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Cow milk or milk replacer in the diet of Holstein calves: effects on complete blood count, biochemistry variables, and performance

Leite de vacaousucedâneo do leitenadieta de bezerrosholandeses: efeitos no hemogramacompleto, variáveis bioquímicas e desempenho

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ABSTRACT

This study aimed to evaluate whether feeding calves with replacers instead of cow's milk interferes with complete blood count, biochemistry variables, survival, and weight gain, and the cost-benefit of these feeds in the suckling phase. We used 16 calves of the Holstein breed with an average of 8±4 days and 39±6 kg of average body weight, randomly divided into two groups: Replacer Group (N=8), receiving four liters of replacer milk during the 60 experimental days; and the Milk Group (N=8), calves receiving four liters of cow's milk. We observed that animals fed with cow's milk had higher body weight and weight gain at all weightings compared to those who consumed the dairy replacer. There was no calve death during the study. The cost (R$) of the diet of the calves that consumed replacer was lower. However, if we consider the weight gain during the experiment, the cost to produce 1 kg of body weight was similar between the treatments, because the calves that consumed milk were weaned with an average of 19kg more body weight. In conclusion, the use of dairy replacers as a replacer for cow's milk caused calves to have an overall lower performance compared to those who received cow's milk during the suckling phase.
Keywords: calves, cow's milk,milk replacer, performance, biochemistry.

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RESUMO

Este estudo teve como objetivo avaliar se a alimentação de bezerros com sucedâneoem substituição ao leite de vaca causa interferência no hemograma, variáveis bioquímicas, sobrevivência e ganho de peso e o custo-benefício desses alimentos na fase de aleitamento. Foram utilizados 16 bezerros da raça Holandesa com média de 8±4 dias e 39±6 kg de peso corporal médio, divididos aleatoriamente em dois grupos: Grupo Sucedâneo (N=8), recebendo quatro litros de leite em pó durante os 60 dias de experimentos; e o Grupo Leite (N=8), bezerros recebendo quatro litros de leite de vaca. Observamos que os animais alimentados com leite de vaca apresentaram maior peso corporal e ganho de peso em todas as pesagens em relação aos que consumiram o sucedâneo lácteo. Não houve morte de bezerros durante o estudo. O custo (R$) da dieta dos bezerros que consumiram substituto foi menor. No entanto, se considerarmos o ganho de peso durante o experimento, o custo para produzir 1 kg de peso corporal foi semelhante entre os tratamentos, pois os bezerros que consumiram leite foram desmamados com média de 19kg a mais de peso corporal. Em conclusão, o uso de sucedâneos lácteos como substituto do leite de vaca fez com que os bezerros tivessem um desempenho geral inferior em comparação com aqueles que receberam leite de vaca durante a fase de aleitamento.
Palavras-chave: bezerros, leite de vaca, sucedâneo do leite, desempenho, bioquímica.

INTRODUCTION

The success of livestock is related to the efficiency of the animal during its growth. However, the performance of calves can be affected by environmental, sanitary, nutritional, and genetic factors (France et al. 2011). Nutrition is a determining factor in animal performance (France et al. 2011) and the supply of milk to calves is essential since it provides the necessary nutrients for tissue development (Kertz et al.2017). Calves have no rumen developed in the suckling phase. Thus, solid foods are not often used, with milk as primarily responsible for providing the nutrients (Lage2018). However, one disadvantage is the high cost of production, which is why many farms replace milk with dairy replacers (Lage 2018).

Recently, researchers have aimed to encourage more research on the use of soy protein in young calf diets by learning from the mistakes of the past and acknowledging the promising results found when modern techniques are applied to treat soybeans. According to Ansia&Drackley (2020), the total or partial substitution of milk proteins with soy proteins can significantly increase the economic efficiency of calf diets, provided it does not affect calf performance. It is known that the interaction of antinutritional factors and soybean antigenic proteins in the gastrointestinal tract triggers physiological response with negative consequences for the digestive tract and immune system of the calf (Kertz et al. 2017,Ansia&Drackley 2020). It is worth noting that calves can use soy-based replacers more effectively with age (Akinyele&Harshbarger 1983).

