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# Propolis extract in the diet of crossbred (½ Angus *vs.* ½ Nellore) bulls finished in feedlot: animal performance, feed efficiency and carcass characteristics

# Extrato de própolis na dieta de machos mestiços (½ Angus *vs.* ½ Nelore) não castrados terminados em confinamento: desempenho animal, eficiência alimentar e características de carcaça

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## Abstract

Current research studied the replacement of monensin by propolis on performance, feed efficiency and carcass characteristic of bulls finished in feedlot. The bulls, kept in feedlot for 70 days, were allocated in three diets: Control (CON), Monensin (MON) and Propolis (PRO). They were fed on corn silage, cracked corn, soybean meal, urea, limestone and mineral salt. Further, 250 mg monensin and 35 g propolis/bulls/day were included respectively in the MON and PRO diets. Animal performance and carcass characteristics were similar (P>0.05) among diets. Feed intake was higher (P<0.05) for bulls fed on CON (9.17 kg/day) and PRO (9.31 kg/day) diets. Dry, organic matter and carbohydrates digestibility was similar (P<0.05) among the three diets. Protein digestibility was lower (P<0.05) for bulls fed on CON (55.3%) diet and similar for MON (62.3%) and PRO (59.8%) diets. Ether extract digestibility was higher (P<0.05) for bulls fed on PRO (84.6%) diet and lower for bulls fed on CON (73.4%) diet, with MON (80.7%) diet as intermediate. The addition of monensin or propolis did not affect (P>0.05) urinary excretion, microbial synthesis and carcass characteristics.
**Key words:** Cattle, carcass quality, ionophores, natural additives

## Resumo

O presente trabalho estudou a substituição da monensina por própolis sobre o desempenho animal, eficiência alimentar e características de carcaça de bovinos não castrados terminados em confinamento. Os bovinos, mantidos em confinamento durante 70 dias, foram alocados em três dietas: Controle (CON), Monensina (MON) e Própolis (PRO). Os bovinos foram alimentados com silagem de milho, milho quebrado, farelo de soja, ureia, calcário e sal mineral. Ainda, 250mg monensina e 35g própolis/animal/dia foram incluídos respectivamente nas dietas MON e PRO. O desempenho animal e características de carcaça foram similares (P>0,05) entre as dietas. A ingestão de alimentos foi maior (P<0,05) para os bovinos alimentados com as dietas CON (9.17 kg/dia) e PRO (9.31 kg/dia). A digestibilidade da matéria seca, matéria orgânica e carboidratos foram similares (P>0,05) entre as três dietas. A digestibilidade da proteína foi menor (P<0,05) para os animais alimentados com a dieta CON (55.3%) e similar para as

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dietas MON (62.3%) e PRO (59.8%). A digestibilidade do extrato etéreo foi maior (P<0,05) para os bovinos alimentados com a dieta PRO (84.6%) e menor para os bovinos alimentados com a dieta CON (73.4%), sendo a dieta MON (80.7%) intermediária. A adição de monensina e própolis não alteraram (P>0,05) a excreção urinária, síntese microbiana e características de carcaça.
**Palavras-chave:** Bovinos, características de carcaça, ionofóros, ruminantes

## Introduction

Feed additives, such as antibiotics or growth-promoting agents, have become an integral part of ruminant production (BERGEN; BATES, 1984). The polyether antibiotic monensin is one of the most common additives used to modulate ruminant fermentation. Monensin's modes of action rely on the selective growth inhibition of *gram*-positive bacteria (BERGEN; BATES, 1984), reducing lactic acid production and methanogenesis in the rumen (GOODRICH et al., 1984) and increasing the molar proportion of propionate (GOODRICH et al., 1984) and N retention (PRADO et al., 2010). However, in Europe, resolution EU 1831/2003 prohibited the use of sodium monensin since January 2006. The development of alternative products that replace the above feed additive is thus necessary.

