

Effect of Azawak Cattle Colostrum Supplementation on Performance and Survival of Red Goats During the First Year of Life.

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Article Received 27-05-2022, Article Revised 25-06-2022, Article Accepted 03-08-2022

Abstract

The aim of this work was to measure the effect of supplementation with bovine colostrum Azawak among newborn Red goats breastfed in breeding conditions for semi-intensive type of Niger. The study was conducted in Secondary Goat Breeding Center of Maradi. Forty newborn kids, regardless of sex, were divided randomly into two groups: a "T-Control" group receiving only breast milk per feeding ($n = 20$) and a "C-Colostrum" group having the same diet but supplemented with bovine colostrum thawed (50 ml the first day of life, then 25 ml in 2 meals/day between the ages of 2 and 15d, $n = 20$). The results indicate that supplementation with bovine colostrum in the first 15 days of life, increases the growth of kids until weaning, modified some barometric changes some settings improves health status and reduces the mortality rate. Birth weights in both groups were similar (1.65 kg vs. 1.64 kg; NS). However, at the end of period 1, the live weight and thus the total weight gain of the kids in-group C was higher (0.61 kg; $p < 0.001$) than those in-group T. Growth rate was also improved (+41.0 g/d; $p < 0.001$). For reproductive parameters and body measurements, the mean values of the BMPA were 13.2 ± 0.7 and 14.2 ± 0.2 months, respectively for group C and T; $P = 0.07$). The values of body measurements in group C animals were higher than those in group T, but the differences were not significant, except for head length and thoracic girth ($p < 0.001$ and 0.05, respectively). To our knowledge, in the studied environment, this work is original and seems to bring new knowledge likely to have practical applications in areas with farming conditions quite difficult.

Keywords: Colostrum, Growth, Kids, Birth, Protection, Survival, Protection

Introduction

The profitability of goat rearing is closely linked not only to the number of weanlings obtained per goat per year, but also to the growth rate of the young, which in turn depends on a balanced diet (Apper-Bossard et al., 2009). In Niger, where climatic conditions are unpredictable, feeding is a limiting factor and animals most often die of starvation. In the red goat, multiparous twin births are frequent and mothers struggle to cover the nutritional needs of their offspring in colostrum. In 2010, unpublished statistics from the Secondary Center for breeding Goat of Maradi (SCBGM), revealed that an average of 76% of goats die before the age of two months, mainly due to malnutrition. Furthermore, a cow generally produces more colostrum than her calf needs, which allows for a mini colostrum bank. The supplementation of Azawak zebu colostrum could be considered (Lamirault, 1998; N'Diaye-Wereme et al., 1998), as it contains primary defence factors (immunoglobulins, lactoferrin), nutrients, growth factors (IGF1 and 2) of interest for young goats (Godden et al., 2009; Du et al., 2011; Khul et al., 2011; Moretti et al., 2012). Birth is one of the critical periods in the life of goats that play a major role in the profitability of

production. Moreover, feeding is the main problem. Inadequate feed leads to weight loss, especially during the lean season. In addition, health has a favourable effect on production, but it is often lacking in our herds. Young udders are the most affected (Voisin, 2005; Agbokounou et al., 2017; Agbokounou et al., 2018). It is therefore necessary to provide protection to enable young kids to cope with these environmental constraints. Immunity and colostrum nutrition appear to be well suited (Rawal et al., 2008; Darby et al., 2019) to support goats that are frequently doomed to die. This study, which aims to highlight the beneficial effects of bovine colostrum supplementation in kids, is intended to be an original contribution to the improvement of zootechnical performance and health in small ruminants in general and red kids in particular. The aim of this study is to evaluate the impact of early administration of Azawak zebu colostrum on the performance of Maradi red goat kids during the first year after birth

Materials and Methods

Experimental site

The study was conducted at the SCBGM in Niger. The average annual rainfall in the region is between 600

and 700 mm and the average ambient daytime temperature is 35°C in the rainy season. The city of Maradi is located about 600 km south-east of Niamey between 13° and 15°26' North latitude and 6°16' and 8°33' East longitude. The SCBGM, created in 1963, is located 3.5 km east of the town of Maradi and covers an area of 1,850 hectares (ha) divided into three parks (x, y and z). The herds are housed in buildings constructed of hard materials. The breeding system practiced at the SCBGM is semi-intensive where the basic feed is obtained from grazing on natural pastures. Animals grazed under shepherd's guidance and received a supplement of concentrates consisting of wheat bran and cotton seed cake twice a week. They have permanent licks tones at their disposal in the racks. Water is given *ad libitum* to the animals

