Effects of feeding raw, micronized and extruded flaxseed on rumen fermentation parameters and nutrient utilization by lactating dairy cows. C. Gomtier1, A. F. Mustafa1, D. R. Ouelett1, R. Berthaume1, and H. V. Petiti2. 1Macdonald Campus of McGill University, 2Dairy and Swine Research and Development Centre, Agriculture and Agri-Food Canada.

Four ruminally and duodenally cannulated multiparous lactating Holstein cows (average BW 595 ± 70 kg, average DIM 225 ± 35) were used in a 4 x 4 Latin square experiment to investigate the effects of feeding unheated, micronized and extruded flaxseed on nutrient utilization and ruminal fermentation parameters of dairy cows. Four diets were formulated; a control diet with no flaxseed (NF), an unheated flaxseed diet (RF), a micronized flaxseed diet (MF) and an extruded flaxseed diet (EF). The flaxseed diets contained 60% fatty acids while NF contained 3% fatty acids (DM basis). All diets were formulated to be isonitrogenous. Results showed that feeding flaxseed had no effect on DMI, ruminal pH or NH3-N concentration. Duodenal flow of DM was lower (P < 0.05) for cows fed EF compared with the other dietary treatments. Cows fed EF had a higher (P < 0.05) ruminal degradability of DM, OM and gross energy and a lower (P < 0.05) ruminal degradability of fatty acid compare with those fed MF. Ruminal CP degradability was higher (P < 0.05) for cows fed EF than for those fed the other dietary treatments. Intestinal digestibility of DM and CP were higher (P < 0.05) for cows fed MF than for cows fed NF or EF. Feeding RF also increased (P < 0.05) intestinal digestibility of CP relative to feeding NF or EF. Whole tract DM, OM, CP and NDF digestibilities were all higher (P < 0.05) for cows fed flaxseed diets than for cows fed NF. No differences in whole tract nutrient digestibilities were found between cows fed EF and those fed MF. We concluded that inclusion of flaxseed in dairy cow diets up to 2 kg of the diet DM increased whole tract nutrient utilization by dairy cows with no negative effects of ruminal fermentation. Micronization can be used to increase ruminal ungraded protein content in flaxseed while extrusion can be used to increase nutrient availability in the rumen.

Key Words: Flaxseed, Heat treatment, Nutrient utilization

Effects of rumen-inert fat saturation on feed intake, milk production, and plasma metabolites in lactating dairy cows. K. J. Harvatine* and M. S. Allen, Michigan State University, East Lansing.

Saturated (SAT) and unsaturated (UNSAT) rumen-inert fat sources were evaluated for effects on feed intake, milk yield, and plasma metabolites. Eight ruminally and duodenally cannulated multiparous Holstein cows (77 ± 12 DIM) were used in a duplicated 4 x 4 Latin square design with 21 d periods. Treatments were control (CON) and a linear titration of 2.5% added rumen-inert fatty acids (FA) varying in unsaturation; SAT (prilled FA, Energy Booster 108), UNSAT (calcium soaps of long chain FA, Megalac R8), and UNSAT (Megalac R8), and UNSAT. Experimental diets were 40% forage and contained 27.5% NDF, 30% starch and 2.5% FA from supplemental vegetable fat (14% cottonseed). Fat treatments increased gross energy (GE) of the diet 8.2%. Increasing fat saturation increased milk yield 2.9 kg/d, however there were no treatment effects of concentration or type of fat on 3.5% FCW, SCM or energy corrected milk. Yield of milk components and milk composition were not affected by treatment. Negative effects of fat supplementation on DMI increased linearly as UNSAT increased (25.8, 24.5, 24.1, 23.0 kg/d for CON, SAT, 50:50, and UNSAT, respectively). Dry matter intake for SAT was not different from control while UNSAT decreased DMI relative to control (P < 0.05). UNSAT linearly decreased DMI up to 1.5 kg/d (P < 0.05) and tended to decrease GE intake up to 3.94 Mcal/d (P < 0.10) compared to SAT. Wet weight of rumen contents tended to decrease 8.9% with rumen inert fat treatments compared to CON (P < 0.1) and decreased linearly by UNSAT compared to SAT (P < 0.05). Plasma NEFA, BHBA and glucose also were not affected by level or type of fat. UNSAT linearly increased empty body weight gain up to 0.84 kg/d (P = 0.01) and NEt increased 3.9 Mcal/d calculated from empty body weight (P = 0.02) compared to SAT. Fat supplementation with rumen-inert fat sources had no effect on milk yield or composition but type of fat affected DMI and tissue energy gain.

Key Words: Rumen-inert fat, Saturation, Hypophagic effects

Ruminant Nutrition: Additives, enzymes and feedstuff analysis

Effects of cinnamaldehyde, garlic and monensin on nitrogen metabolism and fermentation profile in continuous culture. M. Busquet1, S. Calsamiglia1, A. Ferret1, and C. Kamel2. 1Universidad Autonoma de Barcelona, Spain, 2University of Leeds, UK.

