EVALUATION OF ORGANIC SALTS ON THE PERFORMANCE OF DAIRY CROSSBRED MILKING COWS AND GROWING ANIMALS ON PASTURE

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ABSTRACT – The use of additives in ruminant diets has occurred more intensely in recent years to increase animal performance, through changes in the ruminal microbiota. Thus, this study aimed to evaluate: 1) the use of Isomix (Iso) and virginiamycin (Vir) in concentrate, in a 2x2 factorial (without and with 30 g of Isomix/cow/day; without and with 210 mg of virginiamycin/cow/day), on the productive performance of mixed cows on pasture; 2) the use Isomix in multiple supplement (without and with 30 g of Isomix/animal/day), on the productive performance of pasture growing dairy mixed animals; and 3) the use Isomix in concentrate, at an increasing level (without and with 30, 60 or 90 g of Isomix/cow/day), on the productive performance of crossbred cows on pasture in the wet season. The work was conducted at Fazenda Boa Vista, district of Cachoeira de Santa Cruz, Viçosa, MG, and belonging to the Federal University of Viçosa. In experiment 1, there was no significant effect of the additives in the concentrate on milk production in cows producing 13.4 kg of milk/day in tropical pasture during the wet season, and more production research and nutritional parameters were required under these conditions. In experiment 2, there was an effect of Isomix on body weight gain, and therefore, the use of this additive in multiple supplements is recommended to improve the performance of growing cattle in the wet season, depending on the cost-benefit ratio with supplementation. In experiment 3, there was no significant effect of Isomix on the concentrate on milk production in cows producing 6.8 kg of milk/day, with presence of calves during milking, in tropical pasture of the wet season, but there was a tendency to increase fat, protein and lactose contents with the use of Isomix, being a possible benefit from the use of that additive.

***Keywords**: additive, Isomix, milk, ruminant nutrition, weight gain.*

AVALIAÇÃO DE SAIS ORGÂNICOS SOBRE O DESEMPENHO DE VACAS MESTIÇAS LEITEIRAS E DE ANIMAIS EM CRESCIMENTO A PASTO

RESUMO – O uso de aditivos nas dietas dos ruminantes tem ocorrido com mais intensidade nos últimos anos para aumentar o desempenho animal, mediante modificações na microbiota ruminal. Assim, este trabalho objetivou avaliar: 1) o uso Isomix (Iso) e virginiamicina (Vir) no concentrado, em fatorial 2x2 (sem e com 30 g de Isomix/vaca/dia; sem e com 210 mg de virginiamicina/vaca/dia), sobre o desempenho produtivo de vacas mestiças a pasto; 2) o uso Isomix no suplemento múltiplo (sem e com 30 g de Isomix/animal/dia), sobre o desempenho produtivo de animais mestiços leiteiros em crescimento a pasto; e 3) o uso Isomix no concentrado, em nível crescente (sem e com 30, 60 ou 90 g de Isomix/vaca/dia), sobre o desempenho produtivo de vacas mestiças a pasto no período das águas. O trabalho foi conduzido na Fazenda Boa Vista, distrito de Cachoeira de Santa Cruz, Viçosa, MG, e pertencente à Universidade Federal de Viçosa. No experimento 1, não houve efeito significativo dos aditivos no concentrado sobre a produção de leite em vacas produzindo 13,4 kg de leite/dia em pastagem tropical no período das águas, sendo necessário realização de mais pesquisas de produção e sobre os parâmetros nutricionais nestas condições. No experimento 2, houve efeito do Isomix sobre o ganho de peso corporal, sendo recomendado, portanto, o uso deste aditivo no suplemento múltiplo para melhorar o desempenho dos bovinos em crescimento no período das águas, a depender da relação benefício custo com suplementação. No experimento 3, não houve efeito significativo do Isomix no concentrado sobre a produção de leite em vacas produzindo 6,8 kg de leite/dia, com bezerros ao pé durante as ordenhas, em pastagem tropical no período das águas, mas houve tendência sobre o aumento dos teores de gordura, proteína e lactose com o uso de Isomix, sendo um possível benefício do uso do referido aditivo.