Colostrum collection and analysis

The composition of the colostrum, as presented in the studies, was based on an average observed on the seven samples initially collected for the meta-analysis. For the present study, the collection of colostrum was done by hand milking in the Station Saélienne Expérimentale of Toukounous (SSET) allowing the creation of a mini colostrum bank. The colostrum (8.5 litres) came from a single Zebu Azawak cow with a basic diet grazing on natural pastures. During the dry season, the dairy cows are supplemented with wheat bran or cottonseed (2 kg DM/day/animal). Colostrum was collected in a container before the first feeding, homogenised, aliquoted into tubes and stored in the freezer within the first hour after collection. The cold chain was uninterrupted from collection to administration. The colostrum donor cow had been vaccinated against contagious bovine pleuropneumonia. The colostrum was analysed for chemical composition and immunoglobulin content (Table 1). Enzyme-Linked Immunosorbent Assay (ELISA), following the

manufacturer's recommendations (Bethyl quantitative sandwich ELISA®, Montgomery, USA), measured immunoglobulins (Ig) and lactoferrin (Lf) in colostrum at the Centre d'Economie Rurale de Marloie (Belgium). The content of dry matter (DM), mineral matter (MM), lactose, non-nitrogenous extractive ether extract (NEE) and total nitrogenous matter (TNM) were measured according to the methods of the Association of Official Analytical Chemists (AOAC, 2006). Calcium (Ca) and magnesium (Mg) were determined by atomic absorption, potassium (K) and sodium (Na) by flame emission and phosphorus (P) by spectrophotometry

Animals and experimentation

Laboratory of Animal Production/Faculty of Agronomy/Abdou Moumouni University of Niamey approved the experimental protocol in collaboration with General Directorate of Veterinary Services of Niger. Forty (40) newborn goats (Figure 1) of both sexes (mean weight 1.7 ± 0.1 kg) old were considered. An alphanumeric number indicating the park affiliation (x, y and z), birth rank and sex identified each animal. The kids were randomly divided into two groups: control (group T) and colostrum (group C), each consisting of 20 animals (Table 2) that were fed the same diet (staple diet) consisting of breast milk per suckling and clean water distributed *ad libitum*. Group C kids were given an individual oral supplement of 50 ml of colostrum by bottle in two meals on day one (d1) and 25 ml/d from day two (d2) at day 15 (d15), while group T kids were not given any supplement. Kids were given thawed colostrum a few minutes before administration. To thaw the colostrum, warm water was used for 5-10 min. From the collection of the colostrum to the administration to the kid, the cold chain was never interrupted. From weaning onwards, the kids were fed on natural pasture.

Table 1: Chemical composition and immunoglobulin content (mean \pm standard deviation) of colostrum from Azawak cattle (Harouna et al., 2012).

Composition (g/L)	Mean \pm SE (n = 7)
IgG	22.5 \pm 10.7
IgA	3.3 \pm 2.1
IgM	1.7 \pm 0.8
Lactoferrin	0.2 \pm 0.1
DM	149.8 \pm 15.3
CP	67.6 \pm 9.2
EE	28.9 \pm 0.2
NFE	43.4 \pm 3.2
ash	9.9 \pm 0.7
Ca	1.3 \pm 0.2
P	1.3 \pm 0.2
K	1.4 \pm 0.2
Na	0.7 \pm 0.2
Mg	0.2 \pm 0.0

n: number

Measured parameters

The effect of bovine colostrum administration was studied up to the age of 365 days for the kids, during 3

successive periods: period of colostrum supplementation (period 1, duration: 15 days), from 16 days to weaning (period 2, duration: 182 days), from

weaning to the end of the study (period 3, duration: 168 days). In all kids, individual weekly weighed were carried out until one month after birth and then biweekly until 365 days of age. In the kids, from weaning (at 197 days of age) to the end of farrowing (duration of 168 days), the following reproductive parameters were measured: mean age at first farrowing (MAFF), fertility rate, fertility and prolificacy. In all animals, barymetric measurements (height at withers, scapulo-ischial length, head length, thoracic perimeter, and hair length) were taken with a tape measure at 365 days of age. Mortalities observed throughout the study were also recorded and their probable causes identified following diagnoses made by the agents responsible for monitoring the health of the animals in the various rearing buildings (x, y and z). This diagnosis is based on an examination of clinical signs accompanied by an interview (anamnesis) with the shepherd in charge of the animals.

