Artículo de investigación

Nutrient utilization in buck lambs with different genotypes

Использование Питательных Веществ Баранчиками Разного Генотипа

Utilización de nutrientes en corderos con diferentes genotipos

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Written by:
A.Ch. Gagloev[228]
https://elibrary.ru/author_items.asp?authorid=676938
ORCID ID: 0000-0001-7594-0927
V.A. Babushkin[229]
https://elibrary.ru/author_items.asp?authorid=265993
ORCID ID: 0000-0001-7111-322X
A.N. Negreeva[230]
https://elibrary.ru/author_items.asp?authorid=570741
ORCID ID: 0000-0003-0486-3287

Abstract

The paper presents the results of a comparative study of feed nutrient utilization in buck lambs with different genotypes under the same growth and management conditions. It has been established that the crossbred and purebred buck lambs have a substantial difference in digestibility of dry and organic matter, as well as protein and fiber. Differences in digestibility of nitrogen-free extractive substances are smaller, although they are significant. Hybrids born to ewes of meat-wool type are superior in terms of feed utilization efficiency in comparison to lambs born to ewes of wool-meat type. The nitrogen balance is also higher in the hybrids. The differences between purebred lambs and hybrids born to ewes of meat-wool type are as follows: hybrids with the Romney Marsh breed – 1.16 g, hybrids with the Kuibyshev breed – 0.1 g. A similar trend is observed for the balance of calcium and phosphorus.

Keywords: Buck lambs, hybrids, digestibility coefficient, nitrogen balance, calcium balance, phosphorus balance.

Аннотация

в статье представлены данные по сравнительному изучению использования питательных веществ корма баранчиками разного генотипа в одинаковых условиях вы-ращивания и содержания. Установлено, что у помесных и чистопородных баранчиков наблюдалась значительная разница по переваримости сухого и органического вещества, протеина и клетчатки. По переваримости БЭВ полученные различия менее значительные, хотя и достоверные. При этом следует отметить превосходство помесей, полученных от овцематок мясошерстного типа по эффективности использования кормов по сравнению со сверстниками, полученными от шерстномясных маток. Баланс азота оказался выше также у помесей. При сравнении с чистопородными сверстниками разница у варианта с ромни-марш составила 1,16г, а у варианта с куйбышевской - 0,1г у мясошерстных маток. Аналогичная тенденция и по балансу кальция и фосфора.

Ключевые слова: баранчики, прекос, помеси, коэффициент переваримости, баланс азо-та, кальция и фосфора.

[228] Michurinsk State Agrarian University, Michurinsk, Russia
[229] Michurinsk State Agrarian University, Michurinsk, Russia
[230] Michurinsk State Agrarian University, Michurinsk, Russia

Resumen

El artículo presenta los resultados de un estudio comparativo de la utilización de nutrientes en corderos con diferentes genotipos en las mismas condiciones de crecimiento y manejo. Se ha establecido que los corderos cruzados y de raza pura tienen una diferencia sustancial en la digestibilidad de la materia seca y orgánica, así como de las proteínas y la fibra. Las diferencias en la digestibilidad de las sustancias extractivas sin nitrógeno son más pequeñas, aunque son significativas. Los híbridos nacidos de ovejas del tipo carne-lana son superiores en términos de eficiencia de utilización de alimento en comparación con los corderos nacidos de ovejas del tipo carne-lana. El balance de nitrógeno también es mayor en los híbridos. Las diferencias entre los corderos de raza pura y los híbridos nacidos de ovejas del tipo lana de carne son los siguientes: híbridos con la raza Romney Marsh - 1.16 g, híbridos con la raza Kuibyshev - 0.1 g. Se observa una tendencia similar para el equilibrio de calcio y fósforo.

Palabras clave: Corderos, híbridos, coeficiente de digestibilidad, balance de nitrógeno, balance de calcio, balance de fósforo.

