M339 Manipulation of rumen fermentation and ecology of swamp buffalo by coconut oil and garlic powder supplementation. P Kongmun*[1,2], M Wanapat[1], and Z Yu[2], [1]*Khon Kaen University*, *Khon Kaen, Thailand, 40002*, [2]*The Ohio State University*.

This experiment was conducted to investigate the effect of coconut oil (CO) and garlic powder supplementation on digestibility of nutrients, ruminal fermentation, ecology, microorganisms and methanogen diversity. Four, 3-year old, rumen fistulated swamp buffalo bulls were randomly assigned in a 4 × 4 Latin square design to receive 4 dietary treatments; 7% CO, 7% CO with 50 g/d of garlic powder, 7% CO with 100 g/d of garlic powder and non-supplemented (control). During the experiment, concentrate was offered at 0.5% of BW while rice straw was given on ad libitum basis. It was found that supplementation of 7% CO had significantly influenced on total DM intake, OM, NDF and ADF digestibilities while supplementation of 7% CO with garlic powder (50 and 100 g/d) were not significantly different when compared with the control. Blood urea nitrogen was significantly higher in supplemented groups. Total VFA concentration, proportion of C2 and C2:C3 ratio was reduced by supplementation. Proportion of C3 was increased ($P < 0.05$) when supplemented with 7% CO and 7% CO with 100 g/d of garlic powder. Methane production was dramatically reduced ($P = 0.005$) in supplemented treatments and was 10% reduced in 7% CO supplementation. Amylolytic and proteolytic bacteria were increased ($P = 0.007$ and $P = 0.024$) while protozoal population by decreased 68 – 75% ($P < 0.01$) by supplementation. Total bacterial population was increased by supplementation while total fungi and total methanogens were not significantly different among treatments. Percentage of cellulolytic bacterial population was not different among treatments. However, dietary supplementations were reduced ($P < 0.001$) percentage of F. succinogenes population. However, methanogen diversity was not changed using PCR-DGGE as technique. Based on this study, supplementation with 7% CO plus 100 g/d of garlic powder could be efficiently utilized in the rumen and thus, could provide good fermentation end-products and improve rumen ecology for the host swamp buffaloes particularly in reducing 9% methane gas production without changing nutrient digestibilities.

Key Words: garlic powder, coconut oil, swamp buffalo

M340 Adding whole hops to high concentrate diets enhances *in vitro* ruminal fermentation. N. Narvaez*, Y. Wang, Z. Xu, and T. McAllister, *Agriculture and Agri-Food Canada*, *Lethbridge, AB, Canada*.

To assess the potential of hops (*Humulus lupulus*) as an alternative to antimicrobials for improving ruminant production, whole hops (pelleted and ground) were included in batch culture in vitro ruminal incubations (500 mg substrate + 40 mL inoculum) of barley grain (Exp 1) and barley grain:barley silage-finishing diet (Exp 2). Hops were included at 0, 50, 100, 200 and 400 μg/mL in Exp. 1; in Exp. 2, at 0, 200, 400, 800, and 1600 μg/mL, with and without polyethylene glycol (PEG; 250 μg/mL). PEG was included to selectively deactivate condensed tannins (CT). In Exp. 1, ^{15}N-labeled $(NH_4)_2SO_4$ was used to measure microbial protein (MP) synthesis. Gas production and methane concentration were measured at 3, 6, 12, and 24 h in both Exps. Concentrations of VFA and ammonia (NH_3-N), starch disappearance and MP synthesis were determined at 3, 6, 12, and 24 h in Exp 1. Total VFA, NH_3-N and apparent DM disappearance (DMD) were analyzed after 48 h in Exp. 2. Adding PEG did not alter the in vitro rumen fermentation suggesting that hop CT were not responsible for altering microbial activity. With hops inclusion, gas production from barley grain was linearly increased ($P = 0.029$) but from finishing diet, it was linearly ($P < 0.001$) decreased. Apparent dry matter disappearance (DMD) from finishing diet and starch disappearance from barley grain increased linearly ($P < 0.001$) with increasing hops content. Hops linearly increased ($P < 0.001$) VFA production from the finishing diet but with barley grain, VFA were decreased by hops only at 100 μg/mL. The acetate:propionate ratio was decreased quadratically ($P < 0.001$; minimum at 800–1600 μg/mL) by hops added to finishing diet, but A:P was unaffected by hops during incubation with barley. Methane production from both diets was quadratically reduced ($P < 0.01$) by hops. These results suggest that including hops in high-grain diets for ruminants may have potential to improve feed efficiency, possibly by reducing enteric methane emissions.

Key Words: barley grain, ruminal methane, β-acids

M341 Effects of hops on in vitro ruminal fermentation of high forage diets. N. Narvaez*, Y. Wang, Z. Xu, and T. McAllister, *Agriculture and Agri-Food Canada*, *Lethbridge, AB, Canada*.

Hops (*Humulus lupulus)* exert selective antimicrobial effects against gram-positive bacteria and may have potential as an alternative to antimicrobials for growth promotion in livestock. The effects of whole hops on ruminal fermentation of mixed forage (MF; Exp 1) or a barley silage:barley grain-based backgrounding diet (BD; Exp 2) were assessed during 48 h incubations (n = 4). Hop pellets (var. Tea Maker) were included in cultures (500 mg substrate + 40 mL inoculum) at 0, 50, 100, 200 and 400 μg/mL in Exp. 1 and at 0, 200, 400, 800 and 1600 μg/mL in Exp. 2. In Exp. 1, microbial protein (MP) synthesis was determined using $^{15}(NH_4)_2SO_4$, enabling true DM disappearance (TDMD) to be estimated. In Exp. 2, vials were prepared with and without polyethylene glycol (PEG) to bind condensed tannins (CT) and indirectly assess their effects on ruminal fermentation. Lack of any effect of PEG on fermentation suggested that CT in hops do not influence ruminal fermentation. Including hops linearly decreased ($P < 0.001$) gas production from MF and BD. Whereas true DMD from MF was linearly increased ($P < 0.001$) by hops, apparent DMD from BD was linearly decreased ($P < 0.001$). In Exp. 1, a quadratic ($P < 0.001$) response of MP synthesis to hops was observed. With BD, total VFA content was linearly reduced ($P < 0.001$) by hops, but with MF, the response was quadratic ($P = 0.002$). The acetate:propionate ratio was linearly increased ($P < 0.001$) with MF but quadratically decreased ($P < 0.001$) with BD. Hops quadratically reduced ($P < 0.05$) methane emissions from MF and BD. Hops have the potential to decrease methane production and may improve fermentation efficiency in ruminants consuming forage-based diets.

Key Words: hops, methane, β-acid

M342 Microencapsulation strategies to protect plant extracts against heat process of manufacture diets. P. W. Cardozo*[1], D. Ribera[1], A. Viso[1], H. Mengel[2], and M. Coenen[3], [1]*Research and Development Department, Carotech Technologies S.A*, *Tarragona, Spain*, [2]*KoVet, Coordination Staff for Veterinary Clinical Studies, Faculty of Veterinary Medicine, University of Leipzig*, *Leipzig, Germany*, [3]*Institute Animal Nutrition, Nutrition Diseases and Dietetics, Faculty of Veterinary Medicine, University of Leipzig*, *Leipzig, Germany*.

The purpose of this study was to evaluate the thermo-stability of standard combination of cinnamaldehyde and garlic oil in a protection capsule

(WEC) versus without encapsulation (WOEC) and the possible consequences after pellet process. Raw materials were provided by Carotenoid Technologie S.A. (Carotech, Tarragona Spain). Treatments were mixed at the rate of 5 g/ kg of a typical dairy concentrate diet, and were pelleted for 2 min at 80°C. Samples of both groups were taken before and after the pelleting process and the recovery of active ingredients was analyzed by HPLC technique. As expected, before pelleting, the recovery concentration of active ingredients in both treatments was similar ($P > 0.05$; average of 2.15 mg cinnamaldehyde/ g of feed, and average of 0.35 mg garlic oil/ g of feed). However, pelleting process (2 min at 80°C) affected the stability of active ingredients of WOEC recovering only 79.93% of cinnamaldehyde and 69.70% of garlic oil ($P < 0.05$), respectively. In the case of the encapsulated product, both cinnamaldehyde (98.65%) and garlic oil (95.78%) were not affected by pellet process ($P > 0.05$). The results of this trial showed that the stability was significantly higher in WEC than WOEC. The potential contribution of this study is focused on the technology used in this trial that allowed incorporating 100% of active ingredients with a percentage of active compounds recovered of approximately 98% after pelleting process. Further studies are necessary to determine the effectiveness of these active ingredients encapsulated on in vivo rumen microbial fermentation and animal performance.

Key Words: plant extracts, encapsulation system, pellet process

M343 Encapsulated combination of cinnamaldehyde and garlic oil as rumen modifiers in early-lactating dairy cows. X. Guozhong[1], X. Junxin[1], P. W. Cardozo*[2], and D. Yingying[2], [1]*Institute of Shanghai Dairy Science*, *Shanghai, China*, [2]*Research and Development Department*, *Tarragona, Spain*.

Two hundred lactating cows (DIM <60 d) were used in a completely block design (15 d of adaptation and 60 d for sampling period) to evaluate the effects of encapsulated combination of 129 mg/cow/d of cinnamaldehyde and 21mg/animal/d of garlic oil (Next Enhance 300; NE 300). Results obtained during the first 15 d were considered as covariant in the model. Milk yield was recorded every 15 d. Milk samples were taken at 15, 30 and 60 d to determine milk protein, fat percentage as well as milk urea nitrogen (MUN) and somatic cell count (SCC). Differences were declared at $P < 0.05$. Animals fed NE 300 increased ($P < 0.05$) milk production (over 1.7 kg/d) compared with control (37.38 kg/d vs. 35.73 kg/d). There was no overall effect ($P > 0.05$) of feeding NE 300 in milk fat (average 3.32%) and protein (average 2.95%) contents compared with control. However, cows fed with NE 300 showed an important reduction ($P < 0.05$) in milk urea nitrogen (14.7 mg/ dL) and SCC (168 × 1000)/mL) compared with control (15.5 mg/dL, and 337 × 1000)/mL, respectively). This study shows that the inclusion of an encapsulated combination of cinnamaldehyde and garlic oils (Next Enhance 300) in the early-lactating dairy diet has potential to influence milk production and milk composition, especially reducing MUN when fed to dairy cows in early lactation. Further studies are necessary to confirm that this encapsulated combination can be as useful as modifiers of rumen fermentation lactating dairy cows.

Key Words: dairy cows, cinnamaldehyde, garlic oil

M344 Effect of chestnut tannins on rumen activity of dairy sheep grazing on pasture. A. Nudda*[1], G. Battacone[1], R. Boe[1], R. Rubattu[1], A. H. D. Francesconi[1], M. Decandia[2], and G. Pulina[1], [1]*Dipartimento di Scienze Zootecniche, University of Sassari*, *Sassari, Italy*, [2]*Agricultural Research Agency of Sardinia - AGRIS Sardegna*, *Sassari, Italy*.