Propolis is a resinous substance collected by honeybees from the buds and bark of certain trees and plants and which they store inside their hives. Propolis has been reported to possess several biological activities such as antibacterial, antiviral, antifungal, anti-inflammatory (MARCUCCI, 1995), anticancer and antitumoral (BURDOCK, 1998) properties. Propolis usually contains a variety of chemical compounds such as polyphenols (flavonoids, phenolic acids and their esters), terpenoids, steroids and amino acids (BURDOCK, 1998). The major components in propolis of Brazilian origin are terpenoids and prenylated derivatives of *p*-coumaric acids (MARCUCCI, 1995). Propolis is an alternative product that may replace dietary antibiotics (VALERO et al., 2011; ZAWADZKI et al., 2011a, b; AGUIAR et al., 2012). For instance, it has been shown that dietary addition of propolis improved the feed efficiency of bulls finished in feedlot (ZAWADZKI et al., 2011b; VALERO et al., 2014). However, there are few studies on the action of propolis on animal performance, microbial fermentation and carcass characteristics of bulls finished in feedlot. Current investigation evaluates animal performance, feed efficiency and carcass characteristics of bulls finished in feedlot.

## Materials and Methods

*Animal management and sampling*

The committee of Animal Production at the State University of Maringá approved current research which was carried out at the Experimental Farm of the State University of Maringá, Paraná, southern Brazil, and followed the guiding principles of biomedical research on animals (CIOMS/OMS, 1985). Diet analyses were performed at the Laboratory of Feed Analyses and Animal Nutrition of the State University of Maringá.

Thirty-eight bulls (½ Angus *vs.* ½ Nellore) were used with an initial average age of 20 months and initial live weight of 394 ± 24 kg. Bulls were housed in individual 2×5 m metabolism stalls, with concrete floor, and equipped with trough and water drinker. The bulls accessed a diet formulated to meet the requirements of fattening beef cattle (NRC, 2000) at a gain of 1.50 kg/day (Table 1), whereas water was given *ad libitum*. Concentrate amounts offered daily to the animals were adjusted every 14 days after the bulls were weighed. The diet was weighed before delivery and adjusted daily for leftovers at 5%, whilst refusals were weighed daily.

**Table 1.** Chemical composition of ingredients and diets.

| Ingredients | DM[1] | %/DM | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | CP[2] | OM[3] | MM[4] | NDF[5] | ADF[6] | EE[7] | TDN[8] |
| Corn silage | 32.5 | 7.55 | 96.6 | 3.45 | 51.0 | 30.8 | 3.00 | 62.0 |
| Cracked corn | 90.0 | 8.86 | 98.9 | 1.08 | 20.3 | 7.00 | 3.50 | 90.0 |
| Soybean meal | 90.1 | 49.8 | 93.3 | 6.71 | 15.5 | 9.50 | 0.50 | 81.0 |
| Urea | 99.0 | 262 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Limestone | 99.0 | - | - | 35.0 | - | - | - | - |
| Mineral salt | 99.0 | - | - | 99.0 | - | - | - | - |
| Sodium monensin | 98.0 | - | - | - | - | - | - | - |
| Propolis extract | 25.0 | - | - | - | - | - | - | - |
| Diets | 47.2 | 11.5 | 96.8 | 3.18 | 35.1 | 19.0 | 3.03 | 74.3 |

[1]Dry matter, [2]Crude protein, [3]Organic matter, [4]Mineral matter, [5]Neutral detergent fiber, [6]Acid detergent fiber, [7]Ether extract, [8]Total digestive nutrients.
**Source**: Elaboration of the authors.