With the appreciation of milk in the market, the sale of replacers increased in Brazil. The death of newly born male calves is high but difficult to estimate because there is no control and mandatory registration of animals born in competent bodies. However, with the appreciation of beef and the increasing demand for consumption, a new productive niche has expanded because farms have collected newly-born male calves reared in closed systems. However, the feed of these animals is generally the lowest cost, consequently having a nutritional composition limited to meet the minimum requirements. Thus, the objective of this study was to evaluate whether feeding calves with economic replacers instead of cow's milk interferes with complete blood count, biochemistry variables, survival, and weight gain of calves, and determine the cost-benefit of production during suckling.

MATERIAL AND METHODS

Product

We used an economic replacer (Terneron®), a commercial product widely marketed in the country. This product is formulated based on rice flour, wheat flour, whey powder, whole milk powder, micronized soy flour, artificial flavoring additive, antioxidant additive, acidifying additive, and coccidiostatic additive.

Experiment location

The experiment was conducted at the Experimental Farm of the Center for Higher Education of the West (FECEO), of the State University Santa Catarina, located in the municipality of Guatambu, Brazil. The installation used was a shed (20 x 10 m) with daily curtain management, animals allocated in 16 individual stalls (3.0 x 1.5 m), and sawdust bed. The cleaning of the site took place daily, with emphasis on the removal of waste.

At the beginning of the experimental period, the animals of the replacer group went through a gradual feed transition (detailed below). There were several cases of diarrhea with the replacement of milk for the milk replacer (between the 13th and 20th days). The calves of this group were treated with doxycycline hydrochloride (4,520 g) and benzetimide hydrochloride (0.0165 g) at 1 mL per 10 kg body weight for three days since diarrhea persisted for more than 48 hours. The animals that consumed milk did not have diarrhea during this period.

Cow milk, milk replacer, and concentrate

The milk used to feed the calves was purchased from a farm adjacent to FECEO, which had a herd of cows with no defined breed (but with a predominance of Jersey genetics). Four samples were used to analyze the centesimal composition of the milk and four samples of replacer were collected during the experimental period and frozen (-20 ºC) until the analysis of chemical composition. Samples of concentrate provided to calves with 22% protein was also collected and stored. The diet provided to the animals is detailed in Table 1.

Table 1. Feed (green matter) supplied to calves during the suckling phase (Stage I: 1–60 days).

Feed	Days 1 to 35	Days 36 to 60
Milk replacer[1]	400 (g/animal/d)	600 (g/animal/d)
Cow milk[2]	4.0 (L/animal/d)	4.0 (L/animal/d)
Concentrate[2]	Ad libitum	Ad libitum

Note 1: The ingredients used to produce the commercial milk replacer were rice flour, wheat flour, whey powder, whole milk powder, micronized soy flour, artificial flavoring additive, antioxidant additive, acidifying additive, and coccidiostatic additive.

Note 2: Fresh whole milk purchased from the farm from a herd of Jersey cows.
Note 3: The ingredients used in the production of the concentrate were ground corn (410 g/kg), soybean meal (410 g/kg), wheat bran (140 g/kg), and vitamin-mineral core (40 g/kg). The core composition was calcite limestone, bicalcium phosphate, sodium selenite, iron sulfate, ventilated sulfur, magnesium oxide, manganese oxide, sodium chloride, calcium iodate, zinc sulfate, copper sulfate, kaolin, vitamin A/D3, vitamin E, vitamin B1, vitamin B2, vitamin B6, vitamin B12, vitamin K3, cobalt sulfate, monensin sodium, antioxidant, flavoring, choline chloride, niacin, biotin, pantothenic acid, folic acid, and zinc chelate. At the time of production, the concentrate was supplemented with organic chromium (mineral chromium 10%, Aminogel®, São Paulo) at a concentration of 4 mg Cr/100 g of concentrate.

Feed analysis

The milk replacer and concentrate samples were homogenized to form a pool. Consequently, a single sample of concentrate and another of milk replacer were used for chemical analysis. Dry matter, mineral matter, ether extract, and crude protein were measured in the concentrates according to the method described by Silva & Queiroz (2006). Furthermore, neutral detergent fiber and acid detergent fiber were analyzed following the methodology described by Van Soest et al. (1991). Results in Table 2.