A 4-wk trial was conducted to investigate the effect of pasture supplementation with a concentrate (300 g/d; 87.1% DM; 29.4% NDF, 16.9% ADF, 17.6% CP, on a DM basis) containing 3 levels of commercial chestnut hydrolyzable tannin (0, 6 and 12%, on a DM basis; T0, T6, T12, respectively) on rumen activity of dairy ewes. Thirty-six 2- to 4-yr-old Sarda ewes (12 per experimental group), in mid lactation (90–120 DIM) and grazing on pasture of 70% *Medicago polymorpha* (27.5% DM; 44.3% NDF, 29.5% ADF, 18.3% CP, on a DM basis) and 30% of *Lolium rigidum* (39.6% DM; 58.3% NDF, 31.2% ADF, 9.4% CP, on a DM basis) were used. Rumen fluid samples were collected with a stomach tube 3 times (every 10 d) during the experimental period from 5 animals/group. Concentrate intake was measured daily. The pH, VFA (acetic, propionic and butyric acids), ammonia N (NH3-N) and the fatty acid profile of the rumen samples were determined. Data were analyzed by ANOVA including tannin level, sampling and their interaction. Concentrate intake of T6 and T12 were, respectively 10% and 25% lower than that of T0. Rumen pH was higher in T6 than in T0, being intermediate in T12. The T6 group contained the lowest content of acetic acid and the highest of butyric acid. Tannins also influenced the percentages of C18:2 n6 and C18:3 n3, which were lower in the control group, even if its C18:2 n6 content did not differ significantly from T6. The NH3-N tended to be reduced by the inclusion of tannin in the diet. These results suggest that the lack of effect of tannins on rumen activity in T12 was probably related to its lower intake of concentrate.

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Key Words: dairy sheep, rumen activity, tannin

M345 Effect of the inclusion of treated apple waste on in vitro ruminal fermentation of alfalfa hay. Y. Castillo-Castillo[1], O. Ruiz-Barrera*[2], C. Arzola-Alvarez[2], C. Rodriguez-Muela[2], A. Elias-Iglesias[3], C. Angulo-Montoya[2], O. La O-Leon[3], and J. A. Ortega[2], [1]*Universidad Autónoma de Ciudad Juárez.*, *Nuevo Casas Grandes, Chih, México*, [2]*Universidad Autónoma de Chihuahua.*, *Chihuahua, Chih, México*, [3]*Instituto de Ciencia Animal.*, *La Habana, Cuba.*

Feed produced by solid-state fermentation (SSF) has been satisfactorily added to ruminant fibrous diets due to an improvement on the ruminal fermentation patterns, including dry matter digestibility. The objective of this work was to evaluate the effect of the addition of fermented apple waste (FAW) on ruminal pH, ammonia nitrogen ($N\text{-}NH_3$), volatile fatty acids concentration (VFA), in vitro dry matter digestibility (IVDMD), lactic acid content (LA), and microorganisms counting (yeast, total bacteria and protozoa) of good quality alfalfa hay incubated in an in vitro ruminal ecosystem. Four levels of FAW inclusions were evaluated (0, 0.25, 0.50 and 0.75 g DM replacing 1.5 g DM of alfalfa hay and incubated at several times of fermentation (0, 4, 8, 12 and 24 h.) using a completely at random experimental design with repeated measures in time. Results showed that yeast concentration in the ruminal ecosystem was greater in the treatments with FAW addition up to the 12 h of incubation (2.4×10^6, 1.7×10^6 and 3.2×10^6 CFU/mL $\log^{10}$) in relation to the control (1.2×10^6 CFU/mL $\log^{10}$) and 0.75 g FAW addition exhibited the greatest concentration ($P < 0.0001$). LA content also increased at 12 h of incubation in response to the addition of FAW ($P < 0.001$) (13.86, 16.84 and 14.57 µg/ml, respectively) in relation to the control (10.61 µg/ mL). However, other measured variables as ruminal pH, $N\text{-}NH_3$, VFA, IVDMD total bacteria and protozoa counting remained unaffected by the treatments. According to these results, we concluded that substitution of alfalfa hay by FAW incubated in an in vitro ruminal ecosystem during 24 h only modified positively the population of viable yeast and

AL content, with no effect on other fermentative and microbiological parameters of the ruminal environment.

Key Words: fermentation, apple, ruminants

M346 Effects of hops on rumen fermentation, growth, carcass traits and shedding of *Escherichia coli* by feedlot cattle. Y. Wang*[1], A. V. Chaves[1,2], F. L. Rigby[3], M. L. He[1], and T. A. McAllister[1], [1]*Agriculture and Agri-Food Canada Research Centre*, *Lethbridge, AB, Canada*, [2]*The University of Sydney*, *Sydney, NSW, Australia*, [3]*Yakima*, *WA (deceased)*.

Hops (*Humulus lupulus*) have antimicrobial properties, which may have potential in livestock production. Experiments were conducted to evaluate the effects of hops on ruminal fermentation, fecal shedding of *Escherichia coli* and the growth of feedlot cattle. Sixty individually penned British × Charolais steers were randomly assigned to treatment for a 160-d feeding trial (55 d growing + 105 d transition/finishing) using barley grain:barley silage-based diets (n = 15). Hop cone pellets were added to the growing diet at levels of 0, 119, 238 and 476 mg/kg DM and to the finishing diet at 0, 238, 476 and 952 mg/kg DM. Fecal samples were collected every 28 d to assess the effects of hops on fecal shedding of *E. coli*. Feed deliveries were recorded daily and feed refusals were weighed weekly. The steers were weighed every 28 d and warm carcass weight, longissimus muscle area, marbling score and saleable meat yield were recorded at slaughter for each steer. Including hops in the diet did not affect ($P \geq 0.05$) growth (DMI, ADG or feed conversion efficiency) or carcass characteristics of steers, nor fecal shedding of *E. coli*. During both the growing and finishing periods, however, ADG was 6% improved ($P = 0.11$) with the highest levels of hops compared with the controls. In corresponding 24-h batch culture incubations of the 8 diets (n = 6), hops inclusion with the growing diet increased ($P \geq 0.001$) DM disappearance (IVDMD), gas production, and VFA accumulation, with linear increases ($P \geq 0.001$) of IVDMD and total VFA. The proportion of propionate in VFA was increased ($P < 0.001$) and acetate proportion and acetate:propionate ratio were decreased ($P < 0.001$). With the finishing diet, a linear increase ($P = 0.002$) in gas production was observed. However, these in vitro improvements were not reflected in improved growth or efficiency of feedlot cattle. Inclusion of higher levels of hops in the diet may be favorable for ruminant production.

Key Words: growth performance, rumen fermentation, *Humulus lupulus*

M347 Effect of phlorotannins from brown seaweed on ruminal bacteria. Y. Wang*, L. J. Yanke, Z. Xu, and T. A. McAllister, *Agriculture and Agri-Food Canada Research Centre*, *Lethbridge, AB, Canada*.

Brown seaweed has been used as feed additive to mitigate *E. coli* O157:H7 in feedlot cattle, but its impact on rumen bacteria is not clear. The effects of phlorotannins (PT) isolated from the brown seaweed, *Ascophyllum nodosum*, on ruminal bacteria were investigated in pure culture studies. *Prevotella bryantii*, *Ruminobacter amylophilus*, *Selenomonas ruminantium* and *Streptococcus bovis* were cultured through 10 serial 24-h transfers in ruminal fluid medium containing 0 or 50 μg PT/mL. The 4 strains, each non-exposed or pre-exposed to PT, were then inoculated into media containing 0, 75, 150 or 300 μg PT/mL and 24-h growth curves were determined (n = 6). The ruminal cellulolytic bacteria (CB) *Ruminococcus flavefaciens*, *Fibrobacter succinogenes* and *Ruminococcus albus* were also pre-cultured through 10 serial 72-h transfers in ruminal fluid medium containing 0 or 12.5 μg PT/mL and then, for 72 h, on Whatman no. 54 filter paper as a sole carbohydrate source in medium containing 0, 25, 50 or 75 μg PT/mL for the determination of filter paper digestion (n = 4). The effects of PT on growth of non-cellulolytic bacteria (NCB) were species-dependent, and were also affected by their having been pre-exposed to PT or not. At 24 h of incubation, growth of all 4 NCB was inhibited ($P < 0.01$) by as little as 75 μg PT/mL irrespective of their having been pre-exposed. Pre-exposed *P. bryantii* exhibited greater ($P < 0.01$) growth at 24 h in 75 μg PT/mL medium than did its non-exposed counterpart. At PT concentration of 75 μg PT/mL, *Sel. ruminantium* and *P. bryantii* exhibited more growth ($P < 0.01$) between 16 and 24 h of incubation than did *Str. bovis* or *Rb. amylophilus*. Phlorotannins inhibited digestion of filter paper by all 3 CB, but *F. succinogenes* was less ($P < 0.05$) sensitive to PT than were *Rc. flavefaciens* or *Rc. albus*. Pre-exposure to PT did not affect filter paper digestion by the 3 CB. Phlorotannins from *A. nodosum* inhibit both NCB and CB, but CB exhibit greater sensitivity than NCB. Thus, PT could negatively affect fiber digestion if brown seaweed is fed to ruminants.

Key Words: phlorotannins, ruminal bacteria, pure culture

M348 Additives (sodium monensin, salinomycin, and virginiamycin) for Nellore bulls feedlot fed high concentrate finishing rations. C. Sitta*, F. A. P. Santos, G. B. Mourão, A. M. Pedroso, R. Carareto, J. R. R. Dórea, T. G. Neri, and D. A. Rodrigues, *University of Sao Paulo*, *Piracicaba, SP, Brazil*.

The aim of the present study was to compare the effect of different additives on the performance of Nellore bulls fed high concentrate rations. One hundred and 30 4 Nellore bulls with initial weight of 330 kg were tested in a 102 d finishing trial, of which 21 d comprised adaptation to the high concentrate diet. Animals were grouped according to initial live weight and allotted to 24 pens. The final diet contained 12% tifton hay, 78.1% finely ground corn, 6% sugar cane molasses, 1.4% urea, 2.5% mineral and vitamin premix and respective additives. Treatments consisted in: 1) Control (without additives); 2) Sodium monensin 30ppm; 3) Sodium monensin 20ppm + Virginiamycin 15ppm; 4) Sodium monensin 30ppm + Virginiamycin 15ppm; 5) Virginiamycin 17ppm; 6) Virginiamycin 15ppm + Salinomycin 13ppm. Data were analyzed with Proc. Mixed from SAS (1999), version 9.2 for Windows, and the pens were used as experimental units. Dry matter intake and daily weight gain were not affected by treatments ($P > 0.05$). Feed conversion (DMI/ADG) was lower for the treatments containing monensin (M20 + V15; M30 + V15) and salinomycin (S13 + V15), both in combination with virginiamycin. Diet net energy for gain was higher for the treatments with monensin, monensin with virginiamycin, virginiamycin and salinomycin with virginiamycin ($P < 0,05$). The combination of monensin 30 ppm and virginiamycin 15 ppm resulted in an increase in the energy density of the rations in comparison with the other treatments (Table 1).

