

## Nonruminant Nutrition: Feed Ingredients/Feed Additives

**754 A partial replacement of soybean meal by whole or defatted algal meal in diet for weanling pigs does not affect their plasma biochemical indicators.** E. Isaacs<sup>\*1</sup>, K. Roneker<sup>1</sup>, M. Huntley<sup>2</sup>, and X. G. Lei<sup>1</sup>, <sup>1</sup>Cornell University, Ithaca, NY, <sup>2</sup>Cellana, Kailua-Kona, HI.

Marine algae have recently emerged as a new exciting source of biofuel. Our objective was to determine effect of supplemental defatted algal biomass from biofuel production on biochemical indicators of protein metabolism in plasma of weanling pigs. A total of 27 weanling pigs (BW = 10.69 ± 0.22 kg) were divided into 3 groups (n = 9/group), and fed a corn-soybean meal basal diet (BD), the BD plus 6.6% whole algal meal, or the BD plus 7.2% defatted algal meal (provided by Cellana, Kailua-Kona, HI) for 6 wk. Plasma urea nitrogen concentration, an indicator of dietary protein utilization efficiency, was not affected by the treatments as the 3 groups of pigs had similar values (mg/L) at Wk 3 (112.4 ± 9.4, 93.3 ± 11.0, and 102.1 ± 9.1) and Wk 6 (163.0 ± 22.1, 170.8 ± 14.7, and 155.9 ± 16.9). There was no group difference in plasma alanine aminotransferase or alkaline phosphatase activity at either time point. Ultrasound scan of vertebral fat and muscle depth of individual pigs at Wk 3 and Wk 6 predicted similar body lean yield (%) among all the 3 groups (Wk 3: 50.7 ± 0.2, 50.8 ± 0.2, and 50.7 ± 0.1; Wk 6: 52.2 ± 0.2, 52.1 ± 0.4, and 52.4 ± 0.1). In conclusion, adding 6.6% of whole algal meal or 7.2% of defatted algal meal into a corn-soy basal diet for weanling pigs effectively replaced the same amount of soybean meal without adverse effect on the biochemical indicators of protein metabolism or health.

**Key words:** algae, biofuel, pigs, protein, ultrasound

**755 Effects of soybean meal of different origins and micronization of high protein soybean meal on nutrient digestibility and productive performance of weanling pigs.** J. D. Berrococo, E. A. Monteserin, L. Cámara, M. P. Serrano, R. P. Lázaro, and G. G. Mateos<sup>\*</sup>, Universidad Politécnica de Madrid, Madrid, Spain.

The effects of the inclusion in the diet of a regular soybean meal (R-SBM, 44% CP) or a high protein SBM (HP-SBM, 49% CP), and the degree of grinding of the HP-SBM, on apparent total tract digestibility and growth performance of piglets from 27 to 56 d of age were studied. There were 6 diets in pellet form with similar nutrient content based on 6 different sources of SBM that supplied in all cases, 6.5% of dietary CP. There was a diet that included 15.8% R-SBM, a diet that included 10% soy protein concentrate (SPC) in substitution of the R-SBM, and 4 additional diets arranged factorially with 2 sources of HP-SBM (USA or Argentinean origin) ground or micronized (geometric mean diameter of 881 or 60 µm). Each treatment was replicated 8 times (6 pigs per pen). Adequate orthogonal comparisons were performed to test the effects of SPC, type of SBM, and the micronization of the HP-SBM on the traits studied. From 28 to 56 d of age, diet did not affect growth performance, but piglets fed the micronized HP-SBM had better G:F ( $P \leq 0.05$ ) from 28 to 35 d of age and ADFI ( $P = 0.06$ ) from 35 to 42 d of age than piglets fed the ground HP-SBM. In general, nutrient digestibility was higher for the SPC than for the R-SBM with the HP-SBM being intermediate. In fact, N digestibility was higher (84.1 vs. 81.4%;  $P \leq 0.01$ ) for the SPC than for the R-SBM containing diets and that of DM (82.2 vs. 81.1%;  $P \leq 0.05$ ) and OM (86.0 vs. 84.9%;  $P \leq 0.05$ ) was higher for the HP-SBM than for the R-SBM. However, micronization of the SBM did not affect nutrient digestibility. It is concluded that the inclusion of SPC in the diet in sub-

stitution of R-SBM improved N digestibility but did not affect growth performance. Micronization of SBM did not affect nutrient digestibility but improved G:F during the first wk post-weaning but not thereafter. Under the conditions of the present experiment, the inclusion of added value soy products in piglet diets presents slight advantages over the use of R-SBM but further economical studies are required.

