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Effect of dietary supplementation with alfalfa protein-xanthophyll concentrate (PX) on ewe milk performance and offspring growth

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The research objective was to determine the influence of supplementation of ewe diets with protein-xanthophyll concentrate from alfalfa (PX) in the fifth month of gestation and during lactation on milk yield and offspring growth performance. The study was conducted on three sheep breeds, synthetic prolific-meat line BCP, Berrichon du Cher (BER) and Polish Lowland Sheep of the Uhruska variety (PLS), in two consecutive reproductive seasons. During the observation period the animals were assigned to two groups, control (C) and experimental (E). The daily feed ration for the control animals contained sugar beets, pellets from dried sugar beet pulp, meadow hay, and oat grain, while the feed ration for the experimental animals additionally included 60 g PX/animal/day, mixed in with the oats. The feed supplemented with 60 g PX/animal/day, given to ewes in their fifth month of gestation and during lactation, improved milk production and mammary gland health and increased lamb growth and daily weight gains from birth to 100 days of age.

KEY WORDS: sheep / feeding / alfalfa (PX) / milk performance / weight gains

Effective feeding and a well-balanced diet for animals depend not only on essential nutrients but also on feed supplements. For the last 30 years these have primarily been antibiotic growth promoters (AGP) [5]. Due to changes in legal regulation of animal husbandry AGPs were eliminated from animal feed and replaced with natural alternatives exhibiting similar activity [12]. These alternatives included plant-based feed additives (phytobiotics), with alfalfa (*Medicago sativa*) and preparations derived from it playing a major role. Alfalfa is recognized as one of the most valuable forage crops, characterized by high yield, drought resistance and frost hardiness, as well as the capacity to fix atmospheric nitrogen. It is rich in protein (17-22%), minerals (13-14%), vitamins and numerous secondary metabolites [9]. Alfalfa is an excellent source of protein and energy for ruminants.

On average, 1 ha of alfalfa yields 300-500 dt of green mass, i.e. 800-1,500 kg of digestible crude protein. A daily alfalfa forage ration for ruminants ranges from 3 to 30 kg, depending on the animal's species and age.

Currently, alfalfa is marketed as hay and forage, as well as in the form of dehydrated pellets or protein-xanthophyll concentrates PX and APC [2].

PX concentrate produced from alfalfa leaves is a potent source of nutrients, especially amino acids of high biological value, vitamins and minerals. Studies have shown that PX concentrate used as a dietary supplement for pigs, turkeys, cattle and carp improves animal growth and performance [6].

The concentrate production process for APC and PX is the same, but as APC is intended for human diets, it is produced under stringent sanitary restrictions. The primary benefit of APC in the diet is improvement of haematological parameters and general health status [1].

A number of scientific reports discussing the incorporation of PX in the diets of various species of livestock led us to broaden the scope of the research and to determine the effect of a PX feed supplement for ewes in their fifth month of gestation and during lactation on milk yield and offspring growth performance.

Material and methods

The study was carried out on three sheep breeds, the synthetic prolific-meat line BCP (32 animals), Berrichon du Cher (BER – 20) and Polish Lowland Sheep of the Uhruska variety (PLS – 40), in two consecutive reproductive seasons. A total of 184 animals, 92 in each breeding season, were studied. During the observation period, i.e. the fifth month of gestation month and 100-day lactation, the ewes were assigned to two groups: control (C) and experimental (E). The daily feed ration for the control animals contained sugar beets, pellets from dried sugar beet pulp, meadow hay, and oat grain, while the experimental group additionally received 60 g PX/animal/day mixed in with the oats. The feeding level for both groups satisfied the nutritional requirements corresponding to their physiological status.

The animals from both groups were housed in the same conditions. The lambs were reared on their dams to 100 days of age and had free access to their mothers' milk, crushed oats and high quality hay.

During the observation period, ewe milk yield was evaluated on the basis of control milking operations and milk quality was assessed in terms of basic chemical composition (3 milking operations – 15, 45 and 75 days after lambing). Each year milking was performed on 60 randomly selected ewes (10 from each breed from groups C and E). In total, yield was assessed in 120 ewes during the study.

Lamb body weight was recorded on day 2 after birth, at 56 days of age and at weaning at 100 days of age, which allowed for determination of weight gains in the following periods: birth – 56 days, 56-100 days, birth – 100 days.

The results obtained were analysed statistically using analysis of variance and the SAS least squares estimation procedure (SAS v.9.1.3, 2003). Calculations of body weight and weight gain took into account four variables (group, breed, sex, and birth type), while calculations of milk yield and composition included only one variable (group). The mean va-

lues for each trait (LSM) and standard error (SE) were presented in the tables. Significance of differences between mean values was determined using Duncan's multiple confidence interval with significance levels of 0.05 and 0.01.