Table 1. Dry matter intake (DMI), average daily gain (ADG), feed conversion (DMI/ADG) and net energy (NE) of finishing Nellore bulls fed different additives

	Control	M 30	M20 + V15	M30 + V15	V 17	S13 + V15	P-value
DMI (kg DM/day)	9.89	9.20	9.29	8.98	9.76	9.85	0.0600
ADG (kg/day)	1.33	1.33	1.39	1.44	1.45	1.49	0.1784
FC (DMI/ADG)	7.40a	6.90ab	6.66bc	6.21c	6.72bc	6.62bc	0.0429
NEg obs (Mcal/Kg)	1.05a	1.14ac	1.17bc	1.26bd	1.15ac	1.16bc	0.0428
NEg obs/act (Mcal/Kg)	0.78a	0.85ac	0.86bc	0.93bc	0.85ad	0.86bc	0.0413

Key Words: additives, effect, Nellore

M349 In vitro effect of peppermint (*Mentha piperita*) essential oil and non-fiber carbohydrates on gas production parameters of alfalfa hay. M. Danesh Mesgaran*[1], E. Jani[2], A. Vakili[1], A. Solaimany[2], and H. Jahani-Azizabadi[1], [1]*Dept. Animal Science, Ferdowsi University of Mashhad, Mashhad, Iran*, [2]*Islamic Azad University*, *Kashmar, Iran*.

The aim of this study was to evaluate the effect of peppermint essential oil (PE) and non-fiber carbohydrates (NFC) including sucrose (SUC) and starch (STA) on gas production parameters of alfalfa hay (AH). Treatments were AH, AH plus PE (40 and 80 µl/g DM), AH supplemented with SUC or STA at 60 and 90 mg/g DM plus PE (0.0, 40 and 80 µl/g DM). Approximately 0.3 g of each sample (n = 4) was placed into a 100 mL glass syringe containing 40 mL of buffered rumen fluid (buffer to rumen fluid was 2:1). Rumen fluid was obtained from 2 rumen cannulated sheep (body weight = 45.5 ± 2 kg) before the morning feeding and strained through 4 layers of cheesecloth. Animals were fed 1.5 kg DM alfalfa hay and 0.4 kg DM concentrate (165 g CP/ kg DM) per head/ day. Syringes were incubated at 39°C and the volume of gas produced were recorded at 2, 4, 8, 12, 24, 36, 48, 72 and 96 h. Data were fitted to an exponential equation of $P = b\ (1\text{-}e^{-ct})$, where b is the volume of gas produced, c is the fractional rate constant of gas production (/h), t is the incubation time (h) and P is the volume of gas produced at time t. The gas production parameters of the supplemented samples were compared with AH as control using Dunnett's test at $P < 0.05$. The parameters for AH were b = 72 mL and c = 0.07/h. Supplementation of AH with PE reduced the volume of gas produced, however, peppermint essential oil caused to reduce ($P < 0.05$) the volume of gas produced from the samples of AH supplemented with the NFC sources. The rate constant of gas produced (c) from AH was significantly ($P < 0.05$) increased by the adding of the NFC and PE (except PE as 80 µL/g DM, which had no significant effect on c). The fractional rate constant was significantly increased when PE as 40 µL/g DM was added to the AH supplemented with the SUC and STA (0.13 and 0.10, respectively). However, at 80 µL/g DM of PE, c was significantly decreased ($P < 0.05$) for those treatments (0.06 and 0.05, respectively). It was concluded that PE at the both applied rates had a potential to alter the fermentability of AH and AH supplemented with the NFC sources.

Key Words: essential oil, gas production, peppermint

M350 Effect of fennel (*Foeniculume vulgare*) essential oil on in vitro gas production parameters of alfalfa hay supplemented with sucrose or starch. M. Danesh Mesgaran*[1], E. Jani[2], A. Vakili[1], H. Jahani-Azizabadi[1], and A. Solaimany[2], [1]*Dept. Animal Science, Ferdowsi University of Mashhad, Mashhad, Iran*, [2]*Islamic Azad University*, *Kashmar, Iran*.

The aim of the present study was to evaluate the effect of fennel essential oil (FE) on gas production parameters of alfalfa hay (AH) and AH supplemented with sucrose (SUC) or starch (STA). Treatments were AH, AH plus FE (40 and 80 µL/g DM), AH supplemented with SUC or STA at 60 and 90 mg/g DM plus FE (0.0, 40 and 80 µL/g DM). Approximately 0.3 g of each sample were placed in a 100 mL glass syringe containing 40 mL of buffered rumen fluid as 2: 1 (n = 4). Rumen fluid was obtained from 2 rumen canullated sheep (body weight = 45.5 ± 2 kg) before the morning feeding and immediately strained through 4 layers of cheesecloth. Animals were fed 1.5 kg DM alfalfa hay and 0.4 kg DM concentrate (165 g CP/ kg DM) per head per day. Syringes were incubated at 39°C and the volume of gas produced were recorded at 2, 4, 8, 12, 24, 36, 48, 72 and 96 h. Statistical analysis was conducted using SAS (1999) procedure. The gas production data were fitted to an exponential equation of $P = b(1\text{-}e^{-ct})$, where b is the volume of gas produced, c is the fractional rate constant of gas production (/h), t is the incubation time (h) and P is the volume of gas produced at time t. The gas production parameters of the supplemented samples were compared with AH as control using Dunnett's test at $P < 0.05$. Supplementation of AH with FE, at both rates applied, reduced the volume of gas produced ($P < 0.05$; 72, 52 and 54 mL/0.3 g DM, respectively), but increased the fractional rate constant of gas production ($P < 0.05$; 0.07, 0.12 and 0.10, respectively). In addition, FE particularly as 40 µL/g DM, reduced ($P < 0.05$) the volume of gas produced from the AH samples supplemented with both SUC and STA. The rate constant of gas produced (c) from AH supplemented with SUC and STA at both levels (0.09 and 0.08/h, respectively) was increased ($P < 0.05$) by the adding of FE as 40 and 80 µL/g DM (0.13 and 0.09/h, respectively). It might be concluded that FE, as 40 or 80 µL/g, caused an alteration in the fermentation potential of AH alone or supplemented with the NFC sources used.

Key Words: essential oil, gas production, fennel

M351 Effect of individual and mixed natural tree extracts on in vitro ruminal fermentation profiles in sheep. F. S. Jiménez-Peralta[1], A. Z. M. Salem*1,4, H. Ammar[2], M. Ronquio[3], and P. B. Albarrán[1], [1]*Autónoma del Estado de México*, *Centro Universitario UAEM-Temascaltepec, Estado de México, C.P. 51300, México*, [2]*Ecole Supérieure d'Agriculture de Mograne*, *Zaghouan, 1121 Mograne, Tunisia*, [3]*Universidad Autónoma del Estado de México*, *Facultad de veterinaria, Toluca, Mexico*, [4]*Alexandria University*, *Department of Animal Production, Faculty of Agriculture (El-Shatby), Egypt*.

Extracts of 2 tree leaves species [*Salix babilónica* (SB) and *Leucaena leucocephala* (LL)] and their mixture (SBLL, 1:1, v/v) rich in secondary metabolites (ESM, 10 g DM/80 mL of solvent), were in vitro evaluated on ruminal fermentation pattern in 4 levels of 0, 0.6, 1.2, and 1.8 mL extract/g DM of TMR (50:50 forage:concentrate diet). Animals used for the extraction of rumen liquid (RL) for the in vitro incubations were allocated into 2 experimental groups (8 animals/group): control (CG) and treated (TG) group. Animals of CG were fed daily on TMR, while those of TG were fed on the same TMR and drenched a daily oral dose of SBLL (30mL/animal) for 60 d. Concentrations of secondary metabolites (SM) in terms of total phenolics (TP), saponins (SAP) and aqueous fraction (AF, lectins, polypeptides and starch) were examined in each tree extract and gas production was recorded at different incubation times (2, 4, 6, 8, 10, 12, 24, 48 and 72 h) of TMR with different extracts levels. Short chain fatty acids (SCFA), in vitro organic matter degradability (IVD) and metabolizable energy (ME)) were estimated. As compared with SB, extracts of LL had higher TP, SAP and AF (i.e., 24, 14 and 116 versus 15, 6 and 74 g/kg DM, respectively). For both animal groups, increasing the extracts dose until 1.8mL/g DM improved ($P < 0.05$) the ruminal fermentation activities of TMR with increasing the extracts dose until 1.8mL/g DM in ether TG or CG, probably due to a higher extracts -soluble sugars. However, higher fermentation activities were observed in SB than LL and SBLL extracts. Ruminal fermentative activities of TMR were reduced by more than 50% in TG versus to CG during all the incubation times, except the first 2 h. In conclusion, administration of SBLL during 60 d to animals did not enhance the ruminal fermentation activities of TMR in sheep. Individual extracts-rich in secondary metabolites at 1.8mL/g DM, in particular SB extracts, had the most potential on ruminal microorganism's activities and may serve as an alternate to antibiotics and ionophores as a growth promoter of weaned lambs.

Key Words: extracts, secondary metabolites, in vitro fermentation, sheep

M352 Medium-term orally administration of extracts impacts on in vitro rumen fermentative activity of some tree leaves in sheep. A. Z. M. Salem*[1,4], F. S. Jiménez-Peralta[1], H. Ammar[2], R. R. Rojo[1], L. M. Camacho[3], and D. Cardoso-Jiménez[1], [1]*Universidad Autónoma del Estado de México, Estado de México*, *Centro Universitario UAEM-Temascaltepec, Estado de México, C.P. 51300, México*, [2]*Ecole Supérieure d'Agriculture de Mograne*, *Zaghouan, 1121 Mograne, Tunisia*, [3]*Universidad Autónoma de Guerrero*, *Facultad de veterinaria, México*, [4]*University of Alexandria*, *Department of Animal Production, Faculty of Agriculture (El-Shatby), Egypt*.

Four tree leaves species (i.e., *Celtis pallid*, *Ficus trigonata*, *Fraxinus excelsior* and *Prunus domestica*) collected during the dry season were used to explore medium-term effects of *Salix babilónica* and *Leucaena leucocephala* extract (SBLL, 1:1 v/v) rich in secondary compounds (ESC, 10g dry leaves/80 mL of solvent) on fermentative activity in the rumen of sheep. Sixteen crossbreed male (Katahdin × Pelibuey) sheep were fed on a TMR (18%CP) and used as a source of rumen liquor. Eight animals were fed the TMR with a daily oral dose of 30mL/animals/d of SBLL for 60 d and used as the treated group (TG), whereas the other sheep were not received extract and always fed the same TMR and used as the control group (CG). The objective was to investigate if adaptation to ESC at the rumen level may develop in response to regular consumption of secondary compounds (SC), resulting in an enhanced ability to digest tree leaves. Gas production was recorded at 2, 4, 6, 8, 10, 12, 24, 48 and 72 h after incubation of leaves samples. Differences in the fermentative activity (short chain fatty acids (SCFA), in vitro organic matter degradability (IVD) and metabolizable energy (ME)) were examined in batch cultures inoculated with rumen fluid obtained on d 60 from both groups of sheep. Gas production and other fermentative parameters (i.e., SCFA, IVD and ME) of the 4 leaves species were reduced by more than 50% in TG versus CG during the all incubation times, except the first 2 h. The magnitude of this effect may be due to direct negative impact of SC in the orally dose on ruminal microorganisms activities or the indirect impacts of SC on saliva production composition. Highest fermentation activities ($P < 0.05$) were in *P. domestica* while the lowest values ($P < 0.05$) were in *F. excelsior*. This effect may be due to the different SC concentrations as well as ADF and NDF composition in leaves samples. In conclusion, administrations of SBLL to animals do not enhance the ruminal fermentation activities and gas production kinetics of tree leaves species. *P. domestica* demonstrated a higher ruminal digestion than other tree species.