**Key words:** nutrient digestibility, soy products, piglet performance

**756 Effects of adding cracked corn to a pelleted supplement for nursery and finishing pigs.** C. B. Paulk<sup>\*1</sup>, A. C. Fahrenholz<sup>1</sup>, J. M. Wilson<sup>1</sup>, L. J. McKinney<sup>1</sup>, J. D. Hancock<sup>1</sup>, K. C. Benhke<sup>1</sup>, J. C. Ebert<sup>2</sup>, and J. J. Ohlde<sup>2</sup>, <sup>1</sup>Kansas State University, Manhattan, <sup>2</sup>Key Feeds, Clay Center, KS.

Two experiments were completed to determine the effects of feeding ground and cracked corn with a pelleted supplement to nursery and finishing pigs. For both experiments, treatments were corn-soybean meal-based and fed as mash, pellets, and pellets with 50% of the corn (ground or cracked) blended into the diet after the rest of the formulation (the supplement) had been pelleted. In Exp. 1, a total of 224 nursery pigs (avg BW of 7.4 kg) were used with 7 pigs/pen and 8 pens/treatment. For the 28-d experiment, pigs fed mash had greater ( $P < 0.03$ ) ADG and G:F compared with pigs fed the other treatments. However, this resulted from adding ground or cracked corn outside the pellets (complete pellets vs corn and pelleted supplement,  $P < 0.001$ ). In Exp. 2, a total of 252 finishing pigs (avg BW of 40 kg) were used with 7 pigs/pen and 9 pen/treatment. For the 80-d experiment, pigs fed mash had lower ( $P < 0.03$ ) ADG compared with pigs fed diets with pellets. Pigs fed complete pellets had greater ( $P < 0.03$ ) ADG and G:F compared with pigs fed corn and the pelleted supplement and pigs fed the supplement blended with cracked corn had greater ( $P < 0.02$ ) ADG than pigs fed the supplement blended with ground corn. With hot carcass weight used as a covariate, dressing percentage of pigs fed mash was greater than for pigs fed the other treatments with no differences for fat thickness or percentage fat free lean index among pigs (FFLI) fed the various treatments ( $P > 0.13$ ). In conclusion, adding ground or cracked corn to a pelleted supplement had negative effects on growth performance compared with feeding a complete pellet.

**Table 1.**

Item	Mash	Pellet	Ground Corn	Cracked Corn	SE
Nursery (d 0 to 28)					
ADG, g	510	498	487	473	12
G:F, g/kg	719	759	660	643	12
Finishing					
ADG, g	1,045	1,107	1,055	1,094	11
G:F, g/kg	393	408	384	380	6
Dress, %	74.5	74.1	74.5	73.8	0.1
Fat thickness, mm	18.9	19.5	19.9	18.7	0.5
FFLI, %	52.2	51.7	51.6	52.2	0.3

**Key words:** cracked corn, pellet, pig

**757 Inulin, alfalfa and citrus pulp in diets for piglets: Effects on digestibility and metabolism of N.** S. Brambillasca<sup>\*1</sup>, E. Menezes<sup>1</sup>, P. Zunino<sup>2</sup>, and C. Cajaville<sup>1</sup>, <sup>1</sup>Departamento de Nutrición Animal, Facultad de Veterinaria, UdelaR, Montevideo, Montevideo, Uruguay, <sup>2</sup>Departamento de Microbiología, Instituto de Investigaciones Biológicas Clemente Estable, MEC, Montevideo, Montevideo, Uruguay.

The addition of fibrous components in the diet of pigs may reduce the N output in feces and urine. So, the aim of this work was to evaluate the effect of the inclusion of inulin, alfalfa, and citrus pulp in diets for piglets on N digestibility and metabolism. Twenty 4 cross-breed piglets (12.1 ± 1.7kg BW) in a randomized complete block design were housed in metabolic cages and assigned to one of 4 treatments: corn and soybean meal based diet (CO; 3.56% N), 97% CO+3% inulin (IN; 3.08% N), 95.5% CO+4.5% fresh alfalfa (AL; 3.06% N) and 95.5% CO+4.5% fresh citrus pulp (CP; 2.94% N) in DM basis. The experiment consisted of an 11 d adaptation period followed by 5 d of feces and urine collection. Diets, feces and urine were analyzed for N, and digestibility, fecal and urinary output, retention, excretion and utilization of N were calculated. Data were analyzed by PROC MIXED considering treatment effect and means were separated by orthogonal contrasts. Pigs fed CO presented the highest intake, digestibility, retention and utilization of N; these parameters were reduced when additives were included to diets. Urinary N output and total N excretion was higher for animals consuming AL. The low N utilization when animal received AL could be related to a higher N urinary output. Lower N digestibilities could be associated to the inclusion of fibrous components in AL and CP diets. Acknowledgments: ANII for scholarship of the first author.