Statistical analyses

Primary data for live weight measurements are analyzed using a mixed model (SAS, 1999) including the effects of treatment, age, litter, sex and allowing for

the inclusion of a type 1 autoregressive effect for repeated data measured on the same animal. Performance by time (birth, end of colostrum supplementation, weaning, end of trial) was analyzed using a generalized linear model (SAS, 1999) including the effects of treatment, sex and their interaction, with other factors found to be consistently insignificant. Means were compared using Student's t-test. For BMPA and chest circumference, Student's t-test was used to compare arithmetic means. For mortalities, the chi-square test was used to determine the significance of the difference between the two treatments.

Results

Mortalities

At the age of 365 days, both sexes combined, the mortalities recorded in the present study were numerically higher in-group T (10 animals or 50%) than in-group C (3 animals or 15%; $p < 0.05$). Figure 1 and 2 shows the positive effect of colostrum supplementation during the first 15 days of life on the evolution of the survival rate of the animals until the age of 1 year



Figure 1: Red kids

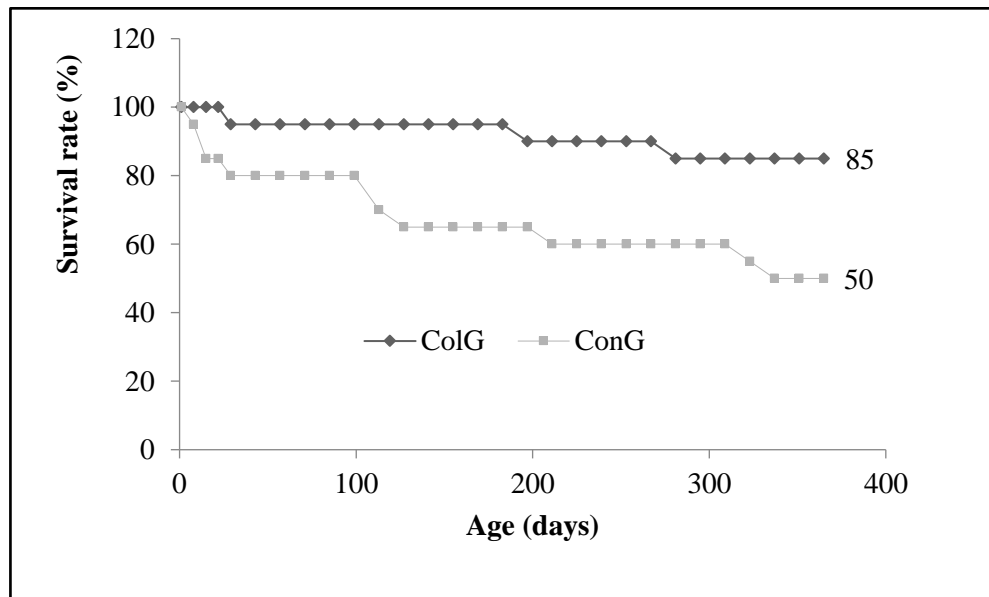


Figure 2: Effect of bovine colostrum supplementation during the first days of life on the evolution of the survival rate in red kids in Niger (mean ± standard error).

Weight

Birth weights in both groups were similar (1.65 kg vs. 1.64 kg; NS). However, at the end of period 1, the live weight and thus the total weight gain of the kids in-group C was higher (0.61 kg; $p < 0.001$) than those in-group T (Table 3). Growth rate was also improved (+41.0 g/d; $p < 0.001$). During period 2 (duration 182 d), growth was lower, but the positive effect of colostrum intake seen in period 1 was maintained. Thus, the average total gain of group C animals was higher (+5.14 kg) than that of group T animals, corresponding to an improvement in the average growth rate (+28.25 g/d, $p < 0.001$). During period 3 (168 days), the average total gain and average daily gain (ADG) were higher in group C than in group T (+2.9 to 5.7%), but the effect of colostrum supplementation was not significant (Table 3). Regarding the weight evolution over the whole study period, live weight and GMQ evolved in an opposite way (Figure 3 a & b). The animal’s in-group C

started to be heavier ($p < 0.001$) than that in-group T from the second week of life. The GMQs reached maximum values during the first 50 days and then decreased steadily, but the effect of colostrum continued consistently and significantly ($p < 0.001$) until weaning, well beyond the supplementation period.

