Chapter

Use of Soy Milk in Lamb Feeding

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Abstract

Soy milk was administered to *Djallonké* Lambs in pre weaning. Three groups of 20 animals, all from a traditional farming, were performed. Group 1 (control) was deprived of soy milk. In the 2nd and 3rd group lambs received 50 and 100 ml soy milk respectively per head. Food supplementation with soy milk began a week after the lambs' birth. Soy milk was administered daily at the same time in one meal using a suckling bottle before leaving to the pasture. The results showed a significant delay of growth of the control group compared to the other groups. At the end of the 2nd week, the body weight difference was in average 0.32and 0.42 kg respectively for the control and the two other groups. At the end of the 12th week this difference became 2.55 and 3.22 kg respectively for the control and the two other groups. No significant differences were observed between the live weights' mean in the 2nd and 3rd group.

Keywords: growth, soy milk, food, *Djallonké* lambs, Benin

1. Introduction

The nutritional importance of animal protein in the diet is well established. However, it is becoming increasingly difficult to make this food in sufficient quantity available to the populations, especially in developing countries. Yet these countries have sufficient local resources that can be better harnessed to meet the food and nutritional needs of their populations. The transformation, by animals, of primary plant resources into animal proteins with high nutritional value for humans remains the most effective means of ensuring populations a healthy and balanced diet. To this end, small ruminants, sheep and goats, represent a real opportunity for poor rural populations to improve the availability of food resources of animal origin. Indeed, these animal species are relatively easy to breed and therefore easily adapt to the socio-economic conditions of rural households. Despite these adaptive qualities and a strong aptitude for reproduction (view video in annex) (precocious puberty, good prolificacy, non-seasonal sexual cycle) [1], the milk yield of local breeds of small ruminants and in particular that of sheep in Benin remains low. This yield is estimated at 57.44 kg and 86.44 kg, for a lactation period of 105 days and 112 days, respectively for ewes with one and two lambs [2]. By crossing this level of milk production of ewes with the nutritional need for maintenance of lambs, which is estimated at 421 kj/kg of metabolizable weight [3], it is clearly seen that the lambs are being fed well below their physiological requirements. Indeed, such milk performance, obviously, does not adequately cover the nutritional needs of two, sometimes three lambs per birth, during the lactation period. Due to the low

milk production of females, young animals in pre-weaning fail to fully express their growth potential [4]. This results in sometimes chronic undernourishment leading to difficulties in the growth of young animals and a predisposition to diseases. The high mortality of lambs is therefore the main factor in the drop in productivity and varies according to the authors between 20 to 48% [3–6] and decreases (5 to 20%) after weaning and in adult animals [7]. To obtain better growth performance from young lambs during the suckling period, it is essential that the nutritional requirements at this stage of life are sufficiently covered. The ideal feed for this, at least during the first two weeks of lambs life, is sufficient natural sheep's milk. Other sources of milk, such as cow's milk or formula made from specific plant material can be used. Various plant products are used for the manufacture of milk drinks. These milk drinks represent for most people, an alternative to natural animal milk, because they do not support lactose, a sugar naturally contained in the milk of mammals. Plant milks also have the advantage of being rich in vitamins and minerals. These milks also contain unsaturated fats, which is more beneficial for health, as they do not contain cholesterol, like the saturated fats found in animal milk. Plant milks produced from legumes, such as soybeans, also contain essential amino acids that are essential for growth. Plant milks are rarely used in animal feed. In developed countries, where cows produce enough milk, its use in animal feed is very widespread. [8] investigated the possibility of raising lambs with milk replacer from cow's milk. [9] used soy milk to supplement pre-weaning lambs. The choice of using cow's milk to supplement the feed of pre-weaning lambs nevertheless poses the problem of availability and accessibility of this foodstuff under farming conditions in Benin. This milk comes mainly from extensive traditional breeding characterized by very low production [10]). This small quantity of milk is usually shared between man and calf which, as a result, cannot adequately cover its nutritional needs and therefore does not manage to fully express its growth potential. To mitigate the consequences of low local milk production, Benin regularly resorts to the massive importation of milk and dairy products. This strategy is proving too costly for a very low income country. Multiple livestock development projects involving the importation of reputed dairy breeds have not made it possible to permanently resolve this problem. However, Benin has diversified natural resources that can be developed. This is the case, among other things, with soy, which is a legume whose food and nutritional properties are highly appreciated [11]. This crop, well adapted to the climatic conditions of Benin, is widely practiced by agro-pastoralists. Rural households use soybeans for making cheese [12] which is perfectly anchored in the eating habits of the populations. Soy is also used in many countries for the manufacture of various foods and drinks commonly known as soy milk [13, 14]. It also finds wide use in animal feed, especially in the manufacture of feeds for monogastrics. Soybeans transformed into milk can be used as an alternative for this purpose to remedy the nutritional deficit of young animals during the lactogenic phase and at the same time contribute to freeing part of the milked milk for human consumption. The research question that emerges from this reflection is whether soy milk can enable *Djallonké* lambs to fill the food and nutritional deficit caused by the low milk production of the ewes during the suckling period.