**Table 1.** Effect of diets on N digestibility and balance

	Treatment				SEM	P-value		
	CO	IN	AL	CP		CO vs ADDIT	IN vs AL+CI	AL vs CI
N intake (g/d)	24.1	20.3	18.6	19.5	1.97	0.05	ns	ns
N digest.	0.86	0.82	0.79	0.80	0.02	0.03	ns	ns
Fecal N output (g/d)	3.5	3.6	3.8	3.7	0.40	ns	ns	ns
Urinary N output (g/d)	1.9	1.8	4.0	2.0	0.59	ns	ns	0.02
N retention (g/d)	18.7	15.0	10.9	13.8	1.77	0.01	ns	ns
N excretion (g/d)	5.5	5.4	7.7	5.7	0.72	ns	ns	0.05
N utilization (%)	77.1	74.1	57.0	69.8	4.21	0.02	0.03	0.02

ADDIT: additives; P: probability of contrasts ( $P \leq 0.05$ ).

**Key words:** fiber, nitrogen balance, swine

**758 Nannochloropsis oculata meal did not alter nutrient usage and had no adverse health effects when fed to rabbits as a protein source.** B. A. Howe<sup>\*1</sup>, I. N. Roman-Muniz<sup>1</sup>, B. D. Willson<sup>2</sup>, and S. L. Archibeque<sup>1</sup>, <sup>1</sup>Colorado State University, Department of Animal Sciences, Fort Collins, <sup>2</sup>Colorado State University, Department of Mechanical Engineering, Fort Collins.

Twenty-four adolescent male New Zealand White rabbits were used (n = 12/treatment) to evaluate the safety and potential animal feed use of *Nannochloropsis oculata* algae meal that remained after oil extraction for biodiesel production. Algae meal was included at 10% (DM basis) to a test diet that was isocaloric and isonitrogenous to the control diet (with no algae meal). Rabbits had ad-libitum access to feed for 45 d, including a 7 d. transition period to the Control and Algae diets. Body weights were recorded every 7 d. Blood was drawn via an ear puncture on d 0 and 28 of the study and analyzed for metabolites. A nutrient balance trial was conducted from d 28 through 35. On d 45 of the study, the rabbits were euthanized, blood was collected via a heart puncture, organs were weighed, and histological samples were collected. Intake of DM (194.9 v. 180.3 g/d), N (6.21 v. 5.68 g/d) and NDF (83.6 v. 76.8 g/d) were similar ( $P > 0.05$ ) across treatments. Intake of ADF (53.41 vs. 42.72 g/d) was greater ( $P < 0.01$ ) for the rabbits fed the Control diet than those fed the Algae diet. Subsequently, apparent ADF digestibility was decreased ( $P = 0.03$ ) for rabbits consuming the Algae diet compared with the Control. Total N excretion (4.41 v. 3.95 g/d) was not different ( $P > 0.05$ ) between the diets, however total P excretion (0.99 v. 0.78 g/d) was greater ( $P < 0.01$ ) for rabbits fed the Control diet. There were no differences ( $P > 0.10$ ) in final BW, blood glucose ( $P > 0.10$ ), or serum urea N ( $P > 0.10$ ). No differences ( $P > 0.10$ ) were observed in kidney, liver or spleen histology of animals fed either the control or diet with algae meal. These data indicate that the algae meal of *Nannochloropsis oculata* may be a safe alternative protein source for herbivorous animals, yet the digestibility may be limited by the increased fiber content of the algae meal.

**Key words:** algae, biodiesel, digestibility

**759 Comparative efficacy of meal and extracts of *Aspilia africana* leaf in laying quails.** O. O. K. Oko<sup>\*</sup>, University of Calabar, Calabar, Cross River State, Nigeria.