Reproductive parameters and body measurements

Despite the small number of animals that could be used in this experiment ($n = 6$ and 8 respectively in groups T and C), it is interesting to report the reproductive parameters obtained, since, to our knowledge, there are no published data in this field in young domestic animals, and more particularly in red cabris. The mean values of the BMPA were 13.2 ± 0.7 and 14.2 ± 0.2 months, respectively for group C and T; $P = 0.07$). The values of body measurements in group C animals were higher than those in group T (Table 4), but the differences were not significant, except for head length and thoracic girth ($p < 0.001$ and 0.05 , respectively).

Table 2: Random allocation of kids to the two groups

Birth number	Cabris	
	Colostrum	Control
1	DB	ND
2	SB	NS
3	SB	NS
4	DB	ND
5	DB	ND
6	DB	ND
7	DB	ND
8	SB	NS
9	DB	ND
10	DB	ND
11	DB	ND
12	DB	ND
13	SB	NS

14	SB	NS
15	SB	NS
16	DB	ND
17	SB	NS
18	DB	ND
19	SB	NS
20	SB	NS

SB: Simple Birth DB: Double Birth

Table 3: Effect of bovine colostrum supplementation during the first days of life on the zootechnical performance of red kids in Niger (mean ± standard error).

Paramètres	Groupes				Significance			SEM
	Colostrum (n = 20)		Control (n = 20)		T*	S†	T* x S† Interaction	
	Male (n = 13)	Female (n = 7)	Male (n = 11)	Female (n = 9)				
Period 1: Birth to 15 days of age (duration: 15 days)								
Number of animals	13	7	9	8				
PV à la naissance (kg)	1.7	1.6	1.8	1.5	NS	NS	NS	0.1
LW at day 15 (kg)	3.5	3.6	3.2	2.8	***	NS	NS	0.2
Total gain (kg)	1.9	2.0	1.3	1.3	***	NS	NS	0.1
ADG (g/j)	123.1	135.2	88.9	87.5	***	NS	NS	6.4
Period 2: From 15 days of age to weaning (duration: 182 days)								
Number of animals	11	7	8	5				
LW at day 15 (kg)	3.5	3.6	3.2	2.8	***	NS	NS	0,15
LW at day 197 (kg)	17.4	16.8	11.5	11.2	***	***	NS	0,1
Total gain (kg)	13.73	13.17	8.38	8.34	***	†	NS	0,2
ADG (g/j)	75.47	72.37	46.07	45.27	***	†	NS	1,0
Period 3: Weaning to end of study (duration: 168 days)								
Number of animals	10	7	6	4				
LW at day 197 (kg)	17.4	16.8	11.53	11.2	***	***	NS	0.1
LW at day 365 (kg)	22.8	21.9	16.8	16.0	***	***	NS	0.2
Total Gain (kg)	5.4	5.0	5.2	4,8	NS	*	NS	0.4
ADG (g/j)	32.1	30.0	31.2	28.6	NS	*	NS	0.8

† (p < 0.1); *(p < 0.05); **(p < 0.01); ***(p < 0.001)

NS: Not Significant (p > 0.05)

T: treatment

S: sex

T x S: treatment x sex (interaction)

LW: Live Weight

ADG: Average Daily Gain

Table 4: Effect of bovine colostrum supplementation during the first days of life on barometric parameters in red kids in Niger (mean ± standard deviation).