2. Material and methods

2.1 Study environment

The animal material, object of the present study, is located in Tourou, a city district of the commune of Parakou located in the center of Benin between

19° 21 'North latitude and 2° 36' East longitude. With an average altitude of 350 m, it extends over an area of 441 km^2 of which about 30 km^2 are urbanized. There is a Sudano-Guinean type climate with an average annual rainfall that varies between 1000 mm and 1500 mm and two seasons which alternate as follows: a rainy season which extends from mid-April to mid-October, and a dry season from mid-October to mid-April. Temperatures in this part of Benin oscillate between 28 and 35° C. The vegetation cover observed in Parakou is dominated by wooded and grassy savannah. Vegetation is abundant during the rainy season and good quality fodder resources are thus available for animal feed.

2.2 Period and duration of the test

The trial was conducted during the rainy season for a period of 3 months. The vegetation cover at that time was luxuriant and offered ruminants an abundant forage availability.

2.3 Preparation and administration of soy milk

The preparation of the soya milk administered to the lambs was carried out from seeds cultivated and marketed in Ouaké, a locality in Benin located about 172 km north of the study site. The soy milk used was obtained by mixing 1 kg of whole soya beans, previously cleaned, with 8 liters of water. After 24 hours of soaking, the seeds, once rinsed, are poured into two liters of water and then mixed using a kitchen Moulinex. The resulting mixture was mixed with six liters of water and then boiled for 30 minutes. After cooking, the resulting porridge was filtered using a very fine mesh sieve to separate the soy milk from the residual mass. Soymilk was fed to the lambs at a temperature of 38° C every morning at the same time as a single meal using suckling bottles.

2.4 Animal material

The animal material used in the present study consists of 60 lambs (27 males and 33 females) of the Djallonké breed from 47 ewes, most of them multiparous. The animals, of which 34 were from a single birth and 26 from a double birth, came from ewes in traditional extensive herds (**Figure 1**). The animals are left to stray during the day and are tied to stakes in the evening when they return from pasture. By the age of 1 month all the lambs had received prophylactic treatment with Oxycline 20%, anti-diarrheal treatment and a vitamin complex by intramuscular injection. Three batches of lambs distributed at random were made. Lot 1 (control) is deprived of soy milk. The lambs of batches 2 and 3 received, from one week of age, respectively a supplement of 50 ml and 100 ml of soy milk.

2.5 Measurement and data collection

The data collected, recorded and analyzed during the present study focused mainly on the nutritional quality of soy milk, the quantity of soy milk served, refused and consumed, as well as on the live weight of the lambs. A sample of 500 g of soy milk was taken every four weeks and analyzed (**Table 1**). These analyzes made it possible to determine the chemical composition of soy milk according to official methods approved by the AOAC [5]. The measurement of the total amount of carbohydrate was estimated by subtracting the various nutrients: water, total nitrogen, fat, and crude ash from the original substance. The estimation of the gross energy of soy milk was carried out by considering that 1 g of carbohydrate and

Figure 1.
Djallonké sheep herd in Benin.