The study evaluated the mode of action of *Aspilia africana* leaf meal and extracts as potential phyto-genic feed additives compared with an antibiotic growth promoter. Three forms of *Aspilia africana* leaf; meal, aqueous and ethanolic extracts were tested against a negative control and a standard antibiotic growth promoter (oxytetracycline) in a 70 d study employing 540 (7 wk-old) growing quails. Each *Aspilia africana* leaf form was supplemented at 2.5%, 5.0%, 7.5% or 10.0% into the basal diet, while oxytetracycline (positive control) was supplemented at 0.002%. Fourteen dietary treatments of 30 birds per treatment with 10 birds per replicate of 3 were studied in a RCB design. Traits measured included; production performance, egg composition, internal and external egg qualities. A 2-way ANOVA at  $P < 0.05$  was conducted. Results showed that the impact of dietary supplementation with *Aspilia africana* leaf were similar to or better than ( $P < 0.05$ ) those of the antibiotic growth promoter. Egg production characteristics were form and dose-dependent. While hen-day production increased up to 86.24% in birds on *Aspilia africana* leaf compared with those on oxytetracycline (69.20%) and basal (61.38%) diets; their egg shell thickened up to 0.35 mm, yolk color intensified ( $P < 0.05$ ) from 3.03 to 6.25 whereas, percentage crack comparatively decreased. Crude extracts of *Aspilia africana* leaf exhibited higher ( $P < 0.05$ ) phyto-genic effects than the meal at supplementation levels of 5–7.5%. The aqueous extract further demonstrated higher egg boosting potentials. Therefore, an inclusion level of 5% aqueous extract of *Aspilia africana* leaf in layer diet is recommended as an alternative growth promoter.

**Key words:** phytobiotic, egg booster, plant extract

**760 Effect of mycotoxin inhibitor (sim wall) on mold colonized feed in broiler chicken.** S. Aikore<sup>1</sup>, D. Eruvbetine\*<sup>1</sup>, R. Bandyopadhyay<sup>2</sup>, J. Atehnkeng<sup>2</sup>, M. A. Oyekunle<sup>1</sup>, and A. M. Bamgbose<sup>1</sup>, <sup>1</sup>University of Agriculture, Abeokuta, Ogun State, Nigeria, <sup>2</sup>International Institute of Tropical Agriculture, Ibadan, Oyo State, Nigeria.

To determine the effect of mycotoxin inhibitor (Sim wall) on mold colonized feed, broiler chickens were divided into 9 treatment groups in a factorial arrangement. Maize grains were colonized with either *A. flavus* 3228 strain (aflatoxin producer) or *A. flavus* 3229 strain (non aflatoxin producer). Non treated maize was used as a control. Sim wall was included at 3 levels (0, 1000 and 2000 ppm). Standard broiler starter followed by broiler finisher diets composed of the treated and untreated maize with and without Sim wall were fed to the birds for 8 wk. Records of BW, feed intake and mortality were kept. Blood samples were collected for determination of blood parameters and enzyme levels. After slaughtering, liver samples were examined for histopathological changes. Data was analyzed using ANOVA (SAS2009). Results revealed that the birds fed atoxigenic maize treated diets had BW, feed intake and feed conversion values similar to that of the control diet ( $P \geq 0.05$ ). However, the birds fed diets containing aflatoxigenic maize had lower BW and less efficient feed conversion and the highest level of mortality ( $P \leq 0.05$ ). Inclusion of 2000 ppm Sim wall had the best result in terms of BW. Among the blood parameters measured, serum total protein, albumin, globulin and enzymes alanine amino transferase and aspartate amino transferase the best results were obtained in the control group, the atoxigenic treated group and the group fed 2000ppm Sim wall ( $P \leq 0.05$ ). Lesions of the liver were pronounced in the birds fed aflatoxigenic treated diets showing severe fatty changes, necrosis and fibrosis. However, inclusion of 2000 ppm Sim wall recorded mild lesions of the liver. It can be concluded that the deleterious effects of aflatoxin contaminated maize in diets for broilers can be ameliorated by the inclusion of 2000 ppm Sim wall.

**Key words:** aflatoxin, mycotoxin inhibitor, broilers

**761 Impact of tylosin phosphate and ractopamine hydrochloride alone or in combination on growth performance, feed efficiency and water intake in finishing pigs.** C. M. Pilcher\*<sup>1</sup>, R. Arentson<sup>2</sup>, and J. F. Patience<sup>1</sup>, <sup>1</sup>Iowa State University, Ames, <sup>2</sup>Elanco Animal Health, Greenfield, IN.