Results and discussion

Table 1 compares lamb body weights recorded at each growth phase, analysed with respect to various factors. In all periods studied, lambs from the experimental ewes fed a PX-supplemented diet, both in the fifth month of gestation and throughout lactation, were found to be heavier. The differences were about 10% at birth and were statistically non-significant. At 56 and 100 days of age, the differences between the groups were approximately 17% and 15%, respectively, and were statistically confirmed at P≤0.01 and 0.05, respectively.

Analysis of the effect of other factors on this trait showed a significant influence (P≤0.01) of breed and birth type but no significant impact of any interactions.

Table 1 – Tabela 1

Lamb body weight (kg)

Masa ciała jagniąt (kg)

Age Wiek	Group Grupa	n	LSM	SE	Effect of factor – Wpływ czynnika				
					group grupa	breed rasa	sex płeć	birth type typ urodzenia	interaction interakcje
At birth Przy urodzeniu	E C	79 41	3.7 3.4	0.13 0.13	NS	NS	NS	**	NS
56 days 56 dni	E C	79 41	15.5 13.0	0.42 0.48	**	**	NS	**	NS
100 days 100 dni	E C	79 41	28.4 24.5	0.88 0.87	*	**	NS	**	NS

*Statistically significant at P≤0.05 – Istotne statystycznie przy P≤0,05
**Statistically significant at P≤0.01 – Istotne statystycznie przy P≤0,01
NS – no significance – brak istotności

In conducting the experiment it was expected that the inclusion of PX concentrate in the diet of pregnant ewes would have a beneficial effect on performance. The differentiation observed in lamb body weight at each growth phase studied were confirmed by their daily weight gain (Tab. 2)

The lambs obtained from ewes in the experimental group had substantially higher daily weight gain from birth to 56 days of age and throughout the lactation period than the lambs from the control. The difference between these groups, i.e. 57 and 40 g/day, respectively, was statistically highly significant (P≤0.01). It was also established that twin lambs had 20% lower daily weight gains than single lambs, which was also confirmed statistically (P≤0.01).

The sex of the lambs did not affect their growth rate, while breed had a significant influence only in the period between 56 and 100 days of age. During this period, when young

Table 2 – Tabela 2

Daily weight gain in lambs (g)

Przyrosty dobowe masy ciała jagniąt (g)

Factor Czynnik	Daily weight gain – Przyrosty dobowe					
	at birth – 56 days urodzenie – 56 dni		56-100 days 56-100 dni		at birth – 100 days urodzenie – 100 dni	
	LSM	SE	LSM	SE	LSM	SE
Group – Grupa						
Experimental Doświadczalna	217**	8	287	13	248**	8
Control Kontrolna	160**	11	269	19	208**	9
Genotype – Genotyp						
BCP	204	10	330^{A}	13	260	10
BER	208	11	227^{B}	19	217	11
PON	153	21	276	21	207	15
Sex – Płeć						
Ewe lamb Maciorki	185	11	277	16	225	10
Ram lamb Tryczki	192	10	279	15	230	9
Birth type – Typ urodzenia						
Single lamb Jedynaki	213**	9	303*	15	253**	9
Twins Bliźnięta	164**	10	252*	14	203**	9

*Statistically significant at P≤0.05 – Istotne statystycznie przy P≤0,05

**Statistically significant at P≤0.01 – Istotne statystycznie przy P≤0,01

A, B – means in columns with different letters differ significantly at P≤0.01 – średnie w kolumnach oznaczone różnymi literami różnią się istotnie przy P≤0,01

ruminant growth and development is increasingly influenced by solid feed, the highest growth rate was achieved by BCP lambs (330g/day), and this value was significantly higher (P≤0.01) than that obtained for Berrichon du Cher breed lambs.

Table 3 – Tabela 3

Chemical composition (%), somatic cell count (log SCC) and milk yield (kg) during complete lactation

Skład chemiczny (%) mleka, liczba komórek somatycznych (log LKS) i wydajność mleczna (kg) w okresie pełnej laktacji

Group Grupa		Milk yield Wydajność mleczna	Protein Białko	Fat Tłuszcz	Lactose Laktoza	log SCC log LKS
Experimental	LSM	141.2**	4.3	8.0*	4.9	4.81*
Doświadczalna	SE	5.4	0.1	0.35	0.10	0.18
Control	LSM	110.8**	4.2	7.0*	5.0	5.45*
Kontrolna	SE	4.21	0.09	0.35	0.06	0.26

*Statistically significant at P≤0.05 – Istotne statystycznie przy P≤0,05

**Statistically significant at P≤0.01 – Istotne statystycznie przy P≤0,01

Milk production in the ewes studied over the course of lactation was high and varied depending on the diet received. The ewes fed concentrated feed supplemented with protein-xanthophyll concentrate from alfalfa had higher milk yield than the control animals. The difference between the groups was statistically highly significant ($P \leq 0.01$).