The milk replacer was analyzed using the chemical method described by Thompson (1990). The levels of dry matter, protein, ether extract, lactose, free glucose, free galactose, and ash were quantified in this sample pool. Results in Table 2.

The lactose, protein, fat, and total solid concentrations of the cow's milk samples were measured using the LactoStar automatic infrared analyzer, Funke Gerber®. Analyzes were performed in duplicate. An average was determined for the four samples analyzed (Table 2).

Table 2. Chemical composition of the feed consumed by the calves during the experiment.

Feed	Chemical composition (%)
Milk replacer	
Dry matter	95.0
Crude protein	22.7
Ether extract	12.9
Lactose	21.3
Free glucose	15.2
Free galactose	0.34
Ash	5.98
Cow milk	
Fat	6.01
Lactose	4.67
Protein	3.82
Total solid	14.5
Concentrate	
Dry matter	92.0
Crude protein	22.7
Ether extract	2.82
NDF	18.1

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ADF	9.54
Ash	4.70

Note: NDF = Neutral detergent fiber; ADF= Acid detergent fiber.

Animals and experimental design
In this study, we used 16 male calves of the Holstein breed with a average age of 8 ± 4 days and a average weight of 39.81 ± 6.9 kg, donated by dairy producers from the western region of Santa Catarina. All animals received colostrum on the property in the first 24 hours, then were transported to the experimental station where they received milk during the adaptation period. The calves were randomly divided into two groups. The animals in the milk group (control; N= 8) received four liters of milk during the 60 days. The calves of the replacer group (N = 8) received four liters of the commercial milk replacer (Terneron®) during the 60 days. The supplied concentrate was purchased containing ground corn, soy flour, wheat bran, and vitamin-mineral core in its formulation (NRC 2001). The animals fed with the cow's milk replacer underwent an adaptation period in the first four days of the experiment; 50% of milk replacer/50% cow's milk on the first and second days; 75% milk replacer/25% cow's milk on the third and fourth days; 100% replacer from the fifth day of experimentation, corresponding to the 13th day of life), according to the manufacturer's recommendations, that is, 100 g of the feed diluted in 1000 mL of water. The animals of the control group were fed with cow's milk, receiving four liters per day, without any adaptive period. Both feeds were provided to the animals at a temperature of 37 ºC, and divided into two moments, at 8:00 and 17:00 hours. Concentrate was supplied *ad libitum* to the calves in both treatments.

Zootechnical performance
The calves were weighed individually every week throughout the trial period using a digital scale. The weighing took place in the morning, with the animals fasting for 12 hours. The consumption of the concentrate was evaluated weekly, weighing the quantity supplied and the leftovers. The consumption of the replacer and the cow's milk did not differ during the entire experimental period, feeds offered in individual suckers. Based on this information, the feed efficiency (%) was calculated according to the daily weight gain equation: (kg)/dry matter intake (kg) x 100.

Sample collection
Blood collection was performed on days 1, 30, and 60 of the experimental period. Samples were collected from the jugular vein using two vacuum tubes, with and without anticoagulant. The samples were stored in a thermal box at 10 ºC during transport to the laboratory. Subsequently, samples without anticoagulant were centrifuged at 7000 rpm for 10 minutes to obtain serum, while samples with anticoagulant were used in the analysis of the complete blood count described below.

Laboratory analyses

Complete blood count
The count of erythrocytes, leukocytes, and hemoglobin concentration was performed using a semi-automatic blood cell counter (model CELM CC530). Subsequently, the leukocyte differential was defined by reading the stained blood smear using a Rapid Panotic kit. The hematocrit was measured with

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microcapillars, centrifuged at 14000 rpm for 5 minutes.

Serum biochemistry

The levels of total proteins, albumin, urea, cholesterol, triglycerides, and glucose were evaluated in the serum using a commercial kit (ANALISA®) and semi-automatic equipment (BIO PLUS 2000®), according to the manufacturers' recommendations. Globulin levels were obtained using the equation: globulin = total proteins - albumin.