Introduction

Sheep farming is a branch of agriculture that produces high-value foods, as well as raw materials for industry. The market share of sheep products is about 4-5% of gross agricultural output (Magomadov et al., 2018; Gagloev et al., 2017b).

A further increase in the production of sheep farming products, an increase in the productivity of animals is determined by both the availability of high-quality fodder and its rational use. Feeding has a decisive influence on the course of metabolic processes in the body and health of sheep and the quality of the products obtained from them. Therefore, in order to increase the efficiency of the fodder use and facilitate the development of optimal diets (from the zootechnical and economic points of view), deep knowledge of the principles of animal nutrition is crucial (Gagloev, Negreeva, 2014).

Digestion is a complex process that consists of mechanical, enzymatic and biological (microbial) feed processing. Therefore, the assimilation of nutrients depends on many factors, among which the age-related features and the properties of the feed itself are worth mentioning (Engovatov, Betin, 2010; Gagloev et al., 2017a; Sushkov et al., 2017). The digestibility of food is the ability of the body to split complex substances of the feed into more simple under the action of enzymes of the gastrointestinal tract and microflora. A universal measure of the efficiency of nutrient digestion is the digestibility coefficient, which shows how much of the substance consumed was digested (absorbed) by an animal. The amount of digested substances is determined in experiments on animals by calculating the difference between the total nutritional composition of feed and non-digested residues. The ratio of the amount of nutrients digested by the body to the amount taken in the feed, expressed as a percentage, is called the digestibility coefficient (Gagloev, Negreeva, Gagloeva, 2017).

Digestibility varies over a wide range and depends on a number of factors: animal species, genotype, diet composition and quantity of feed, feed preparation, feeding techniques and others. Digestibility of feed nutrients varies greatly depending on the heredity of animals, their condition and also on the properties of feed and feeding technology (Lebedev, Usovich, 1976).

Certain breeds utilize feed nutrients 5-10% better than others. Even within the breed, the difference in digestibility of roughage can be as high as 14% and digestibility of concentrates – up to 6% (Kotarev et al., 2014). Considering this, the aim of this research was to study the aspects of the utilization and digestibility of nutrients in purebred and crossbred young sheep born to ewes of different intra-breed types of Precoce and breeders of fast-growing half-fine wool breeds.

Materials and Methods

Experimental studies were carried out at the sheep farm of the integrated agricultural production company "Voskhod" of the Michurinsky district of the Tambov region of Russia. The sheep selection and formation of experimental groups and subgroups are presented in Table 1. The ewes of a single intra-breed type from each group were analogs in age, body weight, shear, length and quality of wool.

Table 1. Sheep selection and formation of experimental groups and subgroups.

Group	Ram breed (and designation)	Intra-breed type of Precoce ewe	Subgroup designation
Control	Precoce (P)	meat-wool (mw)	C-1
		wool-meat (wm)	C-2
I-experimental	Kuibyshev (K)	meat-wool (mw)	I-1
		wool-meat (wm)	I-2
II-experimental	Romney Marsh (RM)	meat-wool (mw)	II-1
		wool-meat (wm)	II-2

The formation of subgroups within groups was carried out according to the method of analogs. Animals in the subgroups had "half-brother" and "half-sister" patrilineal relationships. Offspring of buck lambs were grown in identical conditions – feeding, housing and care for animals were the same. Study of nutrient utilization in buck lambs during the feeding period was carried out by setting up a balance experiment according to the conventional method described by A.B. Modyanov and I.V. Khadanovich (1967) with three buck lambs in each subgroup (Modyanov, 1978; Modyanov, Khadanovich, 1967). The nutritional value of the diet was determined considering the chemical composition of the feed and the palatability of the feed. Stool and urine samples were taken and preserved using toluene and 10% hydrochloric acid, respectively. Conventional methods of zooanalysis were used in the study of feeds and their residues, feces and urine. Statistical processing of the results of the studies was performed using the method of N.A. Plokhinsky (1969) with the use of Microsoft Office Excel and Statistica software. Student's t-criterion at three levels of probability was also calculated (Plokhinsky, 1969).