*Propolis characterization*

Propolis extract was obtained from a beekeeping company in Maringá PR Brazil. The propolis derived from *Vernonia polyanthes* (popular name in Brazil: *assa peixe*) had an oxidation level similar to or lower than 150 g/kg. Propolis contained 199 g/kg dry matter (m/m) and its flavonoid content (m/m) reached 4.5 g/kg, according to Funari and Ferro (2006). Propolis extract was prepared and developed by the Pharmacy Laboratory of the State University of Maringá, following Franco and Bueno (1999). Extracts with alcohol were diluted between 50 and 96º GL and with a fix concentration of propolis extract dried by lyophilization during 24 hours. Propolis was patented as intellectual patrimonial number PI 0605768-3. In practical terms, each bull received a daily administration of 35 mg propolis extract, with dry residual/flavonoid at a proportion of 0.9 g/20.2mg in propolis.

*Diets*

Three treatments were prepared: CON - control (14 bulls), MON - Monensin (11 bulls) and PRO - Propolis (13 bulls). Monensin, produced by Elanco®, and propolis were mixed with concentrate, at 300 mg/animal/day of monensin and 35 g/animal/day of propolis.

*Digestibility trial*

Periods consisted of 36 d, comprising 30 d for adaptation and 6 d for sample collection. Feed refusals were taken from day 30 to day 36 and weight of refused feed was subtracted from the total feed delivered during the 6-day sampling period to estimate DMI. Fecal samples were taken from each bull. For the determination of iDM, about 5 g of each sample (2 mm) of food leftovers and feces were weighed in duplicate and placed in nylon bags (10 cm x 10 cm, 50 micron porosity) which were sealed and incubated in the rumen of two fistulated Holstein cows. The bags were removed after 240 h rumen incubation, placed in ice, washed with water, dried in an oven at 55 °C for 72 h, weighed (pre-dried material) and subsequently placed on the sample field pre-dried oven at 105 °C for analysis.

*Chemical analysis*

Dry matter (DM), crude protein (CP), organic matter (OM), ash, ether extract (EE), neutral detergent fiber (NDF) and acid detergent fiber

(ADF) were determined according to AOAC (1998) methods. Total carbohydrates (TCH) were calculated with equation: TCH = 100 - (CP% + EE% + ash%), according to Sniffen et al. (1992). Non-fibrous carbohydrates (NFC) were the difference between TCH and NDF. Total digestive nutrients (TDN) were calculated by Kearl (1982) equation. Starch content was determined according to Herrera-Saldanha and Huber (1989) using a Technicon Autoanalyzer III to measure free glucose (GOCHMAN; SCHMITZ, 1972). NDF was determined by an Ankom 200 Fiber Analyzer (Ankom Technologies, Macedon NY USA) with procedures by Van Soest, Robertson and Lewis (1991).

Total fecal output was estimated by iDM as an indigestible marker. Diet and fecal samples were oven-dried at 55 °C for 2 d, air-equilibrated and ground by a Wiley mill to pass a 1-mm screen. Approximately 5 g of each dry ground fecal sample were pooled within each collection period per animal and stored for chemical analysis. Ground samples of experimental diets and fecal samples were dried at 105 °C for 24 h to determine DM. For iDM determination, the samples were milled through a 2 mm sieve, packed (20 mg of DM cm-2 filter bags (F57) that had been previously weighed and incubated for 240 hours in the rumen of a crossbred cow fed a mixed diet of equal parts forage (corn silage) and concentrate (the same concentrate used in the treatments). After incubation, the bags were removed, washed with water until clean and dried in a ventilated oven at 55°C for 72 hours. The bags were then removed and oven-dried at 105°C. The iDM was estimated using the difference in sample weight before and after ruminal incubation. Fecal excretion was calculated using the following equations: FE = iDMI / iDMCF, where: FE = fecal excretion (kg day-1 intake (kg day-1 matter concentration in faeces (kg day-1), iDMI = indigestible dry matter) and iDMCF = indigestible dry) as described by Silva et al. (2014).

