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B Chandrika

Sri Venkateswara Veterinary University, Department of Livestock Farm Complex, College of Veterinary Science, Tirupati, Andhra Pradesh, India

MVAN Suryanarayana

Sri Venkateswara Veterinary University, Department of Livestock Farm Complex, College of Veterinary Science, Tirupati, Andhra Pradesh, India

B Devasena

Sri Venkateswara Veterinary University, Department of Livestock Farm Complex, College of Veterinary Science, Tirupati, Andhra Pradesh, India

Y Ravindra Reddy

Sri Venkateswara Veterinary University, Department of Livestock Farm Complex, College of Veterinary Science, Tirupati, Andhra Pradesh, India

Corresponding Author:**MVAN Suryanarayana**

Sri Venkateswara Veterinary University, Department of Livestock Farm Complex, College of Veterinary Science, Tirupati, Andhra Pradesh, India

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A study on citric acid supplementation on growth performance and nutrient utilization in cross bred cattle

B Chandrika, MVAN Suryanarayana, B Devasena and Y Ravindra Reddy

Abstract

Sixteen lactating cross bred cows randomly assigned to four treatments with each group containing four animals in a Completely Randomized Design were evaluated to study the affect of supplementation of Citric acid at different levels in combination with concentrate pellet feed, green fodder and paddy straw on growth performance and nutrient digestibility. The dietary treatments contained *ad libitum* APBN-1 green fodder, concentrated pellets and paddy straw at 2.5% of body weight. The dietary treatments were a basal diet as control (T1), T1 + 30g Citric acid/animal/ day (T2), T1 + 60g of Citric acid/animal/day (T3) and T1 + 120g Citric acid/animal/day (T4). The initial and final body weights (kg) of the four groups were found to be non-significant ($P < 0.05$). The total weight gain (kg) and ADG (g) was significantly higher ($P < 0.05$) among treatments. T1 (control) recorded the lowest ADG (g) ($P < 0.05$) as compared to other treatments. Except for ADF and NDF digestibility (%) all the remaining nutrient digestibilities were significant ($P < 0.05$) among treatments. There was a linear increase in the digestibility of nutrients for DM, OM, CP, EE, CF and NFE as the dose of Citric acid supplementation increased. The metabolic body weight (W kg^{0.75}) and dry matter intake (kg/day) were higher for T4. The value of FCR was lowest for T4 followed by T3, T2, T1 and was in the order of (T4 < T3 < T2 < T1). It was concluded that supplementation has a positive role in improving the growth and nutrient digestibility.

Keywords: Citric acid, FCR, nutrient digestibility, metabolic body weight, dry matter intake

Introduction

Feed additives can potentially reduce the use of antibiotics and ionophores in commercial cattle production and enhance the production efficiency of cattle. Among the feed additives organic acids showed improvement in microbial growth rate, feed efficiency and milk production. Thermal stress reduces feed intake, milk yield, growth rate and reproductive performance which leads to major economic losses to the dairy farmers especially in tropical countries. The lactating dairy cows are more sensitive to thermal stress because they produce much more metabolic heat and accumulate the additional heat from radiant energy than the non-lactating ones. Organic acids supplementation improves the utilization of dietary nutrients in the rumen of dairy cows. Organic acids such as Fumaric acid, Citric acid, Formic acid etc. have been used as growth promoters to enhance the digestibility of feed. They act as key intermediates in Citric acid cycle of biological tissues and in Succinate – Propionate pathway of rumen bacteria such as *Selenomonas ruminantium*.

Materials and Methods

Sixteen healthy lactating crossbred cows (HF × Jersey, Jersey × Sahiwal) were randomly assigned for four treatments. The cows were adapted for stall feeding conditions, dewormed and vaccinated against Foot and Mouth disease before the commencement of the study. The animals were pre-weighed and made into four groups with four animals in each on the basis of their milk yield and body weight in a Completely Randomized Design maintained at Livestock Farm Complex, College of Veterinary Science, Tirupati. A 40-day feeding trial was conducted to assess the effect of supplementation of Citric acid on voluntary feed intake in cross bred cattle. The product Citric acid used in the present study was procured from the company the grater scientifics Vijayawada. Animals were fed with Control diet (T1) - Basal ration (*ad libitum* Andhra Pradesh Bajra Napier -1 + concentrate pellet feed + paddy straw @ 2.5% of body weight). Experimental diet 1 (T2) - Basal ration + Citric acid @ 30g/day. Experimental diet (T3) – Basal ration + citric acid @ 60g/day.