Results

In intensive sheep breeding, young stock is normally sold in the same year as it is born, usually at 8-9 months of age. This makes it possible to obtain sheepskin and mutton of good quality and, additionally, teg wool. At the same time, the organization of complete feeding of young sheep plays a significant role.

The organization of nutrition and feeding of sheep is based on the physiological aspects of the digestive organs of animals. Equally important is to use feed rationally while fully satisfying the nutritional requirements of the sheep body and facilitating their maximum productivity. The efficiency of feed utilization by animals depends on a number of factors, including the genotype.
Several studies conducted in different zones of Russia showed that under the same feeding and housing conditions, animals of different breeds and genotypes have differences in digestion processes, interstitial metabolism and feed expenditure per product unit.

The diet of young stock consisted of grass from natural pastures, concentrated feeds (cake and grain mixture) and mineral supplements (table salt). At the age of seven months, the young animals undergo pasture management and lambs at this age more than adult animals are subject to the negative effect of under-feeding, which also affects the quality of the products obtained from them. The ration of the buck lambs, which were used in the balance experiments, is presented in Table 2.

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Table 2. The ration of the experimental buck lambs.

Feed type and nutrient indexes	Amount of feed and nutrient value of the ration
Grass from natural pasture, kg	5
Concentrates, total, kg:	0.4
which includes cake, kg	0.1
Table salt, g	8
Ration includes:	
Feed unit, kg	1.35
Metabolic energy, energetic feed units	1.45
Digestible protein, g	145
Calcium, g	6.80
Phosphorus, g	4.80
Sulphur, g	3.80
Magnesium, g	0.90
Keratin, mg	9

The data obtained in the balance experiments demonstrated that the crossbred young stock had higher digestibility of feed nutrients (Table 3).

Table 3. Feed nutrient digestibility coefficients in experimental buck lambs, %.

Parameters	PxPmw	PxPwm	KxPmw	KxPwm	RMxPmw	RMxPwm
Dry matter	75.15 ± 0.34*	73.43 ± 0.51	78.03 ± 0.26*	77.18 ± 0.18	78.69 ± 0.32*	77.28 ± 0.45
Organic matter	77.86 ± 0.34*	76.31 ± 0.57	81.05 ± 0.34*	79.79 ± 0.37	81.8 ± 0.22***	80.53 ± 0.07
Protein	74.11 ± 0.93*	70.13 ± 1.26	75.44 ± 0.82*	72.47 ± 0.86	76.22 ± 0.56*	74.08 ± 0.60
Fat	68.01 ± 1.35	66.42 ±2.17	71.52 ± 1.54	70.0 ± 1.69	73.69 ± 0.58	68.12 ± 0.77
Ash	51.64 ± 1.68	49.56 ± 1.28	54.81 ± 2.15	56.21 ± 2.0	53.92 ± 1.05	51.76 ± 3.70
Fiber	55.17 ± 1.37*	50.41 ± 0.77	58.08 ± 0.69**	53.17 ± 0.97	63.12 ± 0.50*	60.39 ± 0.78
Nitrogen-free extractive substances	69.61 ± 1.37	66.72 ± 1.03	75.79 ± 0.51*	72.96 ± 0.60	75.91 ± 0.45	74.72 ± 0.74

Note: data is reliable: * – P≥0.95, ** – P≥0.99, *** – P≥0.999.

The data in Table 3 indicates that there was a substantial difference in the digestibility of dry and organic matter, protein and fiber between crossbred and purebred buck lambs. The differences in digestibility of nitrogen-free extractive substances were smaller, although they were statistically significant. Hybrids born to ewes of meat-wool type were superior in terms of feed utilization efficiency in comparison to lambs born to ewes of wool-meat type.