Allantoin analysis in urine was dosed according to methods by Chen and Gomes (1995). Urinary volume (expressed in liters/day) was determined by dividing the daily excretion of creatinine (mg/kg of body weight) by the concentration of creatinine (mg/L). Average rate 29.33 mg/kg of body weight, as indicated by Rennó et al. (2000), was used to estimate the daily excretion of creatinine per kg of body weight. The production of microbial nitrogen (N) was calculated from the amount absorbed purines (X, mmol/day) estimated from urinary excretion of purine derivatives (PD) (Y, mmol / day), using the equation described by Chen and Gomes (1995). The synthesis of nitrogen in the rumen microbial (Y g N/day) was calculated according to the absorbed purine (X, mmol/day) by equation described by Chen and Gomes (1995). The microbial protein estimate (MPEmic) was obtained by multiplying the microbial synthesis of N by 6.25, while the efficiency of microbial protein synthesis was determined as: MPSmic (g/100 g) = MPEmic (g)/TDNI (100 g), where TDNI = total digestible nutrients intake.

*Carcass characteristics*

The 22-month-old bulls were slaughtered at a commercial slaughterhouse 15 km distant from the Experimental Farm of the State University of Maringá, following the usual practices of the Brazilian beef industry. Carcasses were labeled, weighted and chilled at 4°C for 24 h. The right part of the carcass was then used to determine the quantitative characteristics.

Hot carcass weight (HCW) was determined soon after slaughter and prior to carcass chilling. Hot carcass dressing (HCD) is the percentage of individual animal dressing, defined by the ratio HCW:live weight. Carcass conformation (CONF) was determined after excluding fat thickness where the highest rate indicated the best conformation. CONF may be superior, very good,

good, regular, poor or inferior, coupled to ratings plus, average and minus. Carcass length (CAL) was measured from the skull board to the pubic bone on the anterior side of the first rib. Leg length (LEL) was evaluated with a wooden compass with metallic edges that measured the distance from the anterior border of the pubis bone to a middle point on the tarsus bone. Cushion thickness (CUT) was determined with a wooden compass with metallic edges that measured the distance between the lateral face and the median at the superior part of the cushion. Fat thickness (FAT) was measured by a calliper, between the 12$^{th}$ and 13$^{th}$ ribs on *Longissimus* muscle (LM), with a three points measure average. LM area was measured on the right side of the carcass, after a cross-section cut was made between the 12$^{th}$ and 13$^{th}$ ribs using a compensating planimeter. Marbling (MAR) was measured in the LM between the 12$^{th}$ and 13$^{th}$ ribs, following scores used in Brazilian slaughterhouse (18 to 16 - abundant; 15 to 13 - moderate; 12 to 10, mean; 9 to 7 small; 6 to 4, light; 3 to 1 traces). Texture (TEX) was determined by fascicle size (muscular "grain" size) and evaluated subjectively on a point scale (very fine - 5; fine - 4; slightly - 3; coarse - 2; very coarse - 1). Color (COL) was analyzed after a 24-hour carcass chilling in the muscle according to a point scale, 30 minutes after a cross-sectional cut on the LM between the 12$^{th}$ and 13$^{th}$ ribs (cherry red - 5; red - 4; slightly red - 3; dark red - 2; dark - 1).

Muscle, fat and bone were physically separated from the LM section, which corresponded to the 10$^{th}$, 11$^{th}$ and 12$^{th}$ ribs, and individually weighed, according to Hankins and Howe (1946).

*Experimental design and statistical analysis*

Data were submitted to an analysis of variance and the means (when different) were compared by Tukey's test at 5% significance level, with (SAS, 2004) statistical software, being the variables measured following the model: $Y_{ij} = \mu + d_i + e_{ij}$, where:

$Y_{ij}$ = observation on animal j fed with diet i;

$\mu$ = mean treatments;

di = effect of diet i; 1, 2, and 3;

and eij = residual error.

## Results and Discussion

*Animal performance*

The final weight and average daily gain (ADG) were similar (P>0.05) for bulls fed on control (CON), Monensin (MON) and Propolis (PRO) diets (Table 2).