Cost-benefit

The value used to feed the calves for 60 days, which corresponds to the first 70 days of life, and the costs of acquiring these feeds was calculated according to the amount of feed consumed (concentrate, cow's milk, and replacer) by the calves individually. It is important to note that the amounts paid for the products was R$ 2.88/kg for the concentrate, R$ 2.10/liter of cow's milk; R$ 8.20/kg of replacer.

The calves were medicated for diarrhea during the experimental period, used as a criterion for treatment when diarrhea persisted for more than 24 h. The antibiotic Agroplus® (Virbac) was used as therapeutic conduct, with the application of three doses (1 ml for every 10 kg of live weight) in 24 h interval.

The cost of production to produce one kilogram of body weight of the calves and the total cost of production (feed + medication) were calculated based on the weight gain of the calves during the experimental period.

Statistical analyses

All data were analyzed using the 'MIXED procedure' of SAS (SAS Inst. Inc., Cary, NC, USA; version 9.4), with Satterthwaite approximation to determine the denominator degrees of freedom for the test of fixed effects. Growth performance data (except for BW) and costs of production were tested for the treatment fixed effect using the animal (treatment) as random effect. The data of BW, complete blood count, and serum biochemistry were analyzed as repeated measures and tested for the treatment, day, and treatment × day fixed effects, using the animal (treatment) as a random effect. The day 1 results were including as an independent covariate. Additionally, the day 1 results were removed from the data set of these variables, but kept as a covariate to generate the average per treatment. The first order autoregressive covariance structure was selected according to the lowest Akaike information criterion. Means were separated using the PDIFF method and all results were reported as LSMEANS followed by SEM. Significance was defined when $P \leq 0.05$, and tendency when $P > 0.05$ and ≤ 0.10.

RESULTS

Zootechnical performance

There was no calf death in the two experimental groups. The results of weight, total body weight gain, average daily weight gain, concentrate consumption, and feeding efficiency during the breastfeeding period are described in Table 3. The calves that consumed cow's milk showed higher total body weight gain at all times compared to animals that consumed the milk replacer ($P \leq 0.01$). From day seven of the experiment, a significant difference was also observed ($P \leq 0.01$) for day and interaction (treatment x day). The body weight of the calves increased over time in both groups. However, this weight gain was higher in animals that consumed milk ($P \leq 0.01$).

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Average daily gain, concentrate consumption, and feed efficiency also differed (P ≤ 0.01) regarding the treatment effect, in which animals fed cow's milk were superior to those given the milk replacer.

Table 3. Growth performance of calves consuming milk and milk replacer.

Items	Treatments[1]		SEM	*P* – values		
	Cow milk	Milk Replacer		Treat[&]	Day[#]	Treat × Day*
Body weight (kg)				**<0.01**	**<0.01**	**<0.01**
d 1	42.9[J]	41.1[J]	1.77			
d 7	44.6[I*]	40.9[I*]	1.77			
d 14	47.8[H*]	41.7[G*]	1.77			
d 21	49.5[G*]	41.5[H*]	1.77			
d 28	55.6[F*]	44.8[F*]	1.77			
d 35	59.6[E*]	46.0[E*]	1.77			
d 42	65.3[D*]	51.7[D*]	1.77			
d 49	69.1[C*]	53.7[C*]	1.77			
d 56	77.4[B*]	58.9[B*]	1.77			
d 60	82.2[A*]	63.2[A*]	1.77			
Average[2]	61.4[a]	49.1[b]	1.54			
Body weight gain (kg)						
d 1 to 14	4.90	0.67	1.03	**<0.01**	-	-
d 1 to 35	16.7	4.97	1.64	**<0.01**	-	-
d 1 to 60	39.3	22.1	2.93	**<0.01**	-	-
d 35 to 60	22.6	17.1	1.75	**0.04**		
Average daily gain (kg/day)						
d 1 to 60	0.66	0.37	0.05	**<0.01**	-	-
Feed intake[3]						
d 1 to 60	57.7	49.7	2.09	**0.02**	-	-
Feed efficiency (kg/kg)					-	-
d 1 to 60	0.68	0.43	0.38	**<0.01**	-	-

[1]The treatments were animals feed whit cow milk by 60 days; and calves feed with milk replacer.
[2]The day 1 results were removed from the data set to generate the average per treatment in the statistical analysis.
[3]Concentrate + liquid feed (milk or replacer).
[&] Lowercase letters ([a, b]) show difference between groups - treatment effect.
[#] Within a column, means without a common superscript ([A-J])differ ($P \leq 0.05$) or tend to differ ($P \leq 0.10$) – show day effect.
[*] Within a row, differ ($P \leq 0.05$) or tend to differ ($P \leq 0.10$) - shows treatment x day interaction.