Nutrients	Soy milk during the test period			Ewe's milk*
	1st month	2nd month	3rd month	
Dry matter (%)	9.19 ± 1.11	9.02 ± 1.26	9.43 ± 1.09	16.47
Total Nitrogenous Matter (%)	5.93 ± 1.16	5.90 ± 1.39	5.88 ± 1.06	5.37
Fat (%)	2.38 ± 0.77	2.16 ± 0.32	2.70 ± 0.62	6.02
Crude ash (%)	0.38 ± 0.07	0.47 ± 0.10	0.41 ± 0.10	0.77
Carbohydrate (%)	0.50 ± 0.02	0.49 ± 0.01	0.44 ± 0.01	—
Gross energy (kcal /100 g)	48.02 ± 6.13	45.86 ± 6.47	50.48 ± 6.66	108

**Source: [2].*

Table 1.
Nutritional value of soy milk during the test period compared to whole sheep milk.

protein respectively release 4.1 kcal and that 1 g of fat releases 9.1 kcal [5]. The soy milk was administered individually every morning at the same time between 8 and 10 a.m. before leaving for the pasture. Likewise, individual weighing are carried out weekly on an empty stomach on the lambs and the corresponding weights are recorded on individual monitoring sheets.

3. Results

3.1 Chemical composition and nutritional value of soy milk

The nutritional values of soya milk, compared to that of sheep's milk, are shown in **Table 1**. These values show that the soymilk manufacturing process remained

broadly unchanged throughout the test. However, it emerges from this comparison that the soya milk used in the present study had a much lower dry extract, fat and crude ash content than ewe's milk. The total nitrogen content was slightly higher in soy milk than in ewe's milk [6]. Therefore, soy milk has a gross energy between 45.86 kcal and 50.48 kcal per 100 g of product. It was found to be significantly less energetic than sheep's milk estimated at 108 kcal (**Table 1**).

3.2 Lamb weight growth

The body live weights of the lambs during the test period are shown in **Table 2**.

At the end of the first week of testing, the lambs displayed an average body live weight of 2.34 kg, 2.40 kg and 2.36 kg respectively for lots 1, 2 and 3. At the end of the first week of testing, the lambs displayed an average live weight of 2.34 kg, 2.40 kg and 2.36 kg respectively for lots 1, 2 and 3. At the second week, the lambs of the control group, deprived of soya milk, displayed an average live weight of 0.32 and 0.42 kg significantly ($p < 0.001$) lower than those of groups 2 and 3 supplemented respectively with 50 ml and 100 ml of soy milk. The difference in live weight between the lambs in lots 2 and 3 was not significant ($p > 0.05$). This difference in weight growth between the batch of control animals and the two other batches was significantly ($p < 0.001$) accentuated and was located at 1.28 kg and 1.65 kg respectively for batches 2 and 3 at the 6th week. At the end of the experiment, at thirteen weeks of age, i.e. twelve weeks of soy milk treatment, the animals averaged a live weight of 6.01 kg, 8.56 kg and 9.23 kg respectively for lots 1 (control), 2 and 3 with a significant difference ($p < 0.001$) between lot 1 and the others. No significant difference ($p > 0.05$) could be noted between lots 2 and 3 throughout the experiment.