Ractopamine hydrochloride (RAC) is a nutrient repartitioning agent added to diets in late finishing to increase weight gain, feed efficiency and carcass leanness. Tylosin phosphate (TP) is used in swine diets to control diseases such as ileitis and swine dysentery and to improve growth performance. There is very limited information on the impact of these 2 products when used in combination. The objective of this study was to evaluate the impact of TP and RAC alone or in combination on growth performance, feed efficiency and water intake in finishing pigs fed corn-soybean meal or corn-soybean meal-dried distillers grains with solubles (DDGS) based diets. A total of 72 PIC gilts (start BW = 107.4 ± 0.50 kg) were blocked by weight and randomly assigned to a 2 × 2 × 2 factorial arrangement of treatments: TP (0 or 44 ppm), RAC (0 or 5 ppm), and DDGS (0 or 30%). Pigs were housed individually and fed treatment diets for 17 d. TP treated pigs were administered 66 mg tylosin per liter of water for 3 d before receiving treatment diets. Feed was provided twice daily, as much as the pigs could consume within 1 h per meal (ADFI = 2.98 ± 0.045 kg/d). Water was provided to the pigs between feeding periods, ad libitum (ADWI = 7.76 ± 0.23 kg/d). Data were analyzed with the MIXED procedure of SAS. There were no significant interactions ( $P > 0.10$ ) among any of the treat-

ments. RAC improved ADG (1.31 vs. 1.11 kg/d;  $P < 0.0001$ ) and G:F (0.446 vs. 0.368;  $P < 0.0001$ ) and had no effect on ADFI. TP had no effect on ADG, ADFI or G:F. DDGS inclusion reduced ADFI (2.80 vs. 3.18;  $P < 0.0001$ ) and ADG (1.15 vs. 1.27 kg/d;  $P = 0.001$ ) and had no effect on G:F. There was no significant effect of dietary treatment on water intake ( $P > 0.10$ ); however, pigs fed RAC or DDGS increased water to feed ratio (2.77 vs. 2.47;  $P = 0.03$  and 2.79 vs. 2.49;  $P = 0.02$ , respectively). In conclusion, under the conditions of this experiment, TP did not affect growth performance, RAC enhanced growth performance, and there were no interactions between the response to TP and RAC. The inclusion of DDGS did not affect the responses to either TP or RAC.

**Key words:** ractopamine, tylosin phosphate, swine

**762 Dietary nucleotides as an alternative to antibiotic growth promoters (AGP) for nursery pigs.** R. Patterson\*<sup>1</sup>, E. McMillan<sup>2</sup>, O. Jones<sup>1</sup>, and B. A. Slominski<sup>3</sup>, <sup>1</sup>Canadian Bio-Systems Inc., Calgary, Alberta, Canada, <sup>2</sup>Nutreco Canada Agresearch, Burford, Ontario, Canada, <sup>3</sup>University of Manitoba, Winnipeg, Manitoba, Canada.

The potential of dietary nucleotides to replace AGP in nursery pig diets was evaluated using 168 mixed-sex pigs weaned at 17 ± 2 d of age in a completely randomized design. The test article, Maxi-Gen Plus, is a nucleotide-rich yeast product (NP) containing a mixture of mono-nucleotides. Pigs were randomly assigned to the following dietary treatments: Positive control (PC; containing 110 ppm chlortetracycline HCl and 31.2 ppm tiamulin per kg of feed); Negative control (NC; no antibiotics); NC + 0.1% NP; NC + 0.2% NP. Diets were fed ad libitum for 28 d. On d 14, 0.2% NP pigs had greater BW than NC pigs (9.32 vs 8.76 kg,  $P = 0.005$ ) but did not differ ( $P > 0.1$ ) compared with PC (9.32 kg) or 0.1% pigs (9.11 kg). On d 28, pigs fed the 0.1% NP diet were heavier than NC pigs (16.52 vs 15.40 kg,  $P = 0.028$ ) and weighed the same as PC (16.31 kg) and 0.2% pigs (16.30 kg). FCR was not affected by dietary treatments during the study. From d 7–14, pigs fed the 0.2% NP diet had greater ADG (332 vs 284 g/d,  $P = 0.048$ ) and ADFI (406 vs 349 g/d,  $P = 0.034$ ) than NC pigs but did not differ compared with PC or 0.1% pigs. ADG was not affected by dietary treatments from d 14–21, however during this period, pigs fed a diet supplemented with 0.1% NP had an ADFI of 641 g/d, which tended ( $P = 0.09$ ) to be greater than that of NC pigs (569 g/d). Although ADFI was not affected by dietary treatments from d 21–28, pigs given the 0.1% NP diet had an ADG of 623 g/d which was the same as that of PC (572 g/d) and 0.2% (565 g/d) pigs and greater than that of NC pigs (537 g/d,  $P = 0.041$ ). Overall, no differences were observed for ADFI between either NP treatment. However, pigs fed the 0.1% NP diet had greater ADG than NC pigs (379 vs 335 g/d,  $P = 0.05$ ) and the same ADG as 0.2% (379 g/d) and PC pigs (379 g/d). This study indicates that AGP can be withdrawn from nursery pig diets without a loss of performance when diets are supplemented with 0.2% nucleotides from d 0–14 and with 0.1% nucleotides from d 15–28. It thus appears that dietary nucleotides have the potential to replace AGP in nursery pig diets as pigs receiving dietary nucleotides performed the same as pigs receiving AGP.