Key Words: extracts, in vitro fermentation, sheep

M353 Effect of cumin essential oil on in vitro gas production parameters of alfalfa hay, barley grain and sugar beet pulp. M. Sadjadian, M. Danesh*, A. R. Vakili, H. Jahani, and J. Amini, *Ferdowsi University of Mashhad*, *Mashhad, Iran*.

The objective of the present study was to evaluate the effect of cumin essential oil (CEO) on in vitro gas production parameters of alfalfa hay (AH), barley grain (BG) or sugar beet pulp (BP). Samples of AH, BG, and BP were provided as untreated or treated with CEO (400 mL/g DM). In vitro incubations were carried out using 0.3 g of each sample (4 replicates) which was placed in a 100 mL glass syringe containing 40 mL buffered rumen fluid (ratio of buffer to rumen fluid was 2:1). Rumen fluid was obtained from 2 ruminally cannulated sheep (body weight = 45.5 ± 2 kg), before the morning feeding, and immediately strained through 4 layers of cheesecloth. Animals were fed 1.5 kg DM alfalfa hay and 0.4 kg DM concentrate (165 g CP/ kg DM) per head per day. Syringes were then incubated at 38.6°C and the volume of gas produced was determined at 2, 4, 8, 12, 24, 36, 48, 72 and 96 h after the incubation. The gas production data were fitted using an exponential equation of $P = b \times (1–e^{-ct})$, where b is the volume of gas produced, c is the fractional rate constant of gas production (/h), t is the incubation time (h) and P is the volume of gas produced at time t. Statistical analysis was conducted using SAS (1999) software. Results demonstrated that the gas production parameters of the feed samples (Table 1) were significantly different ($P < 0.05$). In addition, results of the present study indicate that the gas production parameters of the feed samples were significantly altered when CEO was included in the medium. Cumin essential oil caused a significant ($P < 0.05$) decrease of c parameter of BG and BP. While, when cumin was added to the AH and BP samples, the b parameter was decreased (Table 1).

Table 1. Gas production parameters of alfalfa hay, barley grain and sugar beet pulp as untreated or treated with cumin essential oil as 400 mL/g DM

	Treatments						
Gas production parameters	AH	BG	BP	AH+CEO	BG+CEO	BP+CEO	SEM
b (ml/0.3 g)	49.6^{d}	98.7^{b}	84.0^{c}	20.4^{f}	105.6^{a}	44.9^{e}	2.34
c (/h)	0.06^{b}	0.04^{c}	0.09^{a}	0.06^{b}	0.02^{d}	0.06^{b}	0.004

Key Words: cumin, essential oil, gas production

M354 Influence of two browse extracts-rich secondary compounds and their mixture on lamb feed intake and growth performance. A. Z. M. Salem*1,4, H. P. Mejia[1], H. Ammar[2], M. Ronquio[3], J. L. Tinoco[1], R. Rojo[1], and A. M. Garcia[1], [1]*Universidad Autónoma del Estado de México*, *Centro Universitario UAEM-Temascaltepec, Estado de México, C.P. 51300, México*, [2]*Ecole Supérieure d'Agriculture de Mograne*, *Zaghouan, 1121 Mograne, Tunisia*, [3]*Universidad Autónoma del Estado de México*, *Departmento de Nutricion Animal, Facultad de Veterinaria, Toluca, Mexico*, [4]*University of Alexandria*, *Department of Animal Production, Faculty of Agriculture (El-Shatby), Egypt*.

Thirty-two crossbreed male (Katahdin × Pelibuey) lambs (3–4 mo old, average LW 24 ± 0.3kg) were used to study effects of daily oral administration of the extracts-rich secondary compounds (ESC, 10g dry leaves/80 mL of solvent) of either 2 browse species namely *Salix babilónica* (SB) and *Leucaena leucocephala* (LL) or their mixtures (SBLL) during 60 d lamb feed intake and growth performance. Lambs were randomly assigned into 4 groups (8 animals per group) in a factorial design: received no ESC (Control –CTR), and the other 3 groups were submitted to a treatment with ESC (30mL) of either SB, LL or SBLL (1:1 v/v) during the experimental period. Feed intake (FE) was recorded daily while the body weight of lambs was recorded every 20 d among the experimental period: 20 (P1), 40 (P2), and 60 d (P3). Animals of different groups were fed ad libitum on a total mixed ration (18% CP) that was formulated to meet all nutrient requirements for finishing lambs. Oral administration of ESC improved average daily gain (ADG), feed conversion (FC) and economic efficiency (EE) during all the experimental periods, without changing in FE. A gradually improvement in growth performance (ADG and FC) of ESC treated lambs was observed from P1 to P3, versus CTR lambs. Generally, growth performance of SB and LL lambs was better ($P < 0.05$) than SBLL lambs. The cost of one kg DG (i.e., EE) was reduced ($P < 0.05$) by 20.2, 13.3 and 12.88% with ESC administration of SB, LL and SBLL, respectively. This effect may be due to an adaptation of ruminal microorganisms to plant secondary compounds in extracts. Results of our present study revealed that daily administration of ESC, particularly of SB, improved lamb performance rather than LL or SBLL.

Key Words: extracts and secondary compounds, growth performance and feed intake, lambs

M355 Effect of polyclonal antibody preparation on ruminal microbial diversity population in cattle fed three different energetic sources. W. Otero[1], C. Marino*[2], M. Stradiotto[4], C. Barreto[3], V. Pellizari[3], M. Arrigoni[2], and P. Rodrigues[1], [1]*University of Sao Paulo, FMVZ*, *Pirassununga, Brazil*, [2]*University of Sao Paulo State, FMVZ*, *Botucatu, Brazil*, [3]*University of Sao Paulo, ICB II*, *Sao Paulo, Brazil*, [4]*University of Sao Paulo, FZEA*, *Pirassununga, Brazil*.

Nine ruminally fistulated cows were used to test an avian-derived polyclonal antibody preparation (PAP) against specific ruminal bacteria *Streptococcus bovis*, *Fusobacterium necrophorum*, *Clostridium aminophilum*, *Peptostreptococcus anacrobius* and *Clostridium sticklandii*. The experimental design was a 3 × 3 Latin square replicated 3 times with a factorial arrangement of treatments 3 × 3 regarding 2 rumen modifiers, monensin (MON) and PAP plus control group and 3 energy sources. The energetic sources utilized were dry-grounded corn grain (CG), high moisture corn silage (HMCS) and citrus pulp (CiPu). The ruminal content was collected in the d 21 of each trial at 4 h after feeding for the analysis of microbial ruminal diversity by the denaturing gradient gel electrophoresis. Data were submitted to variance analysis by GLM procedure, which separated the effects of interaction between feed additive and energy source, effect of feed additive, effect of energy source as well as effects of period and animal inside the square. Mean effects were separated by Duncan test. Differences were declared at $P < 0.05$. It was observed energetic source effect ($P = 0.0470$) for number of bands amplified in DGGE for *Archaea* community. Animals receiving CiPu demonstrated an increase of 1.56 band (52%) compared with animals receiving CG. Those fed HMCS did not differ between the other 2 groups. For the total sum of bands amplified in DGGE, energetic source effect was observed. The group fed HMCS had more amplified bands than the group fed CG. The group fed CiPu did not differ from the other 2 groups. In general lines, in the present experiment, it was not possible to assign that there was a pattern in the structures of amplification by *Bacteria* and *Archaea* communities of the ruminal content of animals treated with 2 different rumen modifiers or 3 distinct energetic sources.

Table 1. Number of amplified bands obtained by DGGE for *Bacteria*, *Archaea* and sum of *Bacteria* and *Archaea* communities obtained with treatments composed by different energetic sources

	Energy sources					
Variable	CG	HMCS	CiPu	Mean	SEM	Prob.
Bacteria	5.94	9.11	5.94	7.00	0.6400	0.1106
Archaea	3.00^{B}	3.56^{AB}	4.56^{B}	3.70	0.3809	0.0470
Sum	8.94^{B}	12.67^{A}	10.50^{AB}	10.70	0.7123	0.0741

Key Words: denaturing gradient gel by electrophoresis, ionophore, passive imunization

M356 Effect of polyclonal antibody preparation on ruminal protozoa population in cattle fed three different energetic sources. W. Otero[1], C. Marino*[2], M. Stradiotto[4], C. Barreto[3], V. Pellizari[3], M. Arrigoni[2], and P. Rodrigues[1], [1]*University of Sao Paulo, FMVZ*, *Pirassununga, Brazil*, [2]*University of Sao Paulo State, FMVZ*, *Botucatu, Brazil*, [3]*University of Sao Paulo, ICB*, *Sao Paulo, Brazil*, [4]*University of Sao Paulo, FZEA*, *Pirassununga, Brazil*.

Nine ruminally fistulated cows were used to test an avian-derived polyclonal antibody preparation against specific ruminal bacteria *Streptococcus bovis*, *Fusobacterium necrophorum*, *Clostridium aminophilum*, *Peptostreptococcus anacrobius* and *Clostridium sticklandii*. The experimental design was a 3 × 3 Latin square replicated 3 times with a factorial arrangement of treatments 3 × 3 regarding 2 feed additives (monensin and PAP) plus control group and 3 energy sources. The energy sources utilized were dry-grounded corn grain (CG), high moisture corn silage (HMCS) and citrus pulp (CiPu). Sample collection for quantitative protozoa analysis were performed at 19 d of each period at 0 and 4 h after morning meal collected my manual scanning of rumen floor. Data were submitted to variance analysis by GLM procedure, which separated the effects of interaction between feed additive and energy source, effect of feed additive, effect of energy source as well as effects of period and animal inside the square. Mean effects were separated by Duncan test. Differences were declared at $P < 0.05$. Relative counting of *Entodinium* was influenced by the type of energy source at 0 h ($P = 0.0091$) and 4 h ($P = 0.0026$). Animals treated with CG and HMCS showed higher values of these protozoa when compared with animals receiving CiPu but do not differ between them. It was observed feed additive effect for *Isotricha* ($P = 0.1008$) at 4 h. The group treated with PAP showed great values for relative counting compared with CON. The MON group did not differ from the others 2. Also, it was observed energy source effect for *Isotricha* at 0 h ($P = 0.0008$) and 4 h ($P = 0.0001$), where the animals fed CiPu showed greater relative counting than animals fed HMCG and CG that did not differ between them. The utilization of PAP and the addition of CiPu resulted in an increase of total and relative counting of Isotricha which indicate an effect on ruminal microbial population.

Table 1. Absolute (× 10^3/mL) and relative (%) counting of protozoa obtained with the treatments composed by different feed additives and energy sources

	Feed Additive			Energy source				
Variable	CON	MON	PAP	CG	HMCS	CiPu	Mean	SEM
General Count (x10^3/mL)	140.5	143.5	268.7	190.1	226.3	136.3	184.2	37.70
Isotricha								
0 h	9.87^{b}	8.93^{b}	21.73^{a}	6.80^{B}	6.67^{B}	27.07^{A}	13.51	3.06
4 h	6.46^{b}	8.68^{ab}	12.51^{a}	3.97^{B}	3.84^{B}	19.84^{A}	9.22	1.97
Entodinium								
0 h	123.5	123.1	239.2	175.2	209.6	100.9	161.9	36.47
4 h	87.1	81.5	83.7	89.2^{A}	89.4^{A}	73.7^{B}	84.1	2.50

Key Words: additive, passive immunization, ruminant

M357 Effects of ethanol extracts of two specific mixtures of herbs and spices on in vitro rumen microbial fermentation. N. Narvaez*[1], Y. Wang[1], T. A. McAllister[1], and C. Benchaar[2], [1]*Agriculture and Agri-Food Canada*, *Lethbridge Research Centre, Alberta*, [2]*Agriculture and Agri-Food Canada*, *Dairy and Swine R&D Centre, Sherbrooke, Quebec*.

