoșani Karakul vary depending on their biological characteristics. They are typically 34-36 kg for Ţurcană and Karakul, 35-38 kg for Ţigaie, 38-40 kg for Spancă, and 40-45 kg for Palas Merino (Simeanu et al., 2023; Florea et al., 2020).

By comparing the average LW values obtained at nine months of age with the specific LW of adult females (60.43±1.10 kg), it was observed that females in L2 achieved 69.60%, while in L1, the degree of achievement was only 66.35%. According to these statistical values, we can state that under the influence of the experimental treatment represented by the VM complex, the accumulation of live mass was superior in L2, and the difference between L1 and L2 had a high level of statistical significance ($P \leq 0.001$). In line with the differences observed between L1 and L2, it can be specified that daily supplementation of feed with VM had a positive effect. Furthermore, the appearance of differences between groups represents an objective and solid argument supporting the bioavailability and efficiency of trace minerals and their major role in improving growth parameters. In ruminant growth, the efficiency of VM administration can be influenced by ruminal solubility and has positive effects on fermentation parameters and ruminal microbiota (Robertson et al., 2017).

From the analysis of the data obtained in evaluating body condition scores (BCS), it was observed that this characteristic was less influenced by the additional administration of the VM complex, as the average scores were similar between the two groups. These values suggest that the VM complex had a limited and reduced effect on body condition, with the difference between groups being non-significant ($P \geq 0.05$). In this case, BCS was predominantly influenced by the nutritional value of the daily feed and less by the additional VM complex administered to L2.

The effect of the diet on the body size parameters in young ewes

Measuring the body dimensions in farm animals is an important activity as it provides extremely valuable data for accurately assessing the degree of development or body size, reflecting how the growth process has progressed. Additionally, when the obtained values are expressed at a high level, they offer valuable insights into the future production performance levels. Therefore, measuring the body size is very important in raising small ruminants. All scheduled measurements were taken at the time of breeding, and the average values, standard deviations, and significance of the differences between the two groups confirm that, under the influence of the experimental factor, there are several differences between L1 and L2, with different growth rates being recorded, and consequently, different body development (Table 3).

The fact that certain differences are observed in most body dimensions between L1 and L2 confirms that the consistent administration of the VM complex had a positive effect. This statement is supported by data showing that in

L2, the degree of body development is at a high level because most body dimensions have an achievement level of approximately 95% of the average dimensions determined in adult ewes (Figure 4).

Statistical processing of the data obtained based on body measurements applied to L1 indicates that for BW, as well as for dimensions confirming the degree of development of the pelvic area (PH, PW), the average values obtained are below 90% of the statistical average value obtained from adult ewes.

The body measurements clearly highlight the influence of the experimental factor on the growth rate recorded in L2. This is explained by the fact that for all measurements taken, achievement levels higher than 95% were obtained compared to the specific average values of adult ewes. This situation suggests that the applied nutrition was correct, adequately meeting not only the nutritional requirements but also the requirements for vitamins and certain mineral salts (VM) that support the growth and development process of young sheep.

Table 3. Parameters and statistical analysis in maiden ewes in relation with the specific values of the adult sheep

Traits	L1			L2			*P value*	% from the average values determined in adult ewes		
	Mean (cm)	± St. Dev.	CV %	Mean (cm)	± St. Dev.	CV %		L1	L2	*P value*
HW	76.87^{a}	1.39	2.67	78.55^{d}	0.96	1.98	$1.60x10^{-4}$	95.80^{a}	97.91^{d}	$5.11x10^{-7}$
CH	76.61^{a}	1.22	1.60	77.98^{d}	0.86	1.11	4.66x10-^{5}	94.09^{a}	95.90^{a}	0.6077
CC	93.14^{a}	0.60	0.64	96.17^{d}	1.28	1.33	$1.69x10^{-14}$	93.03^{a}	96.06^{d}	$2.90x10^{-18}$
BL	83.23^{a}	1.18	1.41	83.75^{b}	1.01	1.08	0.0147	98.15	98.79	0.1570
BW	23.86^{a}	0.98	4.12	26.80^{d}	1.67	6.22	$3.43x10^{-18}$	88.26^{a}	96.89^{d}	$1.58x10^{-12}$
CD	30.11^{a}	0.72	2.41	31.41^{d}	0.81	2.56	$2.61x10^{-13}$	93.02^{a}	97.02^{d}	$1.21x10^{-9}$
CL	19.20^{a}	0.42	2.16	28.58^{d}	0.73	3.53	$3.29x10^{-20}$	91.87	98.41	0.2040
PA (cm^2)	33.69^{a}	0.62	1.84	34.59^{d}	0.57	1.67	$5.21x10^{-5}$	95.26^{a}	97.25^{d}	0.00025
PH	6.12^{a}	0.20	3.29	6.52^{d}	0.13	2.01	$2.86x10^{-6}$	89.7^{a}	95.55^{d}	$2.13x10^{-5}$
PW	6.32^{a}	0.25	3.99	6.92^{d}	0.18	2.63	$2.13x10^{-10}$	89.72^{a}	98.37^{d}	$2.62 x10^{-6}$

Statistical significance of differences for means with different superscripts within row: ^{ab}for $P < 0.05$; ^{ac}for $P < 0.01$; ^{ad}for $P < 0.001$.



Notes: 1-HW; 2-CH; 3-CC; 4-BL; 5-BW; 6-CD; 7-CL; 8-PA; 9-PH; 10-PW

Figure 4. The percentage of the average values of body dimensions in maiden ewes (L1 and L2) compared to adult ewes (AE)

The obtained data, along with the significance of the differences between L1 and L2, confirm that mineral nutrition is vital for sustaining a more intense pace of body development, ensuring better body condition, and actively contributing to maintaining the health and durability of the animal. Alongside minerals and administered vitamins, they fulfilled the purpose of essential organic compounds, being involved in supporting health and achieving reproductive and production performances.