Apart from the level of soy milk consumption, other variables involved in the statistical analysis model had a more or less significant influence on the weight

Trial period (weeks)	Treatments (Soy milk consumption)								
	Lot 1 (control: 0 ml)			Lot 2 (50 ml)			Lot 3 (100 ml)		
	N	μ (kg)	SE	N	μ (kg)	SE	N	μ (kg)	SE
1	20	2.34[a]	0.04	20	2.40[a]	0.04	20	2.36[a]	0,04
2	20	2.78[a]	0.10	20	3.10[b]	0.10	20	3.20[b]	0,09
3	20	3.14[a]	0.11	20	3.74[b]	0.12	20	3.84[b]	0,11
4	20	3.42[a]	0.14	20	4.28[b]	0.15	20	4.40[b]	0,14
5	20	3.67[a]	0.17	20	3.80[b]	018	20	5.03[b]	0,16
6	20	4.02[a]	0.18	20	5.30[b]	0.19	20	5.67[b]	0,18
7	20	4.31[a]	0.21	20	5.78[b]	0.22	20	6.16[b]	0,20
8	20	4.61[a]	0.22	20	6.26[b]	0.23	20	6.74[b]	0,21
9	20	4.95[a]	0.23	20	6.77[b]	0.24	20	7.34[b]	0,22
10	20	5.29[a]	0.24	20	7.33[b]	0.24	20	7.97[b]	023
11	20	5.61[a]	0.25	20	7.93[b]	0.26	20	8.55[b]	0,24
12	20	6.01[a]	0.26	20	8.56[b]	0.27	20	9.23[b]	0,25

Values with the same letters superscript on the same line are not significantly different at the 5% level.

Table 2.
Live weight of Djallonké lambs supplemented with soy milk in pre weaning.

Trial period (weeks)	Treatments (Soy milk consumption)											
	Lot 1 (control: 0 ml)				Lot 2 (50 ml)				Lot 3 (100 ml)			
	Single birth		Double birth		Single birth		Double birth		Single birth		Double birth	
	μ (kg)	SE	μ (kg)	SE	μ (kg)	SE	μ (kg)	SE	μ (kg)	SE	μ (kg)	SE
1	2.35[a]	0.05	2.33[a]	0.07	2.42[a]	0.05	2.37[a]	0.07	2.44[a]	0.07	2.28[a]	0.05
2	2.71[a]	0.11	2.84[a]	0.15	3.19[b]	0.12	3.01[a]	0.16	3.38[b]	0.15	3.01[a]	0.12
3	3.20[a]	0.14	3.09[a]	0.18	3,87[b]	0.14	3.61[a]	0.20	4.12[b]	0.18	3.55[a]	0.14
4	3.54[a]	0.17	3.29[a]	0.22	4.43[bc]	0.17	4.13[bc]	0.24	4.71[b]	0.22	4.09[c]	0.17
5	3.76[a]	0.20	3.58[a]	0.27	5.10[b]	0.20	4.51[b]	0.29	5.44[d]	0.26	4.61[bc]	0.21
6	4.06[a]	0.22	3.97[a]	0.29	5.74[b]	0.22	4.86[c]	0.31	6.28[d]	0.29	5.06[c]	0.23
7	4.34[a]	0.25	4.28[a]	0.33	6.20[b]	0.25	5.35 [b]	0.36	6.76[c]	0.33	5.56[b]	0.26
8	4.66[a]	0.26	4.57[a]	0.35	6.70[b]	0.27	5.83[b]	0.38	7.40[c]	0.34	6.08[b]	0.27
9	5.01[a]	0.27	4.90[a]	0.36	7.12[b]	0.28	6.43 [b]	0.39	8.02[c]	0.36	6.67[b]	0.28
10	5.40[a]	0.29	5.18[a]	0.39	7.64[b]	0.29	7.01[b]	0.41	8.65[c]	0.38	7.28[b]	0.30
11	5.77[a]	0.30	5.45[a]	0.40	8.28[b]	0.31	7.57[b]	0.43	9.27[c]	0.39	7.84[b]	0.31
12	6.16[a]	0.31	5.86[a]	0.42	8.85[b]	0.32	8.26[b]	0.45	9.94[c]	0.41	8.52[b]	0.32

Values with the same letters superscript on the same line are not significantly different at the 5% level.