Complete blood count

Table 4 describes the results of blood cell count, hematocrit, and hemoglobin concentration. There was no statistically significant difference between treatments in the complete blood count (P>0.05). However, over time, the count of erythrocytes, leukocytes, neutrophils, and lymphocytes, as well as the concentration of hemoglobin, differed in both groups (P ≤ 0.01). The number of total monocytes had a tendency to increase in the blood of calves who received milk replacer compared to the other group (P =0.10).

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Table 4. Complete blood count of calves consuming milk and milk replacer.

Items	Treatments[1]		SEM	*P* – values		
	Cow milk	Milk Replacer		Treat[&]	Day[#]	Treat × Day*
Erythrocytes (x10⁶ µL)				0.44	**<0.01**	**0.05**
d 1	8.47^{A}	9.18^{A}	0.46			
d 30	6.56^{B}	6.61^{B}	0.46			
d 60	7.69^{AB*}	6.24^{B*}	0.46			
Average[2]	6.95	6.56	0.34			
Hematocrit (%)				0.70	0.12	0.11
d 1	40.10	38.1	3.92			
d 30	29.4	36.9	3.92			
d 60	35.6	25.5	4.18			
Average[2]	32.9	31.1	3.17			
Hemoglobin (g/dL)				0.37	**<0.01**	0.13
d 1	8.53^{A}	8.69^{A}	0.35			
d 30	6.87^{B}	6.59^{B}	0.35			
d 60	6.96^{B}	6.10^{B}	0.38			
Average[2]	6.86	6.39	0.36			
Leukocytes (x10³ µL)				0.76	**<0.01**	0.65
d 1	12.4^{A}	11.7^{A}	0.91			
d 30	5.20^{B}	5.98^{B}	0.91			
d 60	4.79^{B}	5.39^{B}	0.91			
Average[2]	5.19	5.52	0.56			
Neutrophils (x10³ µL)				0.90	**<0.01**	0.98
d 1	2.50^{A}	2.59^{A}	0.30			
d 30	1.12^{B}	1.10^{B}	0.30			
d 60	0.96^{B}	0.99^{B}	0.30			
Average[2]	1.02	1.06	0.20			
Lymphocytes (x10³ µL)				0.77	**<0.01**	0.51
d 1	9.09^{A}	8.32^{A}	0.66			
d 30	3.77^{B}	4.59^{B}	0.66			
d 60	3.68^{B}	3.99^{B}	0.66			
Average[2]	3.93	4.11	0.45			
Monocytes (x10³ µL)				**0.10**	**<0.01**	**0.10**
d 1	0.73^{A}	0.62^{A}	0.09			
d 30	0.25^{B}	0.25^{B}	0.09			
d 60	0.12^{B*}	0.36^{B*}	0.09			
Average[2]	0.21	0.28	0.03			
Eosinophils (x10³ µL)				0.87	0.23	0.71
d 1	0.09	0.13	0.03			
d 30	0.06	0.03	0.03			
d 60	0.05	0.05	0.03			
Average[2]	0.05	0.05	0.02			

[1]The treatments were animals feed whit cow milk by 60 days; and calves feed with milk replacer.
[2]The day 1 results were removed from the data set to generate the average per treatment in the statistical analysis.
[&] Lowercase letters ([a, b]) show difference between groups - treatment effect.
[#] Within a column, means without a common superscript ([A-B])differ ($P \leq 0.05$) or tend to differ ($P \leq 0.10$) – show day effect.
[*] Within a row, differ ($P \leq 0.05$) or tend to differ ($P \leq 0.10$) - shows treatment x day interaction.

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Serum biochemistry

The results of serum biochemistry are presented in Table 5. There was no statistical difference for total proteins, albumin, globulins, urea, cholesterol, triglycerides, and glucose between treatments (P>0.05). However, cholesterol and urea levels increased linearly over time only in animals that received cow's milk (P ≤ 0.10).