Monensin addition in the diets for animals had no effect on weight gain (GOODRICH et al., 1984). Likewise, some authors have found no effect of propolis on animal performance (STRADIOTTI JÚNIOR et al., 2004a, b; LANA et al., 2007). However, propolis at the highest concentration (0.054 mg of total flavonoids chrysin measured in g) for Nellore bulls finished in feedlot increased ADG (ZAWADZKI et al., 2011b) and the diet provided was similar to that used in current experiment (50% maize silage and 50% concentrate and 74% TDN). Results indicated that propolis concentration in the diet interfered on animal performance due to its action on ruminal modulation (PRADO et al., 2010; AGUIAR et al., 2012).

**Table 2.** Animal performance and feed intake of crossbred bulls fed on diets with sodium monensin or propolis extract.

| Item | Diets | | | SE | P<F |
|---|---|---|---|---|---|
| | CON[1] | MON[2] | PRO[3] | | |
| Initial weight, kg | 393 | 395 | 395 | 7.13 | NS |
| Final weight, kg | 495 | 504 | 505 | 10.7 | NS |
| ADG[4], kg | 1.45 | 1.55 | 1.57 | 0.12 | NS |
| DMI[5], kg/day | 9.17a | 8.40b | 9.31a | 0.22 | 0.05 |
| DMI/BW[6], % | 2.07a | 1.87b | 2.07a | 0.03 | 0.05 |
| DMC[7], kg/ADG | 6.29a | 5.39b | 5.92a | 0.56 | 0.05 |
| CPI[8], kg/day | 1.05a | 0.97b | 1.07a | 0.02 | 0.05 |
| OMI[9], kg/day | 8.88a | 8.13b | 9.01a | 0.17 | 0.05 |
| NFDI[10], kg/day | 3.22a | 2.95b | 3.27a | 0.06 | 0.05 |
| NFDI/BW[11], % | 0.72a | 0.66b | 0.73a | 0.01 | 0.05 |

[1]Control, [2]Sodium monensin, [3]Propolis extract, [4]Average daily gain, [5]Dry matter intake, [6]Dry matter intake/body weight, [7]Dry matter conversion, [8]Crude protein intake, [9]Organic matter intake, [10]Neutral detergent fiber intake, [11]Neutral detergent fiber intake/body weight. Means followed by different letters are different. NS - not significant.
**Source**: Elaboration of the authors.

The high final weight (501.3 kg) and ADG (1.52 kg) were determined by genetic groups (F1 - ½ Angus *vs.* ½ Nellore), diet type (energy high - 74% TDN) and finishing in a short period (70 days in feedlot). Experiments by the same researchers showed final weight similar to or higher than results observed in current research (PRADO et al., 2008a, b, c, d; AGUIAR et al., 2012). Thus, crossbred bulls finished on diet with high energy density in feedlot system may be slaughtered at a lower age (24 months) and with high body weight (around 500 kg).

Dry matter intake (DMI) and other nutrients (kg/day or in ratio - %/BW) were lower (P<0.05) for bulls fed on MON diet when compared to those on CON and PRO diets (Table 2).

Mean DMI was 2.0% of body weight. In general, crossbred cattle finished in feedlot had their DMI changed from 2.0 to 2.5% of body weight. Stradiotti Júnior et al. (2004a, B) observed that the inclusion of monensin or propolis could reduce feed intake. Decrease in total DMI of diets with the addition of monensin has been demonstrated in other studies (OLIVEIRA et al., 2004). According to Goodrich et al. (1984), diets with ionophores generally reduced the feed intake by approximately 8 to 10%. It has been reported that the addition of propolis in the diet had no effect on DMI, as recorded for dairy cows and dairy goats (LANA et al., 2007).