Palavras-chave: aditivo, ganho de peso, Isomix, leite, nutrição de ruminantes.

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INTRODUCTION

Brazil stands out as the third largest milk producer in the world, reaching the mark of 35.4 billion liters in 2020 (IBGE, 2021 - https://www.ibge.gov.br/indicadores), with a dairy herd of approximately 17.1 million cows and 1,963 liters/cow/year (PPM - Pesquisa Pecuária Municipal, 2018), in production systems predominantly under pastures and largely by tropical forage.

However, tropical forages have limitations due to lower growth and availability in the dry season, with high cell wall contents and consequently low digestibility (Stobbs, 1973). It is also added the lower content of digestible nutrients, among them, protein, which is a natural precursor of branched chain volatile fatty acids and ammonia. These, along with ruminal ammonia, are sources of nutrients for cellulolytic bacteria that, after their absorption, are used to produce their amino acids through reductive carboxylation (Allison, 1969).

The use of concentrate supplementation allows to correct the nutritional deficiencies of pastures, ensuring the maintenance of animal productivity indexes throughout the year, especially in the dry season. There is a curvilinear increase in animal performance in which the highest response occurs in low level of supplementation (Lana et al., 2011; Oliveira et al., 2011; Teixeira et al., 2013). Specific organic minerals, which added to the feed or concentrated supplement, supply these nutrients to ruminal microorganisms. Specific organic salts have a constant rate of nutrient release, thus allowing optimal efficiency in ruminal microbial synthesis. Organic salts intensify ruminal fermentation, providing higher microbial protein production and consequently animal performance (Val Neto, 2009)..

As a hypothesis, it is expected an improvement in the productive response with the use of organic salts associated with urea or amirea supplementation, favoring the synthesis of ruminal microbial protein.

The general objectives are to evaluate whether organic salts improve the performance of dairy crossbred milking cows and growing animals when supplemented to pasture. The specific objectives are to evaluate weight and body weight gain, intake (supplement, pasture, dry matter, total digestible nutrients and crude protein), milk production and its composition (fat, protein and lactose).

MATERIALS AND METHODS

The protocol for use of animals in this research was approved by the ethical committee of use of animals of production of Federal University of Viçosa, MG, Brazil (Comissão de Ética no Uso de Animais de Produção - CEUAP/UFV), with numbers 03/2020 and 048/2021.

Experiment 1

The experiment was carried out at Fazenda Boa Vista, district of Cachoeira de Santa Cruz, Viçosa, MG, and belonging to the Federal University of Viçosa. A total of eight Holstein Gyr crossbred cows were used, with 486 ± 39 kg body weight; 186 ± 69 days in milk; and initial daily average production of 12 kg of milk. The cows were kept in *Brachiaria decumbens* pastures during the wet season and received supplements during morning and afternoon milkings.

A total of 4 kg of concentrate/cow/day (with 28% crude protein and 59% of ruminal degradable protein) and 103 g of proteinate/cow/day (with 63% crude protein and 84% ruminal degradable protein) were provided (Table 1). Two of the eight cows were milked with the presence of calves during milking, and all were submitted to four treatments in the concentrate supplements in 2x2 factorial (without and with 30 g of Isomix/cow/day; without and with 210 mg of pure virginiamycin/cow/day), for four 14-day periods, with a total of 56 days. After the time period, milk production was evaluated, adding the quantities produced in the two milkings. A doubled Latin square experimental design was used and variance analysis was performed at the 5% probability level, including Isomix, virginiamycin and interaction effect.