Table 5. Serum biochemistry of calves consuming milk and milk replacer.

Items	Treatments[1]		SEM	*P* – values		
	Milk	Milk Replacer		Treat[&]	Day[#]	Treat × Day*
Albumin (g/dL)				**0.02**	**<0.01**	0.19
d 1	2.44^{B}	2.41^{B}	0.16			
d 30	4.04^{A}	3.37^{A}	0.16			
d 60	2.28^{B}	2.11^{B}	0.16			
Average[2]	3.16	2.73	0.11			
Globulin (g/dL)				0.88	**<0.01**	0.60
d 1	4.06^{B}	4.14^{B}	0.45			
d 30	1.94^{C}	2.50^{C}	0.45			
d 60	5.90^{A}	5.55^{A}	0.48			
Average[2]	3.91	3.99	0.38			
Total protein (g/dL)				0.54	**<0.01**	0.83
d 1	6.49^{B}	6.55^{B}	0.43			
d 30	5.96^{B}	5.87^{B}	0.43			
d 60	8.16^{A}	7.69^{A}	0.47			
Average[2]	7.06	6.74	0.37			
Glucose (mg/dL)				0.25	**<0.01**	0.41
d 1	95.3^{A}	96.9^{A}	9.05			
d 30	65.7^{B}	63.4^{B}	9.05			
d 60	81.9^{AB}	60.1^{B}	9.67			
Average[2]	73.4	62.5	6.47			
Triglycerides (mg/dL)				0.16	**<0.01**	0.61
d 1	47.6^{A}	41.3^{A}	3.81			
d 30	22.4^{B}	22.6^{B}	3.81			
d 60	26.4^{B}	23.0^{B}	4.03			
Average[2]	24.4	22.8	2.95			
Cholesterol (mg/dL)				**0.06**	**0.05**	0.20
d 1	67.3^{B}	67.3	9.36			
d 30	89.9^{AB}	62.1	9.36			
d 60	96.4^{A}	74.6	9.87			
Average[2]	93.2	69.0	8.31			
Urea (mg/dL)				0.96	**0.03**	0.42
d 1	21.9^{B}	25.5	2.51			
d 30	28.7^{AB}	28.2	2.51			
d 60	31.8^{A}	28.8	2.62			
Average[2]	30.3	28.5	2.66			

[1]The treatments were animals feed whit cow milk by 60 days; and calves feed with milk replacer.
[2]The day 1 results were removed from the data set to generate the average per treatment in the statistical analysis.
[&] Lowercase letters ($^{a,\ b}$) show difference between groups - treatment effect.
[#] Within a column, means without a common superscript ($^{A\text{-}C}$)differ ($P \leq 0.05$) or tend to differ ($P \leq 0.10$) – show day effect.
[*] Within a row, differ ($P \leq 0.05$) or tend to differ ($P \leq 0.10$) - shows treatment x day interaction.

Cost-benefit effect

Table 6 describes the feeding costs of calves that received cow's milk and milk replacers and the cost-benefit ratio of each treatment. For all expenditure variables (R$/animal), a lower cost per animal was observed for calves fed with the milk replacer, except for the ratio of drugs used per animal (R$/animal) during the experimental period, which was higher for the animals of the replacer treatment. In other words, there was a higher incidence of problems in relation to the feed adaptation of this group. Animals fed with the milk and milk replacer had a similar cost to produce 1 kg of body weight. However, at the end of the experiment, we found that the calves of the control group (milk) had on average gained 19kg more than those fed the replacer.

Table 6. Production costs of calves consuming milk and milk replacer.

Costs	Treatments[1]		SEM	*P* – values
	Milk	Milk Replacer		
Concentrate (R$/animal)	71.6	66.5	6.55	0.59
Cow milk or milk replacer (R$/animal)	504	234	24.1	**<0.01**
Milk or milk replacer + concentrate (R$/animal)	575	301	6.55	**<0.01**
Medications (R$/animal)	9.75	26.1	3.07	**<0.01**
Feed + medications (R$/animal)	585	327	5.92	**<0.01**
Costs to gain 1 kg of body weight	15.2	16.7	1.42	0.45

[1]The treatments were animals feed whit cow milk by 60 days; and calves feed with milk replacer.