Dry matter conversion (DMC) was better (P<0.05) for bulls fed on monensin in the diet. Similarly, previous works demonstrated that inclusion of monensin or propolis improved the feed efficiency (STRADIOTTI JÚNIOR et al., 2004a, b; ZAWADZKI et al., 2011b). Monensin or propolis reduced *gram*-positive microorganisms which caused methane production in the rumen. Thus, the inclusion of these products reduced the particles emission to the environment, with a decrease in greenhouse effects (STRADIOTTI JÚNIOR et al., 2004a, b). Broudiscou, Papon and Broudiscou (2000) studied the effect of thirteen dry extracts of plants with high flavonoids levels on fermentation and methanogens in culture of rumen microorganisms and observed that propolis increased the propionate production (energy source) by 10.3% and reduced the microorganisms population. The above authors observed that propolis did not alter pH and ammonia levels in the

rumen and the microbial protein in the rumen liquid. Since propolis hindered desamination by rumen microorganisms, the possible reduction in ammonia levels in rumen with diets featuring elevated protein degradable/fermentation carbohydrates has been demonstrated.

Average NDF intake was 0.68% of body weight. According to Mertens (1994), the intake of NDF should be around 1.20% of body weight per day to allow adequate supplementation of concentrate and prevent intake by limiting the filling of the rumen. Thus, the concentration of fiber in the diet (quantitatively the main nutrient) was not the limiting factor in feed intake.

*Apparent digestibility*

Apparent digestibility (AD) of DM, OM and carbohydrates fractions (NDF, ADF, NFC and TC) were not affected (P>0.05) by the inclusion of additives (Table 3).

**Table 3.** Apparent digestibility coefficient of dry matter and other nutrients of crossbred bulls finished in feedlot.

| Item | Diets[1] | | | SD | P≤F |
|---|---|---|---|---|---|
| | CON | MON | PRO | | |
| Dry matter | 62.6 | 67.2 | 66.9 | 1.66 | NS |
| Organic matter | 63.7 | 67.9 | 67.8 | 1.55 | NS |
| Crude protein | 55.3b | 62.3a | 59.8ab | 2.44 | 0.02 |
| Neutral detergent fiber | 38.9 | 45.3 | 43.6 | 2.48 | NS |
| Non-fibrous carbohydrates | 97.1 | 97.4 | 97.6 | 1.55 | NS |
| Total carbohydrates | 64.6 | 68.3 | 68.3 | 1.78 | NS |
| Ether extract | 73.4c | 80.7b | 84.6a | 1.63 | 0.01 |
| Total digestible nutrients[2] | 64.1 | 68.4 | 68.4 | 1.56 | NS |

[1]Diets with 50:50% roughage:concentrate without (CON) and with sodium monensin (MON) or propolis extract (PRO). [2]TDN = digestible crude protein + digestible neutral detergent fiber + digestible non-fibrous carboydrates + (2.25 x Digestible ether extract). Means followed by different letters are different (P<0.05). NS - not significant.
**Source**: Elaboration of the authors.

Average AD of NDF (42.6%) was low for diets with 50% corn silage and 50% concentrate. Normally, the apparent digestibility of carbohydrates was low with diets high in forage (ZEOULA et al., 2008). Some studies showed AD of NDF higher than 50% (ZEOULA et al., 2008) in diets containing 50% or over of the concentrate. However, Resende et al. (2001) registered a negative effect on fiber digestibility with a high amount of concentrate. The additive effect on digestibility in cattle seemed to be in some specific nutrient. As an example, monensin is mainly related to increase in nitrogen retention in animals with less ruminal protein degradability (GOODRICH et al., 1984). Similarly, low ammonia production in the rumen was also observed when propolis was added (STRADIOTTI JÚNIOR et al., 2004a). Reduction of protozoa in buffalo rumen with the addition of propolis in diet was observed by Rispoli et al. (2009). These factors may reduce the excretion of ammonia and increase nitrogen retention in diets with propolis. The propolis action on rumen microbial communities appears to be different from monensin´s action. Takaishi-Kikuni and Schilcher (1994) observed that antibacterial activity of propolis is given by the inhibition of bacterial RNA polymerase. Van Nevel (1991) concluded that ionophore addition had no