Two in vitro batch culture experiments were conducted to assess the effects of ethanol extracts of 2 different combinations of herbs and spices (ApexRuminant and ApexCalf; Nutri-Ad, Elgin, IL) on rumen microbial fermentation. The treatments were control (no additive), monensin (10 µg/mL), ethanol extract of ApexRuminant (ARe, Exp. 1) and ethanol extract of ApexCalf (ACe, Exp. 2) both supplied at 125, 250, 500, 1000 and 2000 µg/mL. Production of total gas (GP), volatile fatty acids (VFA) concentration, microbial protein (MN), and true dry matter disappear-

ance (TDMD) were determined after 24 h of incubation. Data were analyzed as a completely randomized design and polynomial contrasts were used to determine linear and quadratic dose-effects. Significance was declared at $P \leq 0.05$. In both experiments, monensin increased propionate proportion but decreased GP, TDMD, MN synthesis, total VFA production (mmol/g DM), molar proportions of acetate, butyrate, and branched-chain VFA (BCVFA), and the acetate:propionate ratio (A:P). Addition of ARe at levels up to 500 μg/mL and ACe up to 1000 μg/mL did no cause substantial modifications of rumen fermentation, whereas at higher doses it resulted in different effects that in most cases inhibited rumen fermentation. These effects were dose-dependent and entailed both linear and quadratic trends. When supplied at 1000 or 2000 μg/mL, ARe reduced GP, TDMD, and total VFA production, but increased butyrate and BCVFA proportions, whereas at 2000 μg/mL, ARe supply increased MN and A:P ratio. Addition of ACe at 2000 μg/mL reduced GP, TDMD, but increased MN without altering VFA production or A:P ratio. Results from this study suggest that the active compounds of Apex mixtures are ethanol soluble and exhibited antimicrobial activity at high doses with greater inhibitory effects exerted by ARe compared with ACe on ruminal microbial fermentation.

Key Words: plant extract, rumen fermentation, ethanol extract

M358 Assessment of the effects of two herbs and spices mixtures and their ethanol extracts on in vitro rumen microbial fermentation. N. Narvaez*[1], Y. Wang[1], T. A. McAllister[1], and C. Benchaar[2], [1]*Agriculture and Agri-Food Canada*, *Lethbridge Research Centre, AB,Canada,* [2]*Agriculture and Agri-Food Canada*, *Dairy and Swine R&D Centre, Sherbrooke, QC, Canada.*

An in vitro batch culture experiment was conducted to determine the effects of 2 specific mixtures of herbs and spices (ApexRuminant: AR and ApexCalf: AC; Nutri-Ad, Elgin, IL) and their ethanol extracts (ARe; ACe) on rumen microbial fermentation. Treatments were control (no additive), monensin (10 μg/mL), AR, AC, ARe or ACe, supplied at 250, 500, 1000 and 2000 μg/mL. Production of total gas, volatile fatty acid (VFA) and ammonia N (NH_3-N) concentrations, and apparent dry matter disappearance (ADMD) were determined after 48 h of incubation. Data were analyzed as a completely randomized design and according to a 2 × 2 × 4 factorial to determine the effects of the type of product and the method of extraction. Polynomial contrasts were also used to determine linear and quadratic dose-effects. Significance was declared at $P \leq 0.05$. Compared with the control, monensin reduced ADMD, NH_3-N concentration, total VFA production (mmol/g DM), and acetate:propionate (A:P) ratio. Addition of AR and ARe linearly reduced gas production, ADMD, VFA but linearly increased the A:P ratio. Addition of AC and ACe did not alter gas production, but linearly reduced ADMD and VFA production. The A:P ratio from ACe linearly increased but a quadratic response was observed with AC, being lowest at 500 μg/mL. Compared with AC and ACe, the addition of AR and ARe resulted in lower ADMD, NH_3-N concentration, VFA production, but higher A:P ratio. Addition of AR and AC had higher NH_3-N concentration, but lower ADMD and A:P ratio than ARe and ACe. Considering the type of product (ApexRuminant vs. ApexCalf) and preparation method (no extraction vs. ethanol extraction), ApexRuminant and ethanol extracts (ARe and ACe) exerted greater effects on rumen fermentation than ApexCalf and no extraction. These effects became statistically significant at the supplementation levels of 1000 and 2000 μg/mL.

Key Words: plant extract, ethanol extraction, in vitro rumen fermentation

M359 Use of pine sawdust (*Pinnus patula*) as a fiber source in lamb finishing rations. E. C. Guerra-Medina[1], O. D. Montañez-Valdez*[2], M. A. Cobos-Peralta[3], and M. Pérez-Sato[4], [1]*Centro Universitario de la Costa Sur de la Universidad de Guadalajara*, *Autlán, Jalisco, México*, [2]*Centro Universitario del Sur de la Universidad de Guadalajara*, *Ciudad Guzmán, Jalisco, México*, [3]*Colegio de Postgraduados*, *Montecillo, Texcoco, México*, [4]*Benemérita Universidad Autónoma de Puebla*, *Puebla, Puebla, México*.

Rations for sheep include 5 to 40% of fibrous sources that can be used as cereal straws, alternate sources of oak (*Quercus ilex*) or pine (*Pinnus patula*) sawdust have been used; however its effectiveness has not been researched in depth. With the objective of using an alternative source of fiber in diets for sheep in feedlots, 2 treatments were assessed for 4 periods of 14 d each. There were 2 treatments, one with 30% pine sawdust (SD) and another with 30% corn straw (CS). The variables evaluated were average daily gain (ADG), dry matter intake (DMI), ruminal pH, concentration of volatile fatty acids, and concentration of ammonia. A Completely Randomized Design was used and the data were analyzed using the procedure of repeated measurements. The ADG (246.07 g d^{-1}), concentration of propionic acid (27.3 mol/100 mol), and the average ruminal pH (6.28) was higher ($P < 0.05$) in the SD treatment, while the average concentration ammonia was higher ($P \leq 0.05$) in the CS treatment (33.6 m*M*). There no were differences in DMI ($P \leq 0.05$) between treatments. The results indicate the possibility of using until 30% of pine sawdust as a source of fiber in diets for sheep in feedlots.

Key Words: fiber substitute, average gain, ruminal fermentation

M360 Effect of an inoculum and additive on in situ nutrients digestibility of sugar cane silage. J. A. Reyes-Gutiérrez[1,2], O. D. Montañez-Valdez*[1], R. Rodríguez-Macías[2], M. A. Ruiz-López[2], E. Salcedo-Pérez[2], and M. R. Rodriguez-Ramirez[3], [1]*Centro Universitario del Sur de la Universidad de Guadalajara*, *Ciudad Guzmán, Jalisco, México*, [2]*Centro Universitario de Ciencias Biológicas y Agropecuarias de la Universidad de Guadalajara*, *Las Agujas, Jalisco, México*, [3]*Instituto Nacional de Investigaciones Agricolas y Pecuarias*, *Tecomán, Colima, México*.

The objective of this study was to evaluate the effect of adding an inoculum and an additive handmade in sugar cane silage (SCS) on the in situ digestibility of DM, OM and ruminal pH. Four Holstein cows fitted with rumen cannula (BW 650 ± 50 kg) were randomly assigned to a 3 × 3 Latin square and they were housed in individual pens. Each period was 15 d, 10 for adaptation to experimental diets and 5 to collect samples. The treatments were: T1) sugar cane silage; T2) sugar cane silage with 1% inoculum and 1% additive; T3) sugar cane silage with 3% inoculum and 1% additive. The inoculum consists of 10.0% molasses, 1.0% of yogurt, 5.0% chicken manure, urea 0.5% and 83.0% water and the additive was formulated with 1.0% urea, 0.1% ammonium sulfate and 0.25% phosphorus. There were differences ($P \leq 0.05$) among treatments on the in situ digestibility of DM and OM and ruminal pH (Table 1).The ruminal pH was higher in T1 (7.15) and T2 (6.91) and lower in T3 (6.52). T3 showed higher percentages of DM and OM compared with T2 and control, these results could be explained because the inoculums improve predigestion of nutrients from the sugar cane during the ensiling process. The use of an inoculums and additive on cane sugar silage changes the ruminal pH and disappearance of DM and OM

Table 1. Coefficients of digestibility in situ of DM and OM of experimental materials (%)

Component	T1	T2	T3	SEM
Dry Matter				
96[1]	56.60c	59.99bc	67.11a	1.15
72	52.29b	51.04b	58.22a	0.89
48	51.45b	51.31b	53.79ab	1.08
36	44.08b	49.42a	47.46a	0.66
Organic Matter				
96	47.43b	60.21a	63.16a	2,35
72	56.66b	44.65c	64.28a	0.90
48	45.87c	53.80b	61.90a	1.50
36	47.50c	49.77c	60.30a	1.06

[a,b,c]Different letters in the same row differ ($P < 0.05$).

[1]Hours of incubation.

Key Words: sugar cane, digestibility, additive

M361 The effects of cinnamaldehyde and garlic extract on feed intake and nutrient digestibility by lambs. T. M. Norvell*, B. M. Nichols, T. J. McDonald, M. M. Harbac, and J. A. Paterson, *Department of Animal and Range Sciences, Montana State University*, *Bozeman*.

Three lamb experiments were conducted to evaluate the effects of a commercially available feed additive containing cinnamaldehyde and garlic (CG) on DM intake, DM, NDF and N digestibilities. Experiment one was a 3 × 3 Latin square to determine individual DMI. Twenty-one ewe lambs were randomly assigned to 3 treatments (7 ewes/treatment) in a GrowSafe facility which measures individual feed intake. Diets consisted of 85% ground grass hay and 15% supplement. Dietary treatments were control (no CG), 70 ppm CG, and 140 ppm CG. For each period, individual DMI was measured for 10-d with no adaptation to diets. Average DMI was similar ($P = 0.82$) for the 3 treatments (average = 2.3 kg/d). For Exp. 2, 24 wether lambs were placed in individual metabolism crates and randomly assigned to treatments to measure nutrient digestibility. Wethers were again fed increasing levels of CG. Diets consisted of 77% ground grass hay and 23% supplement. Treatments compared were control (no CG) and diets with 20, 40, or 80-ppm dietary CG. Wethers were fed diets at 3.3% of BW for 10-d of adaptation followed by 6-d fecal collection. The CG did not change DM ($P = 0.99$), NDF ($P = 0.90$) or N digestibilities ($P = 0.82$). Experiment 3 was designed as a 2 × 2 factorial arrangement of treatments using 24 wethers housed in individual metabolism crates. Main effects evaluated were 85% roughage (grass hay) vs. 85% concentrate (corn), and 0 vs. 80 ppm dietary CG. Wethers were offered diets at 2.7% of BW for 18-d of diet adaptation followed by 5-d of feces collection. There were no CG × forage level interactions and CG did not change DM ($P = 0.69$), NDF ($P = 0.33$), or N digestibilities ($P = 0.46$). Average DMI was greater ($P < 0.05$) for the 85% forage diets compared with 85% concentrate diets. Results indicate that at the levels offered, CG did not negatively affect DMI and had no affect on nutrient digestibility.