Parameters (cm)	Colostrum (treatment)		Control		Significant
	Mean ± Standard error		Mean ± Standard error		
	Male (n= 8)	Female (n= 6)	Male (n= 6)	Female (n= 4)	
Height at withers	61.2 ± 1.7	56.6 ± 3.0	57.8 ± 3.4	50.0 ± 0.8	NS
Scapulo-ischial length	63.9 ± 1.8	54.4 ± 2.4	61.5 ± 3.2	49.2 ± 1.5	NS
Thoracic perimeter	57.2 ± 1.3	49.2 ± 3.4	57.2 ± 1.3	38.3 ± 2.4	P < 0,05
Length of hair	1.3 ± 0.2	1.2 ± 0.1	1.3 ± 0.2	0.2 ± 0.05	NS
Length of the head	15.1 ± 0.2	14.5 ± 0.3	15.2 ± 0.2	13.3 ± 0.4	P < 0,001

NS : Not Significant (p > 0,05).

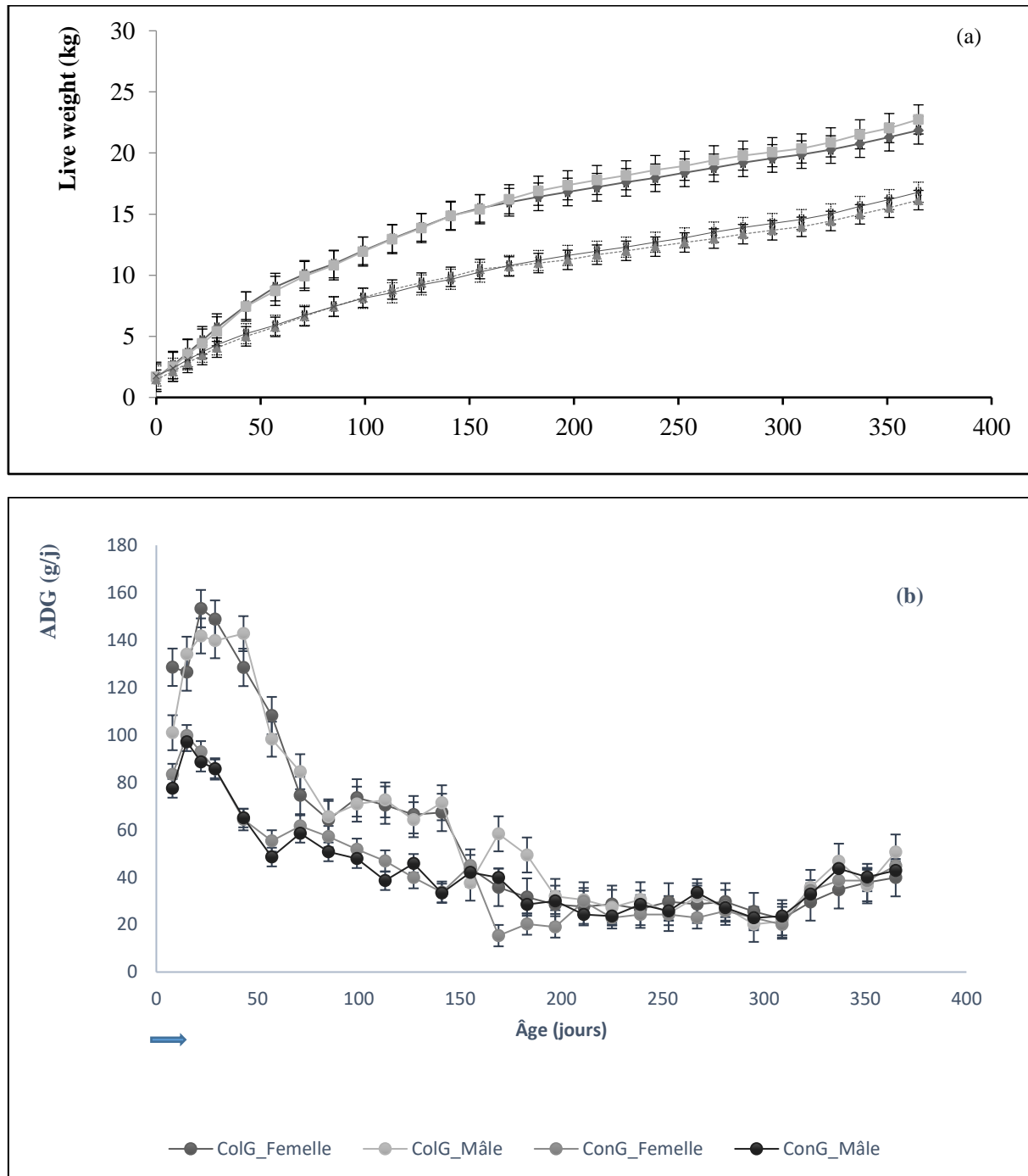


Figure 3 a & b: Effect of bovine colostrum supplementation during the first days of life on the evolution of live weight (a) and Average Daily Gain (ADG) (b) in red kids in Niger (mean \pm standard error). The starting sample size was 40 (20 in each of the T-control and Colostrum-C groups). The curves were constructed taking into account mortality during the trial (10 and 3 in groups T and C respectively).