effect on apparent digestibility of nonstructural carbohydrate. Similarly, Lana et al. (2005) also found no effect of propolis on AD of NFC. On the other hand, AD of NFC was high (97.4%) for all diets. The AD of NFC were overestimated when compared to those observed by Lana et al. (2005). These high rates may be explained by the use of internal flow fecal indicator (iDM). The internal indicators provided underestimated rates of fecal output for its recovery in variable segments of the digestive tract of interest, or even feces (FAHEY; JUNG, 1983) or by incomplete recovery as a function of time incubation (ZEOULA et al., 2002). The AD of ether extract (EE) varied with the diet and dose of propolis included in the diet (LANA et al., 2005; PRADO et al., 2010). In current study, DA of EE was higher for propolis diet (85%) when compared to that for monensin (81%) and control (73%) diets. The DA of EE in diet with propolis (85%) was similar to that observed by Lana et al. (2005) (85%).

*Microbial synthesis*

Urine volume was not affected (P>0.05) by the addition of monensin or propolis in the diets (Table 4). The average estimated excreted urine (gathering spot) was 11 L animal/day. OLIVEIRA et al. (2001) also observed no change in urine output due to different levels of non-protein nitrogen in the diet of dairy cows, with an average of 13 L animal/day. The addition of monensin and propolis in the diets did not affect (P>0.05) urinary excretion of allantoin and uric acid (Table 4). The average excretion rates represented 99% allantoin and 1% uric acid of total purines, without taking into consideration the participation of xanthine which was low in cattle. Chen and Gomes (1995) reported that the proportion of the compound (allantoin) in relation to total purine was 80-85% in cattle. Rennó et al. (2008) estimated microbial protein production by means of urinary purine derivatives in steers fed on 50% forage and 50% concentrate and found that the proportion of allantoin in relation to total purine was 91.7.

**Table 4.** Efficiency and microbial synthesis of crossbred bulls fed on diets with sodium monensin or propolis extract.

| Item | Diets[1] | | | SD | P<F |
|---|---|---|---|---|---|
| | CON | MON | PRO | | |
| Urinary volume, L | 12.8 | 11.0 | 9.21 | 1.46 | NS |
| Allantoin, mmol/d | 265.6 | 300.6 | 313.2 | 38.3 | NS |
| Uric acid, mmol/d | 3.22 | 2.25 | 3.81 | 0.13 | NS |
| Purines derivatives, mmol/d | 268.7 | 302.8 | 317.0 | 37.8 | NS |
| Microbial purines absorbed, mmol/d | 267.7 | 308.1 | 325.6 | 46.5 | NS |
| Microbial nitrogenous compounds, g/d | 194.6 | 224.0 | 236.7 | 33.9 | NS |
| Microbial protein synthesis, g/d | 1216.3 | 1400.0 | 1479.5 | 210 | NS |
| EMSmic, g Pmic/100 g TDN | 15.0 | 18.2 | 16.6 | 5.62 | NS |

[1]Diets with 50:50% roughage:concentrate without (CON) and with sodium monensin (MON) or propolis extract (PRO). NS - not significant.
**Source**: Elaboration of the authors.

Monensin and propolis affected neither (P>0.05) the microbial protein synthesis (g/day) nor the efficiency of microbial synthesis (g/100 g TDN) (Table 4). The PRO diet produced an average microbial efficiency of 16.6 g/100 g TDN, or rather, an intermediate value in relation to dietary monensin 18.2 g/100g TDN and TDN control of 15.0 g/100g. According to NRC (2000), the value of 13 g PB/100 g TDN for EMSmic was a good estimate, although it did not apply to all situations. In fact, highly

digestible diets (rich in grains) should decrease the rumen pH, with a subsequent reduction in the renewal microbial rate, which leads to a reduced efficiency in the conversion of carbohydrates and protein microbial fermentation.