Experimental diet (T4) – Basal ration + citric acid @120g/day. The concentrate feed was mixed with Citric acid for an hour before feeding for the supplemented groups. All the experimental procedures were reviewed and approved by Institutional Animal Ethics Committee with a reference number 281/GO/Rebi/S/2000/CPCSEA/TPTY/024/Animal Nutrition/ 2021 in the College of Veterinary Science, Tirupati.

Results

Citric acid supplementation on body weight gain

The effect of supplementation on body weight gain is presented in table 1. No significant difference was found among treatments with regard to initial and final body weights (kg). However, significance difference ($P < 0.05$) was found among the treatments weight gain (kg) the values were 3.5 ± 1.30 , 7 ± 0.86 , 8.25 ± 0.54 and 11.05 ± 1.24 for T₁, T₂, T₃ and T₄, respectively. Higher weight gains (kg) with higher average daily gain (g) were recorded for T₄ ($P < 0.05$) with 276.4 ± 3.12 and lowest for T₁ (87.5 ± 2.58). T₂ and T₃ have recorded 175 ± 2.16 and 206.3 ± 1.36 , respectively.

Table 2: Effect of Citric acid supplementation on apparent nutrient digestibility (%)

Nutrient	T ₁	T ₂	T ₃	T ₄	P value
DM	60.10 ^a ±0.58	62.54 ^{ab} ±0.30	64.33 ^{bc} ±1.44	66.50 ^c ±0.35	0.001
OM	61.16 ^a ±0.65	63.31 ^b ±0.58	65.55 ^{bc} ±0.69	67.30 ^c ±0.53	0.001
CP	61.40 ^a ±0.65	63.65 ^b ±0.39	65.04 ^{bc} ±0.67	67.46 ^c ±0.45	0.02
EE	74.20 ^a ±0.69	75.82 ^a ±0.46	76.49 ^{ab} ±0.53	75.05 ^b ±0.61	0.03
CF	42.42 ^a ±0.79	45.08 ^b ±0.49	47.14 ^{bc} ±0.51	49.21 ^c ±0.71	0.01
NFE	64.42 ^a ±1.13	66.56 ^{ab} ±0.93	68.28 ^{bc} ±0.96	70.64 ^c ±0.80	0.05
ADF	54.25±0.32	55.94±0.73	57.92±0.80	56.63±0.89	0.53
NDF	65.275±0.43	66.15±0.18	67.14±0.54	66.39±1.01	0.25

^{abc} Values in the rows bearing different superscripts differently ($P < 0.05$)

Effect of Citric acid supplementation on plane of nutrition in cross bred cows

The metabolic body weight is 89.56, 89.98, 91.07, 90.69 for T₁, T₂, T₃ and T₄, respectively. The dry matter intake (kg/d) was 10.98, 11.34, 11.64, 11.84 for T₁, T₂, T₃ and T₄, respectively. The DMI in percent body weight was 2.73, 2.81, 2.84, 2.9 for T₁, T₂, T₃ and T₄, respectively. The FCR ratios were 3.13, 1.62, 1.41, 1.03 T₁, T₂, T₃ and T₄, respectively. The value of FCR was lowest for T₄ followed by T₃, T₂, T₁. It was in the order of (T₄ < T₃ < T₂ < T₁).