Table 1 - Experimental concentrate rations

Item (kg)	Treatment				Proteinate
	Con	Iso	Vir	Iso*Vir	(All)
Corn meal	66	65	66	65	50 kg of corn meal
Soybean meal	32	32	32	32	30 kg mineral salt
Ureia+AS	2.1	2.1	2.1	2.1	20 kg UR+AS
Virginiamycin-10%	0	0	0.05	0.05	-
Isomix	0	0.75	0	0.75	-
Total	100	100	100	100	100

Con – control; Iso – Isomix; Vir – Virginiamycin; UR – ureia; AS – ammonium sulphate..

Experiment 2

The experiment was carried out at Fazenda Boa Vista, district of Cachoeira de Santa Cruz, Viçosa, MG, and belonging to the Federal University of Viçosa. Fourteen growing cattle with an average initial body weight of 319 kg were used, distributed in two paddocks of 2.5 hectares each, during 97 days in the wet season, between October 2021 and January 2022. The animals were ranked in weight order for male animals and for female animals, each two animals in descending order of weight randomly distributed, one for paddock 1 and one for paddock 2. Four male and three female animals were allocated at each paddock. Paddock 1 corresponded to the control treatment and paddock 2 to the treatment containing Isomix. The paddocks were formed by *Brachiaria decumbens* pastures and the animals received 0.5 kg of multiple supplement/animal/day (with 41% crude protein and 89% ruminal degradable protein; Table 2), provided daily in the morning. The animals were weighted, and each two animals in decreasing order of weight, within the same sex, were distributed, one in each treatment. A completely randomized experimental design was used, including Isomix effect, sex and Isomix*sex interaction.

Table 2 - Experimental multiple supplements[a]

Item (kg)	Treatment	
	0	30[b]
Corn meal	74.5	68.5
Amirea	17.0	17.0
Mineral salt	8.5	8.5
Isomix	0.0	6.0
Total	100	100

[a] 0.5 kg/animal/day; 41% crude protein and 89% rumen degradable protein.

[b] Isomix, 30 g/animal/day.

Experiment 3

The experiment was carried out at Fazenda Boa Vista, district of Cachoeira de Santa Cruz, Viçosa, MG, and belonging to the Federal University of Viçosa. A total of sixteen Holstein Gyr crossbred cows were used, with an average weight of 480 ± 44 kg body weight; 267 ± 118 days in milk; and initial daily average production of 7.3 kg of milk. The cows were kept in *Brachiaria decumbens* pastures during the wet season and received supplements during morning and afternoon milkings. A total of 2 kg of concentrate/cow/day (with 20% crude protein and 80% ruminal degradable protein; Table 3) were supplied. The cows were milked with the presence of calves during milking, and were submitted to four treatments present in the concentrated feed (without and with 30, 60 or 90 g of Isomix/cow/day), for two periods of 14 days, in a total of 28 days. In the last two days of each period, milk production was evaluated, adding the quantities produced in the morning and afternoon milkings. A randomized blocks experimental design was used, repeated in time, and variance analysis was performed at the level of 5% probability, including Isomix, block and period effects.

Table 3 - Experimental concentrate rations

Item (kg)	Treatment			
	0	30[a]	60[a]	90[a]
Corn meal	85.3	83.8	82.3	80.8
Amirea	6.7	6.7	6.7	6.7
Mineral salt	8.0	8.0	8.0	8.0
Isomix	0.0	1.5	3.0	4.5
Total	100	100	100	100

[a] Isomix, g/cow/day.

RESULTS AND DISCUSSION

Experiment 1

Table 4 presents the estimates of daily intakes of dry matter (DMI), total digestible nutrients (TDNI) and crude protein (CPI) from pasture, concentrate and proteinate, values obtained by the composition of foods and nutritional requirements of the integrated spreadsheet - Plan 5 and 6 - of the ration calculation program of the book Sistema Viçosa de formulação de rações (Lana, 2020a).