Discussion

Mortalities

The causes of goat mortality at the CSECM are not well known. Even if the physical and human environment in Niger is favourable to the development of goat rearing, it is still confronted with enormous difficulties, particularly in terms of health (Oumarou, 1986). During the present study, the diagnosis made by the agents in charge of monitoring the health of the animals in the different parks showed that the mortalities recorded were due to gastro-intestinal (5 cases) or respiratory (6 cases) diseases, malnutrition (1 case) and trauma (1 case, following a blow from a horn). This confirms that poor feeding of goats during gestation and lactation, combined with a lack of general hygiene and poor surveillance, seem to be at the origin of the high mortality rates that are sometimes observed (Poindron et al., 2007). Other factors could also be involved. Birth weight (Baillet, 2009) and season (Youssao et al., 2009) can influence mortality rates in animal species. Generally, birth weight is a key determinant of newborn survival (Trocon and Petit, 1989). According to unpublished data from the ECDC (2010), the mortality rate is close to 100% for young animals with a birth weight of 1 kg or less. In the present study, birth weight cannot be blamed as there is no significant difference between the two groups and the average value observed is 1.6 kg. The same is true for the birth season, since it began in the rainy season, during which the climatic conditions (ambient temperature, humidity, rainfall) are favourable and fodder is abundant. The level of technical skills of the herdsmen in managing the herd could interfere. These results are in agreement with the fact that a precise and well-chosen birthing season, as well as an improvement in the conditions of calving and the management of the kids under the mother's care, would reduce these mortalities (Hoch et al., 2003).

During gestation, good feeding could reduce postpartum losses by increasing the quantity and quality of colostrum produced by the mother (Kuralkar and Kuralkar, 2010; Kaewlamun et al., 2011; Hawken et al., 2012). Survival rates are better in calves that have received colostrum beyond the period of closure of the intestinal barrier (Brignole and Stott, 1980). In this case, immunoglobulins may have a local prophylactic effect on the gut and reduce the occurrence of common postnatal pathologies (Mayer et al., 2002). In the present study, the significant reduction in mortality observed in-group C, compared to group T, indicates that under the rearing conditions of the experiment, colostrum probably had a very important impact on animal survival.

Weight growth

To our knowledge, this is the first time that such a phenomenon is described in the literature. Estimating

the effects of supplementation reported in the literature remains difficult due to the lack of evidence to establish the calculations on the same basis. Furthermore, comparisons should be made with caution, as some experiments have only looked at supplementation after weaning, whereas in the present experiment, supplementation starts as early as day 1 postnatal. The digestive physiology is indeed different at these 2 stages and the comparison is probably not appropriate. The protocol used in the present experiment is the main originality of the trial.

At 30 days of age, the average weight of group T is relatively similar to those obtained by other authors (Robinet, 1967; Oumara, 1986; Marichatou et al., 2002). On the other hand, the average weight of animals in group C was significantly higher than that of kids in group T (5.6 ± 0.5 vs. 4.2 ± 0.5 kg, $p < 0.001$). Referring to the above literature data, the results obtained for group C animals are associated with bovine colostrum intake.

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In the model used, the data were corrected for the effects of treatment, age and sex. The observed difference in growth between the two groups can only be attributed to the treatment effect associated with age. The analysis also revealed several points. Treatment strongly influenced growth performance until weaning. Sex interfered from weaning onwards when males started to be heavier than females. However, the other factors studied had no significant effect on the results obtained. The overall results are improved compared to those obtained ($+21.8 \pm 0.2$ kg at 365 d for live weight) by Abdou et al. (2013) in a previous trial. In the latter trial, colostrum supplementation was lower (50 ml/animal during the first day after birth and only 15ml/animal/d for the following 14 d) under the same rearing conditions as the animals in the present study, suggesting a dose effect on animal performance.