Table 3.
Live weight of Djallonké lambs supplemented with soy milk during the suckling period depending on the mode of birth.

growth of the lambs during the study. Thus, sex significantly ($p < 0.001$) influenced the mean live weight of lambs at the very start of the experiment. Its influence resulted in higher weights in males than in females after a week of testing. Thus, for all the lambs, the average live weight at one week of testing was 2.46 kg for the males and 2.27 kg for the females. Mode of birth as well as birth weight also had a significant influence ($p < 0.05$) on the weight growth of lambs. While the significant influence ($p < 0.001$) of birth weight was already evident from the start of the experiment, that of mode of birth began a little later in the second week, especially in lambs born from a simple birth, and persisted until the end of the experiment.

The results obtained and presented in **Table 3** showed that at the end of the first week of testing, the supplementation of soy milk had no significant effect ($p > 0.05$) on the live weights of the lambs whatever the mode of birth. The significant effect of supplementing soymilk was evident from the second week of the test. At this time, single born control lambs, with an average live weight of 2.71 kg, showed on average a significant growth retardation ($p < 0.001$) of 0.48 and 0.67 kg respectively vis-à-vis lambs born single from lots 2 and 3. This growth retardation was only 0.17 kg between the twin control lambs and those from the other two lots from the same birth mode during the same period. After four weeks of testing, the weight loss in single born control lambs was 0.89 kg and 1.17 kg, respectively, compared to single born lambs in lots 2 and 3. In twin lambs, this delay from the control batch, although significant, was less pronounced and amounted to 0.84 kg and 0.80 kg respectively compared to batches 2 and 3. At the end of the experiment at twelve weeks of testing, this difference in live weight amounted to 2.69 kg and 3.78 kg respectively for the simple birth mode and to 2.4 kg and 2.66 kg for the double birth mode.

3.3 Average daily gain of lambs

The results of the average daily gains are shown in **Table 4**. Overall, consumption of soy milk resulted in average daily gains (ADG) in lambs directly proportional to the level of consumption of soy milk.

After one month of testing, the animals displayed ADGs of 59.76 g, 90.84 g and 95.25 g respectively for batches 1, 2 and 3. Lambs from the control group had a significantly lower average daily growth ($p < 0.001$) than those from groups 2 and 3. Supplementation of 100 ml of soy milk in the lambs from batch 3 did not induce a significantly ($p > 0.05$) more accelerated growth rate compared to their congeners from batch 2 who received 50 ml. At weaning at 3 months, the ADG of the lambs was 50 g, 83 g and 89 g respectively for lots 1, 2 and 3. The difference in ADG between the control batch, which did not receive soy milk, and the other batches was still significant ($P < 0.05$).

Trial period (month)	Treatments (Soy milk consumption)								
	Lot 1 (control: 0 ml)			Lot 2 (50 ml)			Lot 3 (100 ml)		
	N	μ (g)	SE	N	μ (g)	SE	N	μ (g)	SE
1	20	59.76^{a}	4.99	20	90.84^{b}	5.29	20	95.25^{b}	4,90
2	20	42.50^{a}	4.75	20	71.21^{b}	5.03	20	83.86^{b}	4,66
3	20	50.05^{a}	3.95	20	82.83^{b}	4.18	20	89.40^{b}	3,88

Values with the same letters superscript on the same line are not significantly different at the 5% level.

Table 4.
Average daily gain of Djallonké lambs supplemented with soy milk during the suckling period.

3.4 Lamb mortality

No case of mortality was recorded, neither among the control lambs nor among those which benefited from a feed supplement with soya milk, throughout the trial. The sanitary arrangements made at the start of the experiment, namely a prophylactic treatment based on Oxycline 20%, an anti-diarrheal treatment and an intramuscular injection of vitamin complex certainly contributed to obtaining such a result.