In small ruminant farms, monitoring the condition of the animals is essential for maintaining the herd at a level that supports increased productivity and for optimizing nutrition and other corrective measures. Most often, in assessing the overall condition of the breeding nucleus, farmers analyze only live weight and body condition score (Robertson et al., 2017; Pettigrew et al., 2021; Thompson et al., 2021; Shalaldeh et al., 2023) neglecting some elements that can become extremely important. In modern management, evaluating the maintenance status of ewes should also take into account the degree of development of the main body regions, as well as the relationships established between them (Thompson et al., 2021). The height at the withers (WH) is one of the important dimensions, included in the group of basic dimensions, as it indicates the development in height of the body. Based on the obtained data (Table 3), it is observed that the average value of WH in L2 is higher by 1.69 cm, with a high level of statistical significance ($P \leq 0.001$). This difference suggests that under the influence of the experimental factor (VM), the growth rate in body height was more intense in L2. At the time of breeding, maiden ewes in L2 achieved 97.91% of the WH determined in adult ewes, while in L1, a proportion corresponding to only 95.80% was observed. The statistical differences between the groups are highly significant ($P \leq 0.001$) in this case as well.

Analysis of the average values for chest height (CH), chest circumference (CC), body width (BW), chest depth (CD), and chest length (CL) highlights different levels of body development between the measurement points. For each of these body dimensions, the values in L2 are higher, with highly significant statistical differences ($P \leq 0.001$) between L1 and L2. Body length (BL) showed a similar average value between the two groups, with 83.23 ± 1.18 cm in L1 and 83.75 ± 1.01 cm in L2. In this case, the absolute difference between the groups was only 1.45 cm and was statistically significant ($P \leq 0.01$).

The largest difference is recorded for body width (BW). In this case, the average value in L1 is smaller, representing only 88.26% compared to that determined in adult ewes. In L2, the average BW value is higher, corresponding to 96.89% compared to adult ewes. The absolute difference between L1 and L2 for BW is 2.94 cm, with a high level of statistical significance ($P \leq 0.001$). For croup height (CH), although the difference between L1 and L2 is highly significant ($P \leq 0.001$), the comparison with the average value determined in adult ewes is not significant.

At the pelvic level, determining certain dimensions (pelvic width - PW, pelvic height - PH, and pelvic area - PA) is very important, as in the case of lambs, a higher growth rate and increased perinatal mortality are associated with smaller pelvic dimensions. Including measurements in the pelvic area in this study aimed to determine whether the pelvis is sufficiently developed in both groups and whether there are risks that could not only increase the mortality rate at lambing but also lead to more difficult parturition. Due to its effect on survival rate, assessing the degree of development of the pelvic area should be a criterion for selecting breeding ewes (Pascal, 2015; Nechifor et al., 2022; Pascal et al., 2023; Lätt, 2019; Jacobson et al., 2020).

The pelvic area was 33.69 ± 0.62 cm^2 in L1 and 34.59 ± 0.57 cm^2 in L2. Therefore, in young sheep forming group L2, the pelvic area is more developed by 2.60% compared to L1, and the recorded difference is highly significant ($P \leq 0.001$). The obtained data also indicate that at the time of breeding, the pelvic area in young ewes from L2 was closer to the pelvic area specific to adult ewes, representing 97.25%. Similarly, for pelvic width (PW) and pelvic height (PH), the average values obtained are higher in L2, with highly significant differences ($P \leq 0.001$). Additionally, for these dimensions, the average values in L2 represent a higher proportion of 95% compared to those determined in adult ewes. In the case of young ewes forming L1, the measurements for PW and

PH indicate a lower development, representing only 89.7% of the specific values in adult ewes. Reduced values in the pelvic area pose a risk of increased dystocia, which can be associated with prolonged postpartum periods, uterine infections, increased non-reproductive days, as well as reductions in overall conception rate and milk production (Sieber et al., 1989; Walker et al., 1992; Pourlis, 2011).

In comparison to adult ewes, the assessment of body development in maiden ewes based on body dimensions indicates a better level achieved in batch L2. These differences between L1 and L2 clearly highlight the role of vitamins and minerals in the growth process of young animals. Minerals are necessary for various body functions, including skeletal development. Minerals play an important role in the growth process as they, along with vitamins, are involved in numerous enzymatic interactions in the body (Jackson et al., 2000, cited by Nwosu (Corner et al., 2015). Based on detailed research in some bibliographic sources, it is specified that vitamins and minerals are inorganic chemical elements with bioactive roles and are involved in many enzymatic reactions, have specific functions, and are essential for the process of growth and bodily development, supporting health and life (Hutchison et al., 2022; Asin et al., 2021).

CONCLUSIONS

Supplementing the daily feed with a complex of vitamins and minerals contributed to achieving positive results not only in the growth process of young sheep but also in improving the body condition of maiden ewes. The better rate of development and higher values for reproductive traits, along with a greater number of lambs at birth and a reduction in neonatal mortality, confirm the positive effect of additional VM complex administration. The considerable improvement in reproductive traits, especially for litter size, weaning rate, and pregnancy rate, confirms the intense, favourable, and positive effect of additional VM complex administration. The appearance of differences between groups, with certain statistical significance, represents an objective and solid argument supporting the bioavailability and efficiency of trace minerals and their major role in improving production and reproduction parameters.

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