The composition of the feed only slightly increased fat content, i.e. from 7.0% (group C) to 8.0% (group E). Protein and lactose levels remained at a very similar level, i.e. 4.2--4.3% and 4.9-5.0%, respectively. Milk from the experimental ewe group had a significantly lower ($P \leq 0.05$) somatic cell count (log SCC 4.81) than the control (log SCC 5.45).

Protein feeds are an essential component of a well-balanced feed ration for lactating animals. Alfalfa protein-xanthophyll concentrate (PX) is an excellent source of crude protein and xanthophylls [4].

The available literature on PX supplementation mainly presents research on monogastric animals. According to a study done on pigs [3], the animals fed a diet supplemented with 10% alfalfa concentrate for two weeks showed higher daily weight gains than other groups of pigs. In another study [4], as little as 3% PX concentrate added to the diet of grower pigs improved daily weight gain.

The effect of dietary PX on growing animals has also been studied in turkeys, with very interesting results, especially from an economic standpoint. The experimental group receiving a PX dietary supplement had a significantly higher growth rate and lower average feed conversion during the fattening period [4].

Notably, the results were obtained in the present study, in which alfalfa PX concentrate was incorporated into the diet of sheep, are consistent with those described above. Analysis of the results illustrating lamb growth throughout the study clearly shows that at late gestation, the time of the most intensive foetal growth and the highest nutritional demands in the pregnant ewe, dietary supplementation with PX concentrate is highly recommended. The same recommendation holds true for lactating ewes. Throughout the study period (in the present research), growth parameters did not depend on the sex of lambs, whereas birth type was a growth differentiation factor for single and twin lambs. Single lambs had slower weight gains, which in our opinion justifies the need to include PX concentrate in the diet, especially in high fecundity flocks.

Rearing performance and growth in slaughter lambs, particularly at lower slaughter weights, depend on dam milk yield in the early stage of lactation. A high level of this trait ensures proper growth and development of the offspring and hence successful rearing.

In the present study, the milk production of the experimental mother ewes fed a PX-supplemented diet was statistically higher than in the control, which is a major benefit derived from the use of this feed additive.

A similar association was found in a study on the effect of homeopathic feed additives on sheep milk quality and production [10].

Good milk yield and chemical composition are indicative of the health of the mammary gland in sheep. These issues are frequently addressed in the literature, as the aetiology of mammary gland disorders, particularly subclinical ones, is varied and complex, white its prevalence is high (20-50%) [8, 11]. Mastitis results in reduced milk yield, lower milk quality and increased somatic cell count, which may cause a higher lamb mortality rate [7]. The results of the present study indicate a beneficial effect of a diet supplemented

with protein-xanthophyll for nursing ewes. Low somatic cell counts in the milk of the experimental ewes as compared to the control are evidence of the mobilization of defence mechanisms in the mammary gland in response to the pathogen attack. Significantly, the underlying cause of this is the beneficial effect of the PX concentrate feed additive given to the lactating ewes.

Summing up, protein-xanthophyll concentrate supplied at 60 g/animal/day as a dietary supplement for ewes in their fifth month of lactation had a beneficial effect on milk production and the health status of the mammary gland and improved lamb growth and daily weight gain from birth to 100 days of age.

The results of the research provide justification for further studies exploring the use of protein alternatives available on the market, in terms of animal productivity, health, and production costs, with special focus on small ruminants.

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Wpływ stosowania koncentratu białkowo-ksantofilowego z lucerny (PX) w żywieniu owiec matek na ich mleczność i wzrost potomstwa

S t r e s z c z e n i e

Celem badań było określenie wpływu suplementacji koncentratem białkowo-ksantofilowym z lucerny (PX) mieszanek paszowych dla owiec matek w piątym miesiącu ciąży i w okresie laktacji na ich mleczność oraz wyniki wzrostu potomstwa. Badania przeprowadzono w dwóch kolejnych sezonach rozpłodowych na owcach trzech ras: syntetycznej plenno-mięsnej linii BCP, berrichon du cher (BER) oraz owcy uhruskiej (PON). W okresie obserwacji zwierzęta zostały podzielone na dwie grupy: kontrolną (C) i doświadczalną (E). Dzienną dawkę pokarmową dla zwierząt grupy kontrolnej stanowiły buraki cukrowe, wysłodki brykietowane suche, siano łąkowe i ziarno owsa, natomiast zwierzęta grupy doświadczalnej dodatkowo otrzymywały 60 g PX na sztukę/dzień, który był wmieszany w owies. Stwierdzono, że suplementowanie paszy dla owiec matek koncentratem PX w ilości 60 g/sztukę/dzień w 5. miesiącu ciąży i w okresie laktacji wpływa korzystnie na ich mleczność i stan zdrowotny gruczołu mlekowego oraz wzrost i przyrosty masy ciała jagniąt w okresie odchowu do 100. dnia życia.

SŁOWA KLUCZOWE: owce / żywienie / lucerna (PX) / mleczność / przyrosty masy ciała jagniąt