4. Discussion

Soy milk as a feed supplement was accepted by Djallonkés lambs in pre-weaning from the second week of life. Soymilk as a dietary supplement at the start of the breastfeeding period could not differentiate between the live weights of the Djallonkés lambs who benefited from it and those who did not. Obviously, natural ewe's milk has proven at this stage of the animals' life to be a food perfectly suited to their physiological needs. Studies have shown that sufficient ewe's milk is necessary to ensure rapid and steady growth in lambs during lactation [14]. The chemical composition of ewe's milk with particularly high dry matter, protein, fat and lactose contents, compared to goat's and cow's milk [15], clearly illustrates its nutritional quality for pre-weaning lambs. The early introduction of formula milk, such as soy milk, was ineffective in improving the weight growth of Djallonke lambs. However, it should be noted that the chemical composition of the soy milk administered to the lambs in the present study is far from meeting their nutritional requirements. Compared to sheep's milk, soy milk in the present study is clearly deficient in energy, particularly in protein and fat, two nutrients which contribute to the energy coverage of lambs. Improving the nutritional quality of soymilk could allow lambs to better express their growth potential. A special formulation of soymilk that takes into account the nutritional requirements of lambs can improve its effectiveness for this purpose. As the lambs got older, the effect of supplementation with soy milk became noticeable on their weight growth, especially between the lambs from the control lot (lot 1) on one side and those from the lots 2 and 3, with 50 ml and 100 ml respectively, on the other. Lambs from the control group, which did not receive soy milk as a feed supplement, were significantly retarded in their growth, compared to their congeners from lots 2 and 3. However, it emerges from the shape of weight growth curve, that from the sixth week, the weight difference between the animals in groups 2 and 3 became more and more visible although not significant ($p > 0.05$). The 50 ml difference in soy milk consumption between lots 2 and 3 was probably not enough to induce a substantial difference in their average live weight. [16] cited by [2] obtained for its part an average live weight of Djallonké lambs located between 6.61 and 7.13 kg at twelve weeks of age at the Okpara Farm, located in the Commune of Kika, 15 km from the city of Parakou, Benin. Tests carried out in the station also enabled [6] to determine live weights of 5.1 and 10.9 kg respectively on the 30th and 90th day in Djallonké lambs. These results are slightly higher than those obtained during the present study for the lambs of the control group. This is most certainly explained by the fact that animals reared in stations have benefited from better breeding conditions than their counterparts reared in a real environment.

For the same amount of soy milk consumed, lambs from a single birth tend to grow faster than those from a double birth. The difference in weight between lambs in lots 2 and 3, although not significant ($p > 0.05$), is more marked in singles than in twins. This suggests that lambs born single tend to benefit more from soy milk

than their double born counterparts. [3] confirmed that insufficient milk feeding in Djallonké lamb could retard the weight growth of lambs from a double birth.

At the end of the eighth week of the trial, a slight decrease in ADG was recorded in all batches of animals, regardless of feed level. Lambs at this stage of life are probably out of the accelerated phase of their growth. [17] observed a similar evolution in station in Djallonkés lambs in pre-weaning. The trend between the different lots remained nevertheless maintained with a slightly more accentuated gap between lots 2 and 3. The soymilk rationing imposed on lambs in the present study, combined with an eight-week pre-weaning limitation period, partly explains the average weight growth performance recorded. It is not excluded that an ad libitum supplementation based on soy milk over a regularly breastfeeding period of twelve weeks, improves the weight performance recorded.

5. Conclusion

The use of soy milk as a dietary supplement during the pre-weaning period has proved to be a promising strategy to improve the weight performance of Djallonkés lambs in the commune of Parakou in Benin. The consumption of soy milk allowed the Djallonkés lambs to better express their growth potential. A quantity of 50 ml of soy milk in addition to natural sheep's milk was sufficient for the Djallonkés lambs to significantly improve their growth performance. Beyond this quantity, the Djallonkés lambs continued to improve their growth performance, although not significant.

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