DISCUSSION

The performance of calves can be affected by a few factors, such as nutrition, sanitation, and genetics. However, nutrition is the primary responsible for animal performance. Thus, weight gain varies according to age, being usually lower before weaning (Quigley et al. 1991).In this study, the performance results were similar to those of Gurgel et al. (2019), who concluded that calves of dairy aptitude showed superior performance when fed cow's milk during the suckling phase compared to the use of dairy replacers. The weight gain, lower for calves receiving replacers, may have occurred due to sedimentation during the supply, so that it reduced the consumption of dry matter by the animals, leading them to a deficit. The lower performance presented by the animals fed with the milk replacer can be justified by the lower biological value of the milk replacer and the reduced absorption rate of nutrients compared to cow's milk (Boito et al.2015). Another determining factor concerns the organoleptic characteristics of dairy replacers, which makes it difficult for animals to adapt to this diet (Schäff et al. 2018). There was an increasing gain for both groups with the increase in age (treatment/day interaction). Animals of all groups progressively increased concentrate consumption with age and consequently of body weight during the evaluation period. These changes is related to the development of the rumen-reticulum, the growth of calves, and the increase in the demand for nutrients for maintenance, growth, and weight gain (Plaza &Fernadez 1999).

An increase in the levels of urea may be related to the consumption of concentrate due to ruminal degradation of proteins and carbohydrates and the establishment of the urea cycle between the rumen and saliva. According to literature, the higher cholesterol level in animals that intake cow's milk may be due to the higher fat content present in milk compared to the replacer (Lepczyński et al.2015); which we also believe is related to our study, since the animals that consumed milk replacer daily ingested approximately 66% less fat via liquid diet. These values were below those observed by Smith (2009), who established cholesterol levels oscillating between 90 and 170mg/dL as normal. Animals fed with milk maintained their high levels possibly due to greater intake and more intense transport of fat between the intestine, liver, and adipose tissue (Hammon& Blum 1998). On the other hand, the cholesterol levels of the animals that received replacers may have been influenced by the lower concentration of fat in the total diet (Miranda 2013).

Nutrition also exerts an intense effect on the immune response of the animal. Khan et al. (2007) observed better immune response, i.e., higher levels of IgA and IgG in calves fed more cow's milk. Nutrition is critical for determining animal immunity, and the energy and protein of the diet influence cellular immunity, cytokine production, complement and phagocytic systems, and antibodies (Woodward 1998). Thus, the increase in the number of monocytes in animals fed with a replacer is possibly due to the occurrence of sedimentation during feeding. The animals may not have consumed all the nutrients necessary for a full diet. As a consequence, animal development was lower in the group fed cow's milk, therefore, the immune system of these animals was more susceptible to infectious agents and the number of defense cells was higher to protect the animal against disease agents (Miranda 2013).

The reduced feeding cost is the main justification for using milk replacer within rural properties. However, animal performance is compromised since the nutritional contribution provided by milk replacer is lower than cow's milk (Gurgel et al. 2019). Given the cost-benefit results obtained in this study, we concluded that the use of milk replacer is not efficient when the objective is to wean heavier animals. However, the replacer may be a viable option if the objective of the producer is to make low investment with milk in the initial phase, maintaining the minimum nutritional requirements of the calves until weaning, and subsequently investing in solid feeds of lower cost, provided the producer makes use of therapeutic medication in the animals whenever they become ill.

CONCLUSION

In conclusion, the use of dairy replacers as a replacer for cow's milk caused calves to have an overall lower performance compared to those who received cow's milk during the suckling phase. Although feed costs are lower when using milk replacers, the cost-benefit ratio indicates that feeding based on cow's milk was more feasible when the objective is to wean heavier animals at a lower cost per kg of live weight.

ETHICS COMMITTEE

All procedures for this project were approved by the *Comitê de Ética do Uso de AnimaisnaPesquisa* (CEUA) of the Universidade do Estado de Santa Catarina, under the protocol number 1164220620, as well as with the rules issued by the National Council for Control of Animal Experimentation (CONCEA).

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