*Carcass characteristics*

The treatment had no effect (P>0.05) on weight and hot carcass dressing and on the carcass´s physical characteristics (Table 5). Reported hot carcass dressing (50%) may be considered low. Generally, the carcass dressing of crossbred cattle (F1 - ½ European *vs*. ½ Zebu) was around 54% (ABRAHÃO et al., 2005; PRADO et al., 2008a, b, d; MAGGIONI et al., 2009). The low carcass dressing observed may be related to the cleaning methods practiced on the bovine carcass at the Brazilian slaughterhouse.

In general, no difference was reported in the physical carcass characteristics of animals finished with similar carcass dressing levels (PRADO et al., 2008a, b, c, d; MAGGIONI et al., 2009). Similarity, carcass characteristics were determined principally by genetic groups and slaughter weight (WEBBO'NEILL, 2008; ROTTA et al., 2009). The animals in this experiment featured similar genetic groups, with similar carcass weight and age. The low fat thickness observed could be determined by the age of the slaughtered animal, as well as by the breeds involved in the different diets (ABRAHÃO et al., 2005; MAGGIONI et al., 2009; ROTTA et al., 2009). The marbling score of 4.88 points lay between "light minus" and "light". It is known that marbling is related to the meat´s sensory characteristics that may be noticed and appreciated by the consumers (WEBB O'NEILL, 2008). The texture of LM, featuring an average of 4.4 points, corresponded to "fine" texture. The color rate presented an average score of 3.9 points, equivalent to a score between "slightly dark red" and "red". The pH rate averaging 5.8 was considered normal for Brazilian market. The percentage of muscle, fat and bone featured average rates of 64.2, 19.4 and 16.4%, respectively.

**Table 5.** Carcass characteristics of crossbred bulls fed on diets with sodium monensin or propolis extract.

| Item | Diets | | | SE[4] | P<F |
|---|---|---|---|---|---|
| | CON[1] | MON[2] | PRO[3] | | |
| Hot carcass weight, kg | 247 | 252 | 255 | 6.33 | NS |
| Hot carcass dressing, % | 49.9 | 50.0 | 50.4 | 0.67 | NS |
| Carcass conformation, points | 3.50 | 3.63 | 3.71 | 0.23 | NS |
| Carcass length, cm | 131 | 135 | 135 | 1.35 | NS |
| Leg length, cm | 70.8 | 70.9 | 72.1 | 0.79 | NS |
| Cushion thickness, cm | 25.8 | 25.1 | 25.0 | 0.54 | NS |
| Fat thickness, mm | 2.63 | 2.88 | 2.94 | 0.36 | NS |
| *Longissimus* muscle, $cm^2$ | 57.3 | 59.1 | 61.0 | 1.13 | NS |
| Marbling, points | 4.63 | 5.00 | 4.88 | 0.67 | NS |
| Texture, points | 4.50 | 4.38 | 4.38 | 0.19 | NS |
| Color, points | 3.75 | 4.00 | 3.88 | 0.31 | NS |
| pH | 5.68 | 5.67 | 5.63 | 0.13 | NS |
| Muscle, % | 64.1 | 63.5 | 65.0 | 2.77 | NS |
| Fat, % | 19.4 | 19.7 | 19.0 | 2.77 | NS |
| Bone, % | 16.5 | 16.8 | 16.0 | 0.37 | NS |

[1]Diets with 50:50% roughage:concentrate without (CON) and with sodium monensin (MON) or propolis extract (PRO). NS - not significant.
**Source**: Elaboration of the authors.

## Conclusions

The sodium monensin addition in the diet of bulls finished in feedlot with 50% concentrate and 50% corn silage can be used because reduces feed intake and improves feed efficiency. On the other hand, propolis extract addition in the diets does not produce any changes on animal performance, feed intake, microbial synthesis and carcass characteristics.

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