The better GMQ (129.15 g/d) obtained in-group C (vs 88.19 g/d for group T; $p < 0.001$), at the end of the supplementation period, suggests a very positive effect of colostrum supplementation on growth rate. The GMQ obtained in the present study is similar to that (92.0 ± 4.8 g/d at 70 d of age) reported by Mellado et al. (2008) in kids given bovine colostrum at birth. Pluske et al (1999) and Jensen et al (2013) found similar effects in piglets. In contrast, work carried out under good rearing conditions in piglets weaned at 28 days of age

and fed a diet supplemented with 2% colostrum for 14 days post-weaning suggests that growth performance is similar or better than in animals fed a diet supplemented with 4% colostrum (Le Huërou-Luron et al., 2004). Similar studies in piglets supplemented with 2% colostrum in the ration reached the same conclusion at 21 days of age (Boudry et al., 2005).

This interesting result could be associated with a rather long half-life of bovine antibodies in the blood of the kids, which could have a better protective effect against pathogens (bacteria and viruses) at the general or local intestinal level (Godden et al., 2009; Du et al., 2011). However, other factors may be involved. While a positive effect can be linked to the nutritional and especially the energy value (6.0 mJ/l) of bovine colostrum (Blum and Hammon, 2000), it cannot explain an effect beyond the feeding period. The 25 ml of colostrum offered daily to the kids represented about 0.2 mJ/l, or only 15.1% of the daily energy requirement of a newborn kid. The positive effect of colostrum supplementation could also be related to the metabolic effect due to the different compounds (Boland et al., 2005; Donovan, 2016) contained in the product (lipids, protein, minerals, vitamins, hormones, etc.) that would allow a faster development and growth of these kids. Colostrum will be especially involved in lipid metabolism by regulating postpartum plasma concentrations of non-esterified fatty acids, leptin, triglycerides, phospholipids and cholesterol metabolism (Hadorn et al., 1997; Rauprich et al., 2000). It also regulates blood glucose, hepatic glycogenesis, and insulin levels (Hammon and Blum, 2002). Colostrum contains hormones, growth factors (IGF1 and 2), enzymes (lacto peroxidase, lysozymes), cytokines that could stimulate the development and functioning of the gastrointestinal tract from birth (Blum and Hammon, 2000; Ogawa et al., 2016), which would allow it to be more efficient later on.

Reproductive parameters and body measurements

In the case of the C-group, the growth rate of the treated females was higher than that of the control group, resulting in earlier sexual maturity (puberty), weight and fertilization in the C-group. The fertility and fecundity rates were not affected by the addition of bovine colostrum, which could be explained by the fact that in the red goat, twin births are rare at first birth (Marichatou et al., 2002). For body measurements, the results obtained suggest that the treatment was more effective on body volume and soft tissue growth (Moretti et al., 2013) and thus on the animal's ability to store reserves rather than on bone radius growth.

Conclusion and Perspectives

Based on the results obtained, bovine colostrum seems to be a real "growth factor" and to play a protective role against mortality for kids. Indeed, the

live weight and average daily gain of the supplemented animals increased significantly and durably. The animals were also more resistant to environmental stress. It would be interesting to continue these studies to confirm the hypothesis that the administration of bovine colostrum positively influences the level of natural or bovine plasma antibodies in kids. A comparative study of the chemical composition of bovine and caprine colostrum is also necessary. Finally, the longer-term impact of colostrum administration on the reproductive careers of female goats also needs to be investigated.

Acknowledgments:

The authors thank the Belgian Technical Cooperation (BTC) for its financial support.

Conflict of Interest:

The authors declare that they have no Conflict of Interest

Author's Contribution:

All the authors have equal contribution in the planning, conduction and writing of the research article. All the authors have read and approved the final manuscript. Abdou and Hornick designed and planned the study; Abdou collected the data. Abdou wrote the first draft of the manuscript; Abdou, and Hornick performed the statistical analyses; Abdou, Marichatou, Beckers, Dufrasne and Hornick reviewed all versions of the manuscript. Abdou coordinated the work from conception to revision of the latest version of the manuscript.

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