According to the integrated ration calculation worksheet (Lana, 2020a), the DMI and TDN and CP requirements are 14.0 kg and 65% and 13.4%, respectively. When analyzing Table 4, it can be observed that the estimated TDN and CP content were 4.8% and 3.7% lower than the nutritional requirements presented by the integrated ration calculation worksheet (Lana, 2020a). Another observation is that the protein left free choice in the pasture contributes little to the nutrient supply (Table 4), and the supply of concentrate is important for the additional supply of energy and protein for milking Holstein Gyr crossbred cows at pasture (Lana et al., 2011; Vargas et al., 2013)..

Table 4 - Daily intake of dry matter (DMI), total digestible nutrients (TDNI) and crude protein (CPI) as a function of supplementation with concentrates and proteinate by milking Holstein Gyr crossbred cows at pasture, and nutrient content in the diet

Item	DMI (kg)	TDNI (kg)	CPI (kg)
Pasture	10.2	5.92	0.71
Concentrate	3.7	2.70	1.04
Proteinate	0.1	0.04	0.06
Total	14.0	8.66	1.81
Nutrient content (%)	-	61.9	12.9

There was no significant effect (P>0.05) of treatments on milk production, and the average daily production observed was 13.4 kg of milk (Table 5). From the presented results, there was probably no effect of the treatments on nutritional parameters, since effects on the intake and digestibility of dry matter and its constituents reflect changes in milk production (Lana, 2020b).

On the other hand, Val Neto (2009) cites an increase of 4 to 13% in milk production by the use of branched chain fatty acids (BCFA) in the diet of high-production dairy cows consuming complete diets. Therefore, more research on animal production and nutritional parameters is needed to have a conclusive evaluation of the use of Isomix and virginiamycin additives in the nutrition of dairy cows on pasture.

Table 5 - Performance of Holstein Gyr crossbred dairy cows at pasture of *Brachiaria decumbens* in the wet season, without presence of calves during milking

Item	Treatment					P value		
	Con	Iso	Vir	Iso*Vir	SE	Iso	Vir	Iso*Vir
Milk, kg/day	13.4	13.2	13.7	13.2	1.15	0.90	0.95	0.81

Con – control; Iso – Isomix; Vir – Virginiamycin; SE – standard error.

For observed consumption of 4 kg of concentrate/cow/day and 0.21 kg of virginiamycin 10% in 400 kg of concentrate (Table 1), it has been calculated intake of 210 mg of pure virginiamycin/cow/day, or 14.6 ppm, considering dry matter intake of 14.4 kg/cow/day. One option in the next experiment, due to the lack of effect of virginiamycin in milk production (Table 5), would be to move to 27 ppm or 0.39 kg of virginiamycin 10% in 400 kg of concentrate, according to dosage in a large number of experiments with antibiotics in cattle rations (Lana et al., 1997).

Considering, for dairy cows with 486 kg body weight and 13.4 kg of milk/day, dry matter intake of 14 kg/cow/day and crude protein intake of 1.81 kg or 12.9% of protein in the total diet (Table 4) and, in addition, considering 67% of true protein, 60% of CP degradability and 12% of branched chain amino acids (BCAA), we have: 14.0*0.129*0.67*0.6*0.12*1000 = 87 g/cow/day of BCAA available in rumen.

In the case study, for observed consumption of 4 kg of concentrate/cow/day and 3 kg of Isomix in 400 kg of concentrate (Table 1), there has been a calculated consumption of 30 g of Isomix/cow/day, which should contain a much lower value of BCFA than that obtained at the end of the previous paragraph for BCAA (BCFA precursors), because in addition to Isomix containing BCFA, it has other ingredients added to the product. Due to the lack of isomix effect on milk production (Table 5), we suggest the increase in the dose of BCFA and/or increase in isomix recommendation to 60 g/cow/day or even higher value, evaluating the potential use of products (BCFA and Isomix) according to price and feasibility of use.