Key Words: cinnamaldehyde, garlic, feed intake

M362 Interaction of rumen pH, cinnamaldehyde and eugenol mixture and capsicum oleoresin on in vitro fermentation pattern and methane production. D. Bravo[1], S. Calsamiglia*[2], N. D. Pyatt[3], and P. H. Doane[3], [1]*Pancosma*, *Geneva, Switzerland*, [2]*Universitat Autonoma de Barcelona*, *Spain*, [3]*ADM Research*, *Decatur, IL*.

A 2 × 3 factorial arrangement of treatments was used to investigate the interaction between 2 sources of rumen inocula and inclusion of plant extracts on in vitro rumen fermentation and methane. Plant extracts were control (no extract) a mixture of eugenol and cinnamaldehyde (CIE, XT 6965, Pancosma,250 mg/L) or an oleoresin of capsicum (CAP, XT 6933, Pancosma, 250 mg/L). Rumen inocula was obtained from either dairy cows (50:50 forage:concentrate diet, pH 7.0) or beef cattle (10:90 forage:concentrate diet, pH 5.0). Each treatment was tested in triplicate and repeated in 2 periods. Fifty milliliters of a 1:1 ruminal fluid-to-buffer solution were introduced into polypropylene tubes supplied with 0.5 g of DM of DDGS and incubated for 24 h at 39°C. Samples were collected for ammonia N, VFA concentrations and methane analysis. Results were analyzed using SAS, and significant differences declared at $P < 0.05$. The beef-type fermentation resulted in lower total VFA (155.3 mM, −16%), acetate (45.4 mol/100mol, −25%) and butyrate (6.8 mol/100mol, −29%) proportions, reduced acetate to propionate ratio (1.26, −53%), ammonia-N (16.0 mg N/dL, −15%) and methane (18.7 µL/L, −48%) concentrations, and higher propionate proportion (36 mol/100mol, +61%). Using beef inocula, inclusion of CIE increased total VFA (+12%) and the proportion of propionate (+24%), and decreased methane (−18%) concentration. When dairy rumen inocula was used, CIE increased propionate proportion (+25%) and decreased acetate proportion (−8%), the acetate to propionate ratio (−25%), and methane production (−38%). For both inocula environments, CAP had little effect, agreeing with earlier research where the main effect for CAP being reported for DMI and feeding behavior. These results indicated that the mixture CIE reduced methane production in vitro, and that the effect was larger in a dairy-type environment without addition of CAP, compared with the beef-type environment.

Key Words: essential oils, methane, in vitro

M363 Influence of condensed tannin supplementation on intake, ruminal and total digestibility, rate of digestion, and urinary excretion of urea and total nitrogen of beef steers fed high concentrate diet. R. Mezzomo*[1], P. V. R. Paulino[1], S. C. Valadares Filho[1], J. P. I. S. Monnerat[1], G. S. Viana[1], M. G. Machado[1], J. C. M. Lima[1], T. S. Martins[1], P. Lencioni[2], and D. Grandini[3], [1]*Universidade Federal de Viçosa*, *Viçosa, MG, Brazil*, [2]*Silva Team*, *Buenos Aires, Argentina*, [3]*Nutron*, *Itapira, SP, Brazil*.

This trial was conducted to evaluate the effect of condensed tannin (TN) associated or not with a true protein source on intake, ruminal and total digestibility, ruminal digestion rate and urinary nitrogen excretion in beef steers fed high concentrate diet (87% of DM). Four crossbred steers (407 kg BW) fitted with rumen cannula were assigned to a 4x4 latin square design, arranged in a 2x2 factorial arrangement. Steers were fed a basal diet based on cracked corn, whole cottonseed, sugar-cane bagasse, mineral mixture and one out of 4 supplements: soybean meal with condensed tannin (SMT); soybean meal without condensed tannin (SM); condensed tannin without soybean meal (TN) and a treatment without both soybean meal and condensed tannin (BS). Quebracho extract were used as tannin source, included to provide 4 g of tannin/100 g of diet DM and all diets were formulated to be isonitrogenous. Intake of DM and nutrients was not affected ($P > 0.10$) by TN supplementation. However, there was an effect ($P < 0.10$) of TN supplementation on ether extract digestibility. A smaller ($P < 0.10$) excretion of urinary urea nitrogen (71.94 vs. 53.62 g) and total nitrogen (86.43 vs. 74.07 g) was observed in the animals supplemented with TN. Serum urea nitrogen concentration did not differ ($P > 0.10$) among treatments. There was an interaction ($P < 0.10$) between condensed tannin and soybean mean on ruminal digestibility and digestion rate of crude protein (CP).

When soybean meal was provided in the diet TN caused a reduction on CP ruminal digestibility from 46.92 to 33.46%, leading to a smaller digestion rate of CP. No differences in DM passage rate were observed ($P > 0.10$) among treatments. Urinary urea nitrogen and total nitrogen excretions were higher in the animals supplemented with soybean meal. The use of condensed tannin as an additive in cattle fed high concentrate diet using soybean meal as true protein source decreases the digestion rate and ruminal degradability of crude protein without affecting feed intake.

Key Words: feedlot, protein, RUP

M364 Effect of Copaiba (*Copaifera* sp.) oils on in vitro rumen fermentation of coastcross hay. R. C. Araujo*[1], A. V. Pires[1], A. L. Abdalla[2], M. R. S. R. Peçanha[2], and A. S. Morsy[2], [1]*ESALQ, Universidade de São Paulo*, *Piracicaba, SP, Brazil*, [2]*CENA, Universidade de São Paulo*, *Piracicaba, SP, Brazil*.

Copaiba oils have antimicrobial properties and are obtained from the trunk of *Copaifera* sp. trees. A randomized complete block design was used to determine the effects of *C. reticulata*, *C. multijuga*, and *C. langsdorfii* oils on rumen fermentation of coastcross (*Cynodon* sp.) hay by using an in vitro gas production (GP) system. Treatments were control (CTL), pure monensin at 3 µM (MON), and 75 or 150 µL of *C. reticulata*, *C. multijuga*, or *C. langsdorfii* oil. In each flask (160 mL), 0.5 g of hay (91.3% DM) was incubated with 50 mL of medium and 25 mL of rumen fluid at 39°C for 24h. Replicates were n = 6 for GP and n = 3 for all other variables. Two inocula (from 3 lambs each) were used as source of variation. PROC Mixed of SAS was used and differences declared when $P < 0.05$. By GC/MS analysis, major secondary compounds in oils were *C. reticulata* – trans-caryophyllene (50.2%) and α-humulene (8.1%); *C. multijuga* – trans-caryophyllene (21.9%), α-trans-bergamotene (11.4%), and β-bisabolene (9.1%); *C. langsdorfii* – trans-caryophyllene (56.5%) and α-humulene (9.4%). MON decreased GP (117.5 vs. 103.7 mL), CH_4 production (13.0 vs. 9.8 mL), CH_4 to gas ratio (0.1100 vs. 0.0943), and truly degraded dry matter (TDDM; 57.4 vs. 50.9%) when compared with CTL. MON did not affect total SCFA and C_2 concentrations, but increased C_3 concentration (12.3 vs. 14.0 mM) and decreased C_4 concentration (8.6 vs. 7.5 mM) when contrasted with CTL. All Copaiba oils at 150 µL had lower GP than CTL. However, TDDM was reduced by all Copaiba oils in both doses. The CH_4 production and CH_4 to gas ratio did not differ between *Copaifera* sp. oils and CTL. Total SCFA, C_2, and C_3 concentrations, as well as C_2 to C_3 ratio were also not influenced by *Copaifera* sp. oils. The only exception was *C. reticulata* oil at 75 µL, which showed a greater C_3 concentration than CTL (12.3 vs.13.0 mM). All treatments showed similar results for ammonia concentration. Results indicate that *Copaifera* sp. oils decreased in vitro DM degradability with minimal effects on fermentation profile of coastcross hay.

Key Words: methane, plant extracts, plant secondary compounds

M365 Effects of garlic oil on methane production, microbial growth and diet fermentation in Rusitec fermenters. M. D. Carro*[1,2], M. L. Tejido[1,2], C. Saro[1,2], and M. J. Ranilla[1,2], [1]*Dept. Producción Animal, Universidad de León*, *24071 León, Spain*, [2]*Instituto de Ganadería de Montaña (CSIC-ULE)*, *Finca Marzanas, 24346 Grulleros, León, Spain*.

Garlic oil (GAR) has been shown to reduce methane production in the rumen, but little is known about its effects on ruminal microbial growth. Two 15-d incubation runs were conducted with 4 Rusitec fermenters to investigate the effects of GAR on ruminal microbial growth and fermentation of a 50:50 alfalfa hay:concentrate diet. Each fermenter received daily 30 g of diet DM. In each run, 2 fermenters received daily 100 mg of GAR dissolved in 0.7 mL of ethanol (180 mg of GAR / L of fermenter content) and 2 received 0.7 mL of ethanol (control). After 11 d of GAR treatment, the main fermentation parameters were determined during 3 consecutive days. Microbial growth was determined on d 15 using 15N as a microbial marker.

No effect of GAR ($P > 0.05$) was observed on dry matter degradability (61.9 vs. 62.3% for control and GAR, respectively), neutral detergent fiber degradability (44.6 vs. 45.9%) and daily production of total volatile fatty acids (VFA; 100 vs. 103 mmol) and ammonia-N (210 vs. 221 mg). The GAR increased the molar proportion of propionate ($P = 0.02$; 17.5 vs. 14.9%), decreased butyrate proportion ($P < 0.001$; 14.6 vs. 17.2%), and tended to decrease the proportion of acetate ($P = 0.07$; 53.6 vs. 54.5%). Fermenters receiving GAR showed greater ($P < 0.001$) proportions of isobutyrate, valerate and caproate compared with controls. Daily production of methane was reduced ($P < 0.001$) by 10.8% by GAR, resulting in lower ($P = 0.002$) methane/VFA ratios in GAR treated fermenters compared with controls. Microbial growth tended to be greater ($P = 0.09$) in fermenters receiving GAR (247 vs. 237 mg of microbial N/d), but its efficiency was similar in all fermenters ($P = 0.12$; 25.5 vs. 23.0 mg of microbial N / g organic matter apparently fermented). Supplementation of GAR to fermenters was an effective means to reduce methane production without negatively affecting microbial growth, diets degradability or VFA production.

Key Words: garlic oil, methane, Rusitec fermenters

M366 Effect of Copaiba (*Copaifera* sp.) oils on in vitro rumen fermentation of a high-concentrate diet. R. C. Araujo*[1], A. V. Pires[1], A. L. Abdalla[2], L. A. Castilho[2], and R. C. Lucas[2], [1]*ESALQ, Universidade de São Paulo*, *Piracicaba, SP, Brazil*, [2]*CENA, Universidade de São Paulo*, *Piracicaba, SP, Brazil*.