The digestibility of dry matter was 2.88% higher in the hybrids of the KxPmw variant (P ≥ 0.999) and 3.54% higher in the hybrids of the RMxPmw variant (P ≥0.999) compared to their purebred peers. The same trend was observed for the digestibility of organic matter.

The maximum coefficient of protein digestibility – 76.22% – was recorded in the hybrids of the RMxPmw variant, which was significantly higher (2.11%) than in purebred PxPmw lambs. Evidently, this is due to the fact that a significant amount of protein, which is used in the formation of muscle tissue and keratin, is used during the growth of lambs and the formation of wool. The difference between the KxPmw variant and purebred buck lambs was smaller – 1.33%. Buck lambs born to all variants of meat-wool ewes utilized protein better compared to those born to wool-meat variants.

A similar trend was observed for the fiber digestibility coefficient, for which the indicators among the variants varied in the range from 50.41% to 63.12% (Fig. 1). The maximum utilization of fiber was observed in the RMxPmw variant – 63.12%. The difference in the fiber digestibility coefficient in comparison to all purebred variants was 7.97% (P ≥ 0.999). Approximately the same pattern for this indicator was also observed between similar variants of the offspring of wool-meat ewes, the difference was 9.98% (P ≥ 0.999).

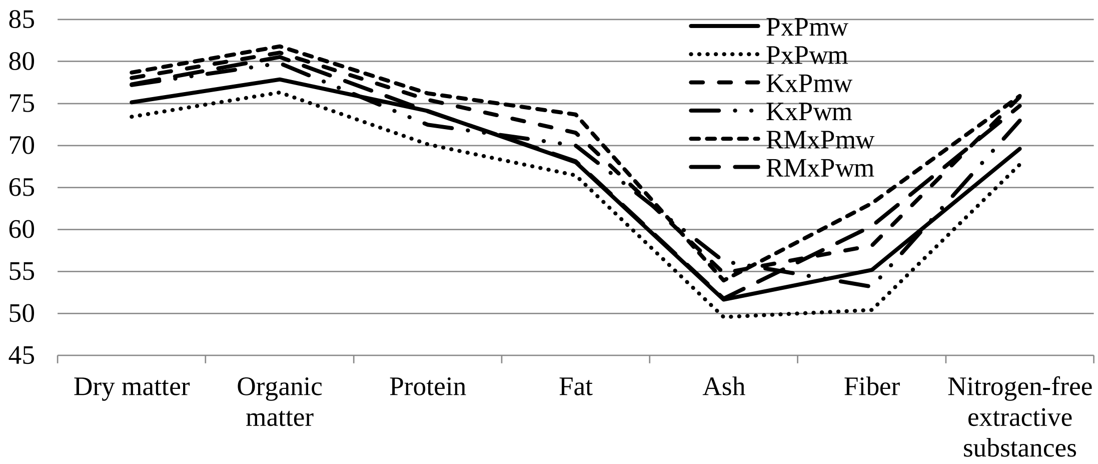

Figure 1. Feed nutrient digestibility coefficients of buck lambs with different genotypes.

Digestibility coefficients for fat and ash were significantly different only between the PxPmw and RMxPmw variants – they were higher in the latter, 5.68% (P ≥ 0.99) and 2.28% (P ≥ 0.95) respectively. Digestibility of nitrogen-free extractive substances in all hybrid variants was significantly higher than in purebred lambs. Among the offspring of ewes of different types, hybrids with Kuibyshev breed had significantly higher digestibility – 2.83% (P ≥ 0.95), compared to others.

During the process of digestion, absorption and intermediary metabolism the nutrients obtained from food undergo significant changes and their fate in the metabolic process can be studied using only circumstantial indicators, for example, the balance of nitrogen and mineral substances. Data on nitrogen balance is presented in Table 4.