Experiment 2

Table 6 presents the estimates of daily intakes of dry matter (DMI), total digestible nutrients (TDNI) and crude protein (CPI) from pasture and supplement, values obtained by the composition of foods and nutritional requirements of growing cattle from the book Sistema Viçosa de formulação de rações (Lana, 2020; p.18, 77 and 78).

According to Lana (2020), the DMI and TDN and CP requirements are 9.3 kg and 50% and 6.2%, respectively, for cattle with 350 kg and gain of 0.3 kg/day on pasture. When analyzing Table 6, it can be observed that the estimated TDN and CP content were 9.6% and 26.6% higher than the nutritional requirements presented by Lana, 2020 (p.18).

There was no significant effect of treatments (P>0.05) on initial and final body weight, with the average observed value of 319 and 362 kg, respectively (Table 7). However, there was an effect of Isomix on average daily

weight gain (P=0.05), due to the possible improvement in nutritional parameters (Medeiros & Marino, 2015).

There is a need for further research on animal production and nutritional parameters, due to the low number of publications regarding the use of organic acids on the performance of growing cattle.

Considering that growing cattle with 320 kg body weight and daily gain of 0.45 kg have dry matter intake of 7 kg/animal/day and crude protein intake of 0.56 kg or 8% protein in the total diet (Table 6) and, in addition, considering 67% of true protein, 60% of degradability of CP and 12% of BCAA, we have: 7.0*0.08*0.67*0.6*0.12*1000 = 27 g/animal/day of BCAA available in rumen.

Table 6 - Daily intake of dry matter (DMI), total digestible nutrients (TDNI) and crude protein (CPI) as a function of supplementation with concentrates by Holstein Gyr crossbred growing animals at pasture in the wet season, and nutrient content in the diet

Item	DMI (kg)	TDNI (kg)	CPI (kg)
Pasture	8.8	4.8	0.53
Supplement	0.5	0.3	0.21
Total	9.3	5.1	0.73
Nutrient content (%)	-	54.8	7.85

Table 7 - Performance of Holstein Gyr crossbred growing animals at pasture of *Brachiaria decumbens* in the wet season, and receiving 0.5 kg/animal/day of supplement

Item	Treatment		SE	VC	P value		
	Control	Isomix		%	Treatment	Sex	Treat*sex
Initial body weight, kg	319	319	21.7	18.0	0.704	0.512	0.688
Final body weight, kg	353	372	22.1	16.2	0.852	0.775	0.992
ADG, kg/animal/day	0.343	0.542	0.059	35.4	0.051	0.181	0.159

[a] Isomix, 30 g/animal/day; SE – standard error; VC – variation coefficient; ADG – average daily gain.

In the case study, for observed consumption of 0.5 kg of concentrate/animal/day and 6 kg of Isomix in 100 kg of concentrate (Table 2), there has been a calculated consumption of 30 g of Isomix/animal/day, which should increase the contribution of BCFA provided by the deamination of the 27 g of BCAA presented at the end of the previous paragraph, thus justifying the improvement of the performance of the animals of the Isomix treatment (Table 7).

Experiment 3

Table 8 presents the estimates of daily intakes of dry matter (DMI), total digestible nutrients (TDNI) and crude protein (CPI) from pasture and concentrate, values obtained by the composition of foods and nutritional requirements of the integrated spreadsheet - Plan 5 and 6 - of the feed calculation program of the book Sistema Viçosa de formulação de rações (Lana, 2020a).

According to the integrated ration calculation worksheet (Lana, 2020a), the DMI and TDN and CP requirements are 10.3 kg and 59.4% and 9.7%, respectively. When analyzing Table 8, it shows that the estimated TDN and CP content were 5.9% higher and 2.9% lower, respectively, than the nutritional requirements presented by the integrated ration calculation worksheet (Lana, 2020a). The supply of concentrate is important for the additional supply of energy and protein for Holstein Gyr crossbred dairy cows at pasture (25% and 39% of the total, respectively; Lana et al., 2011; Vargas et al., 2013).