Copaibas (*Copaifera* sp.) are Brazilian trees whose oil extracted from the trunk shows antimicrobial properties. A randomized complete block design was used to determine the effects of *C. reticulata*, *C. multijuga*, and *C. langsdorfii* oils on rumen fermentation of an 80:20 concentrate:forage diet by using an in vitro gas production (GP) system. Treatments were: control (CTL), pure monensin at 3 µ*M* (MON), and 75 or 150 µL of *C. reticulata* (RET75 and RET150), *C. multijuga* (MLT75 and MLT150), or *C. langsdorfii* (LNG75 and LNG150) oil. In each flask (160 mL), 0.5 g of diet (91.4% DM) was incubated with 50 mL of medium and 25 mL of rumen fluid at 39°C for 16 h. Replicates were n = 6 for GP and n = 3 for all other variables. Two inocula from lambs (n = 3 each) adapted to the incubated diet were used as source of variation. The PROC Mixed of SAS was used with differences declared when $P < 0.05$. By GC/MS analysis, major secondary compounds in oils were RET – trans-caryophyllene (50.2%) and α-humulene (8.1%); MLT – trans-caryophyllene (21.9%), α-trans-bergamotene (11.4%), and β-bisabolene (9.1%); LNG – trans-caryophyllene (56.5%) and α-humulene (9.4%). Compared with CTL, MON decreased GP (160.3 vs. 147.5 mL) and CH_4 production (16.3 vs. 13.8 mL) as well as truly degraded dry matter (TDDM; 81.5 vs. 77.9%). MON did not affect total SCFA and C_2 concentrations, but increased C_3 concentration (17.9 vs. 21.3 m*M*) and decreased C_2 to C_3 ratio (2.67 vs. 2.21) when compared with CTL. MLT75 (164.8 mL), LNG75 (167.7 mL), and LNG150 (165.5 mL) had greater GP than CTL (160.3 mL). No effects were observed for all oils on CH_4 production, CH_4 to gas ratio, and TDDM. Compared with CTL, LNG150 showed greater total SCFA (89.9 vs. 98.7 m*M*) and

C_2 (48.0 vs. 53.9 m*M*) concentrations. RET75, RET150, and LNG150 showed greater C_3 concentration (19.1, 19.3, 18.9 m*M*, respectively) when contrasted with CTL (17.9 m*M*). All oils did not affect C_2 to C_3 ratio. Copaiba oils affected rumen fermentation of a high-concentrate diet without effects on methanogenesis. *C. langsdorfii* oil at 150 µL showed the most positive effects by increasing total SCFA concentration.

Key Words: methane, plant extracts, plant secondary compounds

M367 Effects of supplemental poultry fat on calves grazing bermudagrass pasture. J. G. Powell*, T. J. Wistuba, and E. B. Kegley, *University of Arkansas*, *Fayetteville*.

Bermudagrass is a warm season perennial found throughout the southeastern US If fertilized, bermudagrass can contain adequate crude protein for growing cattle, but energy is often limiting for maximal growth rates. Supplementing grain will increase energy intake; although at high rates of supplementation grain can cause decreased forage intake. The objective of this experiment was to evaluate the effect of adding poultry fat to a grain supplement on growth performance of calves grazing bermudagrass; the supplemental fat could make a more energy dense, beneficial, supplement or alternatively the added fat could impair rumen fiber digestion and thus reduce forage intake. Sixty calves (228 ± 3.2 kg, 30 heifers and 30 steers) were obtained from a single source. Calves were stratified by sex and weight and assigned randomly to 6 2.4-ha pastures. Pastures were assigned randomly to receive 1 of 2 treatments. The 2 treatments were corn-soybean meal supplements with 0 or 5% poultry fat. Supplements were formulated to be isonitrogenous (17% CP, DM basis). Calves were offered 1.1 kg/d of the appropriate supplement for the 140-d trial. Calves were weighed and forage availability in the pastures was measured at 28-d intervals. Cattle growth and forage availability were analyzed using the mixed procedures of SAS with pen as the experimental unit. Pregnancy data were analyzed using the GENMOD procedures of SAS with heifer as the experimental unit. Supplemental poultry fat did not affect final BW (337 vs. 336 kg, $P = 0.76$) or ADG ($P = 0.86$). No differences were detected in available forage due to dietary treatment (treatment × day interaction, $P = 0.43$). After the trial, heifers were kept as a single group, fed a common diet, and bred. There was no effect of supplemental fat during the growing phase on the number of heifers that became pregnant (53 vs. 43%, $P = 0.72$). Adding 5% poultry fat to the grain supplement fed to growing cattle grazing bermudagrass had no impact on growth.

Key Words: growing cattle, poultry fat, bermudagrass

M368 Studying the effect of different direct fed microbials on rumen fermentation in vitro. D. Barrau, M. Quintino Cintora, and N. D. Walker*, *Lallemand Animal Nutrition*, *Montreal, QC, Canada*.

Direct-fed microbials (DFMs) are commonly used in the beef feedlot industry to improve host health and productivity. The aim was to study the effect on rumen fermentation of a live yeast DFM Levucell SC (LSC), and 2 bacterial DFM products; one containing *L. buchneri* (MLB); the other a mixture of *L. buchneri* and *L. acidophilus*, (MLB+LA) with incubations which had no added DFM. Rumen contents were removed before feeding from 3 steers fed a finishing diet (70% high moisture corn, 15% DDGs, 10% alfalfa hay) and pooled. Strained contents (SRF) were mixed with anaerobic buffer (1:1) and used to set up triplicate batch incubations containing either glucose, corn starch or ground corn, +/− the test DFMs. Bacterial DFMs were added at a final cfu/ml of 1 × $10e^{05}$, yeast at 1 × $10e^{06}$. At 0, 3, 6, 9 and 24 h, gas production and pH were measured and samples removed for VFA and lactate analysis. To determine the effect of the 3 DFMs on fiber digestion, the %DM and %NDF disappearance of samples of wet (WDG) and dry Distillers grains (DDG) (+/− solubles), wet corn gluten (CG), alfalfa hay (AH) and the mixed ration (MR) the animals were fed, was measured using the Daisy fermentor. Incubation jars, including a control (no addition) were set up by mixing SRF with anaerobic buffer (1:4). Each DFM was added to a jar along with filter bags containing a known amount of each substrate. Triplicate bags were removed at 0, 3, 6, 12 and 24h and analyzed for fiber content. All incubations were repeated on 2 different days. Compared with control, all 3 DFMs reduced the accumulation of lactate from corn starch at 9 and 24h ($P < 0.008$) and significantly reduced lactate accumulation from ground corn at 6 h ($P < 0.05$). No effect of the DFMs on gas production or pH was seen. The effects on fiber digestion were DFM, substrate and time dependent. MLB significantly increased %NDFd of DDGs at 6 and 12h and MR at 3 and 24h ($P < 0.05$). LSC increased %DMd and %NDFd of CG by 24 h ($P < 0.05$). All 3 DFMs increased %NDFd of WDGS ($P < 0.05$) in the later part of the incubation. No significant effect was observed on the other substrates tested. To conclude, DFMs may help reduce lactate accumulation and improve fiber digestion.

Key Words: DFM

M369 Effect of a commercial microbial inoculant (Promote) on corn silage and animal performance. C. J. Fruge*, F. M. LeMieux, W. A. Storer, and T. H. Shields, *McNeese State University*, *Lake Charles, LA*.

An experiment was conducted to evaluate the efficacy of a commercial microbial inoculant (Promote) for corn silage and the subsequent effect on heifer performance. The 3 experimental treatments were: 1) no inoculant (control), 2) inoculant (100,000 CFU per gram of corn silage), and 3) inoculant (50,000 CFU per gram of corn silage). Promote was applied to corn silage as a liquid suspension during the ensiling process in horizontal poly bags. Silage samples were collected at d 0, 7, 14, 21, and 61 relative to ensiling. Samples were analyzed (Analab, Fulton, IL) for chemical composition for each treatment. Levels of lactic acid increased while pH decreased in both treatments of inoculated silage. A growth study with developing heifers, (n = 225) average initial wt 261 kg, was initiated at d 135 post ensiling. After a 14 d acclimation to feeding, heifers were randomly allotted (n = 75) to receive one of the 3 treatments as the forage component of their diet. Heifers were weighed on d −14, 0, 21, 55, and 86 to obtain ADG. Heifers consuming diets treated with Promote had increased ($P < 0.01$) ADG during the first month. Subsequently, heifers receiving the untreated silage excelled. Overall ADG between heifers receiving treatments 1 and 2 became similar ($P > 0.1$) by d 86 and were greater than ($P < 0.01$) heifers receiving treatment 3.

Key Words: silage, inoculant, heifer

M370 Effects of Fibrozyme on in vitro ruminal digestion and fermentation of a corn and wet distillers-based finishing beef diet with and without monensin. J. M. Tricarico, M. A. Witt, and J. S. Jennings*, *Alltech, Inc.*, *Brookings, SD*.

Two in vitro ruminal fermentation experiments were conducted to analyze the effects of a fibrolytic enzyme (Fibrozyme, Alltech Inc.) dose on digestibility of a corn and wet distillers-based finishing diet with or without monensin. Diets were a conventional finishing diet containing monensin at 50 µg/g of substrate (CONV) or a natural finishing diet with no monensin (NAT). The diet substrate (0.5g) was weighed in an Ankom bag and placed in a sealed 200 mL glass bottle. Bottles were flushed with

CO_2 and 100 mL of a 20% rumen fluid 80% buffer solution was added to begin the 72 h incubation period. Rumen fluid was collected from a single Holstein cow, receiving a common dairy TMR. During Exp. 1, the CONV and NAT diets with and without Fibrozyme at 0, 0.6, and 1.2 mg/mL of inoculum were compared. Fibrozyme was then applied to the NAT diet at 0, 0.6, 1.2, and 1.8 mg/mL of inoculum in Exp. 2. Enzyme by diet interactions occurred ($P < 0.05$) for true DM (TDMD) and NDF digestibility (NDFD) in Exp. 1. Fibrozyme increased TDMD (87.4, 88.7, and 89.1%) and NDFD (26.1, 33.7, and 36.1%) linearly ($P < 0.05$) in the CONV diet but only the highest dose increased TDMD (86.0 vs. 87.0%) and NDFD (30.3 vs. 35.4%) in the NAT diet. After elevating the dose further in the NAT diet (Exp. 2), the increases in TDMD (86.0 vs. 89.0 and 89.1%) and NDFD (25.8 vs. 41.8 and 42.3%) were similar for 1.2 and 1.8 mg/mL of supplemental Fibrozyme inclusion. In addition, 1.8 mg/mL of supplemental Fibrozyme increased ($P < 0.05$) final culture pH (6.51 vs. 6.56) and reduced butyrate molar proportions (0.183 vs. 0.173). Fibrozyme inclusion also tended ($P = 0.06$) to increase the fractional rate of degradation linearly (0.065, 0.073, 0.077, and 0.079 h-1). These results are consistent with our hypothesis that Fibrozyme will increase digestibility in finishing feedlot diets with a lower effective dose of Fibrozyme in the presence of monensin.

Key Words: fibrolytic enzyme, digestibility, finishing diet

M371 Influence of condensed tannin supplementation on protein efficiency, microbial protein yield, nitrogen balance and ruminal fermentation characteristics in beef steers fed high concentrate diet. R. Mezzomo*[1], P. V. R. Paulino[1], M. S. Duarte[1], L. S. Moura[1], L. H. P. Silva[1], E. San Vito[1], L. D. A. Rufino[1], C. Cabral[2], D. Grandini[3], and S. C. Valadares Filho[1], [1]*Universidade Federal de Viçosa*, *Viçosa, MG, Brazil*, [2]*Silva Team*, *Buenos Aires, Argentina*, [3]*Nutron*, *Itapira, SP, Brazil*.