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Table 4. Nitrogen utilization in buck lambs with different genotypes, g

Parameters	PxPmw	PxPwm	KxPmw	KxPwm	RMxPmw	RMxPwm
Excreted with feces, g	8.80 ± 0.29	9.52 ± 0.27	8.22 ± 0.18*	8.9 ± 0.21	8.26 ± 0.25	8.56 ± 0.36
Digested, g	25.2 ± 0.48	22.5 ± 1.32	25.32 ± 0.9	23.5 ± 0.95	26.46 ± 0.04***	24.42 ± 0.32
Excreted with urine, g	1.30 ± 0.08	1.58 ± 0.16	1.32 ± 0.03	1.38 ± 0.06	1.4 ± 0.08	1.4 ± 0.06
Deposited, g	23.9 ± 0.53*	20.92 ± 1.16	24.0 ± 0.88	22.12 ± 1.01	25.06 ± 0.10***	23.02 ± 0.26
% of obtained	70.28 ± 1.15	61.09 ± 4.47	71.5 ± 0.9**	67.25 ± 0.51	72.19 ± 0.67*	69.84 ± 0.66
% of digested	94.83 ± 0.37**	93.02 ± 0.3	94.77 ± 0.18	94.05 ± 0.47	94.71 ± 0.29	94.27 ± 0.18

As can be seen from Table 4, the nitrogen balance was higher in hybrids. Comparison with purebred lambs showed that the difference was 1.16 g for the RMxPmw variant and 0.1 g for the KxPmw variant. The percentage of nitrogen obtained with feeds that were utilized in animals of these groups was 1.91% and 1.22% higher, respectively and percentage of digested nitrogen that was utilized was 0.12% and 0.06% higher, respectively. Nitrogen deposition was higher in the offspring of ewes of the meat-wool type, which also grew more rapidly. Compared to purebred lambs, nitrogen deposition in the offspring of ewes of the meat-wool type was higher by 2.98 g ($P \geq 0.95$), it was 1.88 g higher in the variant with the Kuibyshev breed and 2.04 g higher ($P \geq 0.999$) in the variant with the Romney Marsh breed. This indicates a higher level of protein deposition in the body of mixed sheep-rams of these variants.

In addition to nitrogen balance, special attention is usually paid to the balance of calcium and phosphorus. Calcium balance (Table 5) was also higher in hybrids of all breeding variants

Table 5. Calcium utilization in buck lambs with different genotypes.

Parameters	PxPmw	PxPwm	KxPmw	KxPwm	RMxPmw	RMxPwm
Excreted with feces, g	3.24 ± 0.15	**3.72 ± 0.14***	3.54 ± 0.08	**4.06 ± 0.06*** **	3.5 ± 0.05	**3.76 ± 0.06****
Digested, g	3.02 ± 0.24	2.62 ± 0.26	3.44 ± 0.3	2.86 ± 0.17	3.22 ± 0.19	2.94 ± 0.12
Excreted with urine, g	0.02 ± 0.002	0.03 ± 0.003	0.29 ± 0.002	0.31 ± 0.04	0.29 ± 0.01	0.31 ± 0.02
Deposited, g	3.0 ± 0.24	2.6 ± 0.26	3.15 ± 0.03	2.55 ± 0.21	2.93 ± 0.2	2.63 ± 0.12
% of obtained	**47.72 ± 1.81***	40.63 ± 1.49	**44.81 ± 2.69***	36.67 ± 2.22	**43.42 ± 1.68***	39.25 ± 1.19
% of digested	99.26 ± 0.09	99.01 ± 0.18	91.35 ± 0.67	88.71 ± 2.05	90.8 ± 0.73	89.52 ± 0.81