Table 3: Effect of Citric acid supplementation on plane of nutrition in cross bred cows

Treatment	Average B.wt	W kg ^{0.75}	DMI (kg/d)	DMI as % B.wt	FCR
T ₁	400.75±6.52	89.56	10.98	2.73	3.31
T ₂	403.25±4.21	89.98	11.34	2.81	1.62
T ₃	409.75±4.50	91.07	11.64	2.84	1.41
T ₄	407.5±4.80	90.69	11.84	2.90	1.07

Discussion

Growth performance of treatment with or without Citric acid was presented Table 1. It was shown that final weights (kg) for T₄ and T₃ were higher than T₁ and T₂. It indicated that as level of Citric acid supplementation increased the final weight gain showed a parallel increase. Total weight gain for T₄ was highest followed by T₃, T₂, T₁. There was an increase (%) of 23%, 37%, 69.5% for T₃, T₂, T₁ as compared to the weight gain of T₄. The other parameters of growth ADG, DMI and FCR were affected by treatments as shown in Table 1 and Table 3. Present results are agreement with (Rossi and Vandoni 2009) [1] who reported that higher average daily gain

Table 1: Effect of Citric acid supplementation on body weight gain

Treatment	Initial wt (kg)	Final wt (kg)	Wt gain (kg)*	ADG (g)*
T ₁	400.75±6.52	404.25±4.98	3.5 ^c ±1.30	87.5 ^c ±2.58
T ₂	403.25±4.21	410.25±5.66	7 ^{bc} ±0.86	175.0 ^{bc} ±2.16
T ₃	409.75±4.50	418.1±7.57	8.25 ^{ab} ±0.54	206.3 ^{ab} ±1.36
T ₄	407.5±4.80	418.35±3.94	11.05 ^a ±1.24	276.4 ^a ±3.12
P-value	0.8	0.4	0.006	0.006

^{abc} values in a column bearing different superscripts differ significantly * ($P < 0.05$)

Effect of Citric acid supplementation on apparent nutrient digestibility (%)

Except for ADF and NDF digestibility (%) all the remaining nutrients were significant ($P < 0.05$) among treatments. As the quantum of Citric acid supplementation increased for the treatments there was an increase of digestibility of nutrients for DM, OM, CP, EE, CF and NFE and the value were comparable among treatment for ADF and NDF.

in fattening and finishing periods of bullocks. FCR and DMI were linearly improved in present study which are in line with Wang *et al.* (2009) [2] and Stallcup (1976) [3]. However, contradictory results were reported by Liu *et al.* (2009) [4] in terms of DMI. Another most important probable reason for increased weight gain for Citric acid supplementation among treatment groups could be due to increased nutrient digestibility (%) for DM, OM, CP, EE, CF and NFE. Another possible explanation that can be given for present study is that the total experimentation was carried out during late summer with an average temperature of about 38 °C, at which there is possibility for the animal to undergo thermal stress. It was reported that organic acids either in liquid or solid forms could be reduce the thermal stress by the animal. This situation reflected in present study where in the Citric acid supplemented groups recorded higher dry matter intake compared to control groups. These results are agreement with Ali *et al.* (2013) [5].

Apparent digestibility (%) of nutrient (Table 2) revealed that except for ADF and NDF all the parameters were found to be significant ($P < 0.05$). The digestibility (%) DM, OM, CP, EE, CF and NFE were found were found to be significantly highest ($P < 0.05$) for T₄ fed groups. A quadratical increase in trend was observed as dose of Citric acid increased from T₂ to T₄ groups. The present results were agreement with Wang *et al.*, (2009) [2] where they reported increased ($P < 0.01$) digestibilities (%) of DM, OM, CP, EE, CF, NDF and ADF with increased Citric acid supplementation without differences between medium and high Citric acid supplementation in steers. The increased fibre and protein digestibility in present study could be attributed to the reason that Citric acid has ability to remove H⁺ ions from rumen and

increased fibre digestibility (Hani *et al.*, 2018) [8] and Foley *et al.* (2009) [7]. However contradictory results were reported by Carro *et al.* (2006) [6], Mungoi *et al.* (2012) [9] in lambs. Various factors could be responsible for a varied results in the present study. Among these factors method of application of organic acid, duration of experiment, dose of supplementation, period of experimentation, combination of organic acids (whether fed alone or in combination) and other related factors.

Conclusion

It was concluded that citric acid supplementation has a promising role in improving the growth rate with a significant positive effect on the digestibility of nutrients. There feed conversion efficiency was improved with higher dose of supplementation. However long run trials may alter the situation as prolonged use of organic acids alter the rumen fermentation pattern.

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