This trial was conducted to evaluate the effects of condensed tannin (TN) associated or not with a true protein source on protein efficiency, microbial protein yield, nitrogen balance and ruminal fermentation characteristics (RFC) in beef steers fed high concentrate diet (87% of DM). Four crossbred steers (407 kg BW) fitted with rumen cannula were assigned to a 4x4 latin square design, arranged in a 2x2 factorial arrangement. Steers were fed a basal diet based on cracked corn, whole cottonseed, sugar-cane bagasse, mineral mixture and one out of 4 supplements: soybean meal with condensed tannin; soybean meal without condensed tannin; condensed tannin without soybean meal and a treatment without both soybean meal and condensed tannin. Quebracho extract were used as tannin source, included to provide 4 g of TN/100 g of diet DM and the diets were formulated to be isonitrogenous. The nitrogen balance indicated that the use of TN improved the efficiency of nitrogen utilization ($P < 0.10$), however, no differences were observed when soybean meal was added to the diet ($P > 0.10$). There was an interaction ($P < 0.10$) between condensed tannin and soybean mean supplementation on the flux of rumen undegradable protein (RUP), metabolizable protein (MP) and on the ratio MP:CP. In the presence of soybean meal the addition of TN increased the flux of RUP (302.24 to 416.02 g/d), MP (540.23 to 671.03 g/d) and improved the ratio MP:CP (58.69 to 46.54). Microbial protein yield and microbial efficiency did not differ among treatments ($P > 0.10$). There was no effect of TN supplementation ($P > 0.10$) on ruminal pH, VFA and ammonia (N-NH3) concentration. N-NH3 increased and ruminal pH decreased with the inclusion of soybean meal ($P < 0.10$) in the diet. The utilization of condensed tannin as an additive in cattle fed high concentrate diet using soybean meal as true protein source implies in positive effects on efficiency of N utilization, increasing the flux of metabolizable protein.

Key Words: Quebracho extract, feedlot, RUP

M372 Effects of supplementing an exogenous proteolytic enzyme on growth performance in growing beef steers. J. M. Vera[1], C. T. Noviandi*[1], Arief[2], J.-S. Eun[1], and D. R. ZoBell[1], [1]*Department of Animal, Dairy, and Veterinary Sciences, Utah State University*, *Logan,* [2]*Faculty of Animal Science, Andalas University*, *Padang, West Sumatra, Indonesia*.

An exogenous proteolytic enzyme (EPE) has been previously found to increase in vitro NDF degradability of dried distillers grains with solubles (DDGS). To further investigate the effects of EPE, 48 Angus crossbred growing beef steers (292 ± 25.2 kg BW) were used to assess the growth performance when fed a DDGS-based TMR diet without or with an EPE supplementation in a completely randomized design. The growing TMR diet consisted of 13.6% alfalfa hay, 50.3% corn silage, 30.7% DDGS, and 5.4% feedlot supplement (DM basis). The EPE contained 38,622 U/g protease activity with negligible fibrolytic activities. The EPE was diluted with water and added at a rate of 0.52 g/kg DM TMR as it was mixing for the group of EPE treatment. Four animals were placed in each pen, and 6 pens allocated to each treatment. All steers were adapted to the TMR diet for a 2-week period before start of the trial. Feed was offered for ad libitum consumption once daily at 0800 h with free access to water. Feed intake was measured weekly, and individual BW of steers was recorded on 2 consecutive days at the beginning of trial and wk 4 and 8. The experiment lasted 56 d, and data were analyzed using the MIXED procedure of SAS. There were no significant differences ($P > 0.10$) for final BW (398 vs. 401 kg), BW gain (107 vs. 108 kg), and ADG (1.90 vs. 1.93 kg/d) between control and EPE treatment, respectively. Furthermore, EPE supplementation did not affect DM intake (10.5 vs. 10.0 kg/d) and gain to feed ratio (0.191 vs. 0.199). Therefore, supplementation of an EPE product at the dose rate used in this study did not alter growth performance of growing beef steers fed a DDGS-based TMR diet.

Key Words: exogenous proteolytic enzyme, growing beef steers, growth performance

M373 Effects of zinc and chlortetracycline supplements on growth performance, blood metabolites, carcass characteristics, and claw health in young Holstein bulls. H. Fagari-Nobijari[1], H. Amanlou[1], M. Dehghan-Banadaky*[2], and M. H. Shahir[1], [1]*University of Zanjan*, *Zanjan, Iran*, [2]*University of Tehran*, *Karaj, Tehran, Iran*.

This study conducted to evaluate the effects of supplementing finishing diet with zinc and/or chlortetracycline on growth performance and claw health of calves. Holstein bulls (n = 212; initial BW = 375.5 ± 18.4 kg) were randomly allocated to one of 4 treatments in a completely randomized design as a 2 × 2 factorial experiment for 56 d. Dietary treatments include: 1) the basal diet (control); 2) basal diet plus 150 mg of Zn/kg of DM as ZnSO4; 3) basal diet plus chlortetracycline (200 mg/animal/d; CTC); and 4) basal diet plus 150 mg of Zn/kg of DM + CTC (200 mg/animal/d). Animals received fresh total mixed ration for ad libitum. DMI was measured daily. BWs were recorded and blood samples were collected on d 0, 28, and 56. Liver samples were taken on d 56. Ultrasound measurements of backfat thickness (UFAT), rump fat thickness (URPFAT), and longissimus muscle area (ULMA) were made on d 56. All claws of animals were examined every 2 weeks to identify claw lesions. Data were statistically analyzed using the repeated measures option in Proc Mixed of SAS. Zn supplement decreased ADG, G:F, and apparent DM digestibility ($P < 0.01$); however, DMI was not influenced. Dietary CTC improved G:F on d 28 to 56 and decreased DM digestibility, but it did not affect ADG and DMI. Dietary CTC increased plasma total protein and urea nitrogen. Zinc supplementation decreased ULMA. The supplementation of CTC decreased UFAT and URPFAT.

Serum concentration of Zn, Cu, plasma total protein, albumin, alkaline phosphatase, and Zn concentration of liver were affected by the interaction of CTC × Zn. The prevalence of lameness was 14.15% with the highest odds ratio (OR) for lameness in control and Zn supplemented groups (OR = 7.2, 2.53, respectively). In summary, CTC supplementation did not improve ADG and G:F in bulls, however it affected carcass characteristics and improved claw health. Supplemental Zn decreased ADG and G:F and did not decrease lameness.

Key Words: zinc, chlortetracycline, young bulls

M374 The use of copper and chlortetracycline supplements for improving of growth performance, carcass characteristics and claw health in young Holstein bulls. H. Fagari-Nobijari[1], H. Amanlou[1], M. Dehghan-Banadaky*[2], and A. Shabani[3], [1]*University of Zanjan*, *Zanjan, Iran*, [2]*University of Tehran*, *Karaj, Tehran, Iran*, [3]*Tabriz Islamic Azad University*, *Tabriz, Iran*.

Two hundred 12 young Holstein bulls (initial body weight = 375.4 ± 17.1 Kg) were allotted to one of 4 treatments in a completely randomized design as a 2 × 2 factorial experiment for 56 d. treatments include: 1) the basal diet (control); 2) basal diet plus 30 mg of Cu/kg of DM as CuSO4; 3) basal diet plus chlortetracycline (200 mg/animal/d; CTC); and 4) basal diet plus 30 mg of Cu/kg of DM + CTC (200 mg/animal/d). Animals received a fresh total mix ration for ad libitum. DMI was measured daily. The body weights were recorded and jugular blood samples were collected on d 0, 28 and 56. Ultrasound measurements of backfat thickness (UFAT), rump fat thickness (URPFAT), and longissimus muscle area (ULMA) were made on d 56. All claws of young bulls examined every 2 weeks for identifying claw lesions. Data were statistically analyzed using the repeated measures option in Proc Mixed of SAS. Copper supplementation with or without CTC improved average daily gain, gain:feed and it might also influenced carcass characteristics ($P < 0.05$). Serum cholesterol decreased with Cu supplementation. Serum urea nitrogen tended to decrease by CTC supplementation ($P < 0.1$) and serum Ca tended to increase by supplemental of Cu ($P < 0.1$). Cu supplementation decreased UFAT and UPRFAT; however, it increased ULMA. Interaction of Cu × CTC affected UPRFAT ($P > 0.03$); also, UFAT tended to decrease by interaction of Cu × CTC ($P < 0.1$). Supplemental CTC had no effect on ultrasound carcass characteristics. Hip height was similar between treatments. The prevalence of lameness and skin and interdigital space disorders (ID) were high in Cu supplemented bulls compared with CTC group (OR = 2.97 and 1.94, respectively). The prevalence of white line disorders, heel erosion, and sole disorders statistically were not significant. In summary, supplemental Cu may improve carcass characteristics and growth performance of finishing bulls, but it may not prevent lameness. However, lameness decreased when Cu supplementation was used with CTC.

Key Words: copper, chlortetracycline, young bulls

M375 Chlortetracycline supplementation affected carcass characteristics and claw health in young Holstein bulls. H. Fagari-Nobijari[1], M. Dehghan-Banadaky*[2], S. H. Hosseini-Sabeghi[3], H. Amanlou[1], and A. Shabani[4], [1]*University of Zanjan*, *Zanjan, Iran*, [2]*University of Tehran*, *Karaj, Tehran, Iran*, [3]*Ghaemshahr Islamic Azad University*, *Ghaemshahr, Iran*, [4]*Tabriz Islamic Azad University*, *Tabriz, Iran*.

One hundred and 6 young Holstein bulls (initial BW = 376 ± 19.5 kg) were randomly allocated to 2 treatments in a completely randomized design for 56d. Treatment groups received 1) the basal diet with no supplemental chlortetracycline (control) and 2) basal diet plus chlortetracycline (100 mg/animal/d; CTC). Animals received fresh total mix ration for ad libitum allowing 10% orts. Group dry matter intake was measured daily. The Body Weights were recorded and Jugular blood samples were collected on d 0, 28 and 56. Ultrasound measurements of backfat thickness (UFAT), rump fat thickness (URPFAT), and longissimus muscle area (ULMA) were made on d 56. All claws of animals examined every 2 weeks for identifying claw lesions. Chlortetracycline supplementation tended to decrease average daily gain (ADG) ($P = 0.2$) but gain:feed (G:F) did not differ ($P = 0.48$). Also, URPFAT was not affected by treatments ($P = 0.2$). However, CTC tended to decrease UFAT ($P = 0.07$). Statically, young bulls supplemented with CTC did not increase ULMA vs. unsupplemented animals ($P = 0.3$). Supplemental CTC improved serum concentrations of Cu ($P = 0.04$) and Zn ($P = 0.004$) and also, decreased cholesterol ($P = 0.05$) than control. There was no difference between treatments on concentration of plasma IGF-I ($P = 0.4$). The prevalence of lameness was 19.81%. Lameness was most frequently observed in the control group (OR = 4.08). The prevalence of skin and interdigital space disorders (ID) was the greatest cause of lameness in the present study (52.38% of whole lameness) and was higher in control than the other group (OR = 5.17; 42.85% of whole lameness). Statistically, the prevalence of sole disorders (SD), white line disorders (WD), and heel erosion (HE) were not different ($P = 0.56$, 0.33, and 0.56, respectively). In summary, supplemental CTC may decrease growth performance in finishing bulls, however, it may successfully prevent lameness and may alter fat metabolism.

Key Words: chlortetracycline, claw health, young bulls