**Key words:** nucleotides, piglets, antibiotic replacement

**763 In vitro fermentative characteristics of citrus pulp, apple pomace and inulin combined in increasing levels with a pre-digested dog food.** S. Brambillasca\*, C. Deluca, A. Britos, L. Reyes, and C. Cajarville, Departamento de Nutrición Animal, Facultad de Veterinaria, UdelaR, Montevideo, Montevideo, Uruguay.

The fermentation characteristics of citrus pulp (CP), apple pomace (AP) and inulin (IN) mixed with a pre-digested dog food was studied. A commercial dog food was predigested (pepsin+pancreatin) and mixed with AP, CP or IN to obtain 3 different mixtures: 3, 5 and 7% in DM basis. 0% level consisted in the pre-digested food incubated as sole substrate. In vitro gas production was performed using diluted feces from 3 dogs fed the same dog food and gas volume was recorded at 2, 4, 6, 8, 10, 12, 18, 24, 48, 67 h after inoculation. Organic matter disappearance (OMD) was determined by ashing the fermentation residues. Asymptotic gas production (A, mL/g OM), time to reach 50% of the asymptote (B, h), maximal rate of gas production (Rmax, mL/h) and time of occurrence of Rmax (Tmax, h) were determined. Data were analyzed by PROC MIXED considering fiber source, inclusion level and its interaction, and means were separated by Tukey test. No source x level interaction was detected. IN produced more gas with a faster rate than the other 2 fiber sources. A and Rmax were the highest for the 5 and 7% levels, whereas Tmax for the 0% level was the lowest. OMD was affected by inclusion level and highest for 0 and 7% levels. The fermentative parameters of CP and AP were similar to those produced when IN was included in the mixtures. This suggests that these by-products can be included at 5 to 7% levels in diets for dogs and enhance the fermentative activity of the colonic microbiota as a recognized commercial prebiotic do. Acknowledgments: CIDEC-Fvet for the financial support of this work.

**Table 1.** In vitro fermentation parameters according to fiber source and inclusion level

	A (mL/g OM)	B (h)	Rmax (mL/h)	Tmax (h)	OMD (%)
<b>Fiber</b>					
CP	82.8 <sup>b</sup>	1.10	7.06 <sup>b</sup>	0.58	26.9
AP	86.5 <sup>ab</sup>	1.11	8.55 <sup>ab</sup>	0.51	27.5
IN	92.8 <sup>a</sup>	1.10	10.19 <sup>a</sup>	0.44	29.0
SEM	2.70	0.03	0.60	0.12	1.50
P	≤0.05	ns	≤0.01	ns	ns
<b>Level</b>					
0	54.5 <sup>c</sup>	1.01 <sup>b</sup>	8.32 <sup>ab</sup>	0.08 <sup>b</sup>	30.3 <sup>a</sup>
3	91.0 <sup>b</sup>	1.17 <sup>a</sup>	6.97 <sup>b</sup>	0.85 <sup>a</sup>	23.6 <sup>b</sup>
5	102.9 <sup>a</sup>	1.11 <sup>a</sup>	9.37 <sup>a</sup>	0.48 <sup>a</sup>	27.7 <sup>ab</sup>
7	101.1 <sup>a</sup>	1.13 <sup>a</sup>	9.75 <sup>a</sup>	0.64 <sup>a</sup>	30.1 <sup>a</sup>
SEM	3.11	0.03	0.70	0.14	1.71
P	≤0.001	≤0.01	0.02	≤0.01	0.03

<sup>a,b,c</sup>Values within a column with different superscript differ ( $P \leq 0.05$ ).

**Key words:** canine, fiber, fermentation