The data in Table 5 shows that the maximum calcium balance was observed in the KxPmw variant and it was 3.15 g, which was 0.15 g higher than in the buck lambs of the C-1 subgroup of the 1st group and 0.55 g higher than in the lambs of the C-2 subgroup. The difference in this indicator between crossbred animals of groups and subgroups was substantial and was 0.22 g and 0.52 g, respectively. However, this trend was not observed for the utilized percentage of calcium obtained with feeds and digested – these parameters were higher in purebred lambs. The percentage of calcium obtained with feeds that were utilized was higher in purebred offspring of meat-wool ewes than in hybrids. The difference was 2.91% with the KxPmw variant and 4.3% with RMxPmw variant, however, it was not significant. A similar

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trend was observed for the offspring of the wool-meat ewes. At the same time, the difference in this indicator between the buck lambs of different subgroups within one group was significant and was 7.09%, 8.14% and 4.17%, respectively. Apparently, calcium was used in purebred lambs for better formation of the skeleton.

Table 6. Phosphorus utilization in buck lambs with different genotypes

Parameters	PxPmw	PxPwm	KxPmw	KxPwm	RMxPmw	RMxPwm
Excreted with feces, g	2.38 ± 0.04	2.48 ± 0.12	2.20 ± 0.08	2.34 ± 0.06	2.22 ± 0.05	2.42 ± 0.02**
Digested, g	2.18 ± 0.10	1.98 ± 0.14	2.42 ± 0.01	2.22 ± 0.11	2.56 ± 0.07	2.33 ± 0.16
Excreted with urine, g	0.02 ± 0.001	0.03 ± 0.002*	0.01 ± 0.002	0.01 ± 0.002	0.02 ± 0.002	0.02 ± 0.003
Deposited, g	2.16 ± 0.1	1.96 ± 0.14	2.41 ± 0.1	2.21 ± 0.12	2.54 ± 0.07	2.31 ± 0.16
% of obtained	47.40 ± 1.22	43.81 ± 2.64	52.07 ± 1.0*	48.30 ± 0.88	53.16 ± 0.15***	48.45 ± 1.44
% of digested	99.28 ± 0.47*	98.74 ± 0.22	99.45 ± 0.11	99.37 ± 0.11	99.35 ± 0.07	99.12 ± 0.01

Around 80% of the total phosphorus in the body of an animal can be found in the skeleton and only about 20% is contained in other tissues. Phosphorus is present in bone tissue as a structural material, it is also found in muscles, in phosphoproteins of the blood, in nucleoproteins in the nucleoplasm of all body cells and in phospholipids in the nerve cells. Phosphorus is involved in the metabolism of carbohydrates and fats. The main indicator of the state of phosphorus metabolism in animals is phosphorus balance, the parameters of which are presented in Table 6.

Data in Table 6 indicates that phosphorus of the feeds was better utilized by the hybrids. For example, phosphorus utilization in the hybrid offspring of meat-wool ewes from the groups 2 and 3 was 0.25 g and 0.38 g higher compared to purebred lambs and phosphorus utilization in the hybrid offspring of wool-meat ewes was 0.25 g and 0.35 g higher, respectively. A similar trend was observed for the utilized percentage of phosphorus obtained with feeds and digested. However, a significant difference was recorded between lambs born to ewes of different types – 3.7% ($P \geq 0.95$) for hybrids with the Kuibyshev breed and 4.71% ($P \geq 0.999$) for hybrids with the Romney Marsh breed. This tendency was also observed in purebred buck lambs for the percentage of phosphorus obtained from the digested feed that was utilized – 0.54% ($P \geq 0.95$). The better utilization of phosphorus from the feeds apparently contributed to a better metabolism and phosphorus deposition in the organism of animals.

Conclusion

This study shows that, in both pure breeding and crossbreeding, selection of ewes with consideration of their intra-breed type contributes to the better utilization of nutrients obtained from the feed in young sheep. Digestibility and utilization of feed nutrients were higher in hybrid buck lambs, compared to their purebred peers, which contributed to better growth and development of young sheep.

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