Table 8 - Daily intake of dry matter (DMI), total digestible nutrients (TDNI) and crude protein (CPI) as a function of supplementation with concentrate by milking Holstein Gyr crossbred cows at pasture in the wet season, and nutrient content in the diet

Item	DMI (kg)	TDNI (kg)	CPI (kg)
Pasture	8.4	4.87	0.59
Concentrate	1.9	1.61	0.38
Total	10.3	6.48	0.97
Nutrient content (%)	-	62.9	9.42

There was no significant effect of treatments (P>0.05) on milk production, and the observed average daily production was of 6.83 kg of milk (Table 9). However, there was a tendency to improve the fat, protein and lactose contents in milk (P=0.139). From the results presented, there was probably no effect of the treatments on nutritional parameters, since effects on the intake and digestibility of dry matter and its constituents reflect changes in milk production (Lana, 2020b).

In the previous experiment (Tables 4 and 5), using 30 g of Isomix/cow/day and 210 mg of pure virginiamycin/cow/day, there was no significant effect of treatments on milk production, with the average daily production observed of 13.4 kg of milk per cow. On the other hand, Val Neto (2009) cites an increase of 4 to 13% in milk production by the use of BCFA in the diet of high-production dairy cows consuming complete diets.

Table 9 - Performance of Holstein Gyr crossbred cows at pasture of *Brachiaria decumbens* in the wet season, with presence of calves during milking, and receiving 2 kg/day of concentrate ration

Item	Treatment					P value		
	0	30[a]	60[a]	90[a]	SE	Treatment	Block	Time
Milk, kg/day	7.04	7.27	6.87	6.13	0.82	0.782	0.004	0.665
Fat, %	3.22	3.72	3.23	3.54	0.17	0.139	0.360	0.048
Protein, %	3.01	3.29	3.02	3.18	0.09	0.139	0.360	0.048
Lactose, %	3.93	4.35	3.94	4.19	0.15	0.139	0.360	0.048

[a] Isomix, g/cow/day; SE – standard error.

Considering, for dairy cows with 480 kg of body weight and 7.0 kg of milk/day, dry matter intake of 10.3 kg/cow/day and crude protein intake of 0.97 kg or 9.4% of protein in the total diet (Table 8) and, in addition, considering 67% of true protein, 60% of degradability of CP and 12% of BCAA, we have: 10.3*0.094*0.67*0.6*0.12*1000 = 47 g/cow/day of BCAA available in rumen.

In the case study, for observed consumption of 2 kg of concentrate/cow/day and 1.5 kg of Isomix in 100 kg of concentrate (Table 3), it has been calculated consumption of 30 g of Isomix/cow/day, which should contain a lower value of BCFA than that obtained at the end of the previous paragraph for BCAA (BCFA precursors), because in addition to Isomix containing BCFA, it has other ingredients added to the product. Thus, the low supply of BCFA by Isomix justifies the absence of response in milk production (Table 9).

Although in previous research (Experiment 1) it came to the conclusion by increasing the dosage of Isomix for milking Holstein Gyr crossbred cows at pasture, the results of Table 9 showed no benefit on productive performance.

CONCLUSIONS

The results obtained in the present study allow us to conclude:

1. There was no significant effect of the additives in the concentrate on milk production in cows producing 13.4 kg of milk/day in tropical pasture during the wet season, and more production and nutritional parameters researches were needed under these conditions.

2. There was an effect of Isomix on body weight gain, and therefore, the use of this additive in multiple supplementations is recommended to improve the performance of growing cattle in the wet season, depending on the cost benefit ratio with supplementation.

3. There was no significant effect of Isomix on the concentrate on milk production in cows producing 6.8 kg of milk/day, with calves standing during milking, in tropical pasture during the wet season, but there was a tendency to increase fat, protein and lactose contents with the use of Isomix, being a possible benefit of the use of this additive.

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