Eight 1.3-L dual flow continuous culture fermenters were used in three periods (10 d) to study the effects of natural plant extracts on N metabolism and fermentation profile. Fermenters were fed 95 g/d of a 50-50 forage-to-concentrate diet. Treatments were; no additive (Negative Control, NC), Monensin (4 or 40 mg/d per fermenter, M and M10), Cinnamaldehyde (100 or 1000 mg/d per fermenter, Cl and Cl10) and Garlic (100 or 1000 mg/d per fermenter, G and G10). Fermenters were maintained at constant temperature (39 C), pH (6.4) and solid (5%/h) and liquid (10%/h) dilution rates. Each day, a sample was taken 2 h after the morning feeding for the determination of peptide N (Pep-N), aminoaic acid N (AA-N), ammonia N (NH3-N) and volatile fatty acids (VFA). During the last 3 days, samples were taken at 0, 2, 4 and 6 h
after the morning feeding, and analyzed for Pep-N, AA-N and NH3-N concentrations. Data were analyzed using the PROC MIXED (SAS, 1996) and significance declared at P < 0.05. Total VFA (mM) was higher in M10 (128.7) compared with NC (119.0). Acetate proportion (mol/100mol) was lower for CI (56.8), G (59.6), G10 (48.3) and M10 (46.1) compared with NC (63.1). Propionate proportion (mol/100mol) was higher in CI (23.6), G10 (27.1) and M10 (45.3) compared with NC (19.8). Butyrate proportion (mol/100mol) was higher in G10 (18.3) and lower in M10 (4.1) compared with NC (10.3). The Pep-N concentration across all hours (mg/100ml) was similar in all treatments. The AA-N concentration across all hours (mg/100ml) was higher in G10 (14.6) and M10 (4.4) compared with NC (1.9). The NH3-N concentration across all hours (mg/100ml) was lower in M10 (13.0) compared with C (19.2). The CI and G10 modified propionate and acetate proportions in the same direction as M10. However, the higher proportion of butyrate observed in G10 compared with M10 suggests a different mechanism of action may be involved. The accumulation of AA-N, and the decrease in NH3-N in CI compared with M10 suggests a different mechanism of action may be involved. The accumulation of AA-N, and the decrease in NH3-N in CI compared with M10 suggests a different mechanism of action may be involved. The accumulation of AA-N, and the decrease in NH3-N in CI compared with M10 suggests a different mechanism of action may be involved. The accumulation of AA-N, and the decrease in NH3-N in CI compared with M10 suggests a different mechanism of action may be involved. The accumulation of AA-N, and the decrease in NH3-N in CI compared with M10 suggests a different mechanism of action may be involved. The accumulation of AA-N, and the decrease in NH3-N in CI compared with M10 suggests a different mechanism of action may be involved. 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The accumulation of AA-N, and the decrease in NH3-N in CI compared with M10 suggests a different mechanism of acti...
on the in vitro digestibility of three tropical grass hays. The enzyme was applied at 0, 0.5, 1, 2, and 3 (g/100g DM) on the in vitro digestion of hay produced from 12-wk regrowth of Common bahiagrass (B), Coastal bermudagrass (C), and Tifton 85 bermudagrass (T) 24 h before in vitro digestion. Forages were incubated in triplicate for 6, 24, and 48 h in buffered, ruminal fluid within Ankom Daisy II incubators. Treatments were arranged in a 3 x 5 factorial design with each hour of incubation analyzed separately. The experiment was repeated three times and ruminal fluid used was collected from two cows fed bermudagrass hay supplemented with 0.4 kg/d of soybean meal. The IVDMd of B (133, 159, 165, 156, and 182 g/kg), C (180, 165, 178, 207, and 212 g/kg) and T (99, 113, 97, 149, and 159 g/kg) at 6 h increased linearly (P = 0.001) as the enzyme application rate increased. The increase in IVDMd at the 2% application rate was greater for T compared to C (C vs. T by quadratic interaction, P = 0.018). Likewise, the IVDMd of C at 48 h tended to increase linearly as enzyme application increased (487, 484, 489, 506, and 510 g/kg) but that of T at 48 h was unaffected (485, 481, 478, 485, and 497 g/kg) (C vs. T by linear interaction, P = 0.060).

The NDF digestibility (IVNDFD) of T at 6 h (41, 34, 29, 61, and 72 g/kg) increased linearly with increasing enzyme addition whereas that of C (56, 58, 41, 75, and 63 g/kg) did not increase (C vs. T by linear interaction, P = 0.011). The IVNDFD of B at 24 h (325, 310, 330, 270, and 373 g/kg) increased linearly whereas that of C (305, 280, 299, 300, and 284 g/kg) and T (310, 338, 304, 337, and 331 g/kg) were unaffected by increasing enzyme addition (B vs (C + T) by linear interaction (P = 0.036). In conclusion, the enzyme enhanced the digestion of the hays but the pattern and extent of the improvement was forage specific.

**Key Words:** Tropical grass, Esterase, Digestion

### 592 The potential for enhancing the digestion of C4 grass hays with proprietary fibrolytic enzymes. D. Dean*, N. Krueger, L. Sollemberger, and A. Adesogan, 1University of Florida, Gainesville, FL/USA.

This trial examined the effect of applying four proprietary cellulase/hemicellulose enzymes on the digestibility of two tropical grasses. Promote (P), Biocellulase X-20 (X), Cattle-Ase (CA) and Biocellulase A-20 (A), were applied at: 0, 0.5x, 1x and 2x the recommended rates of enzymes were applied at the rate of 1 g/kg of non-forage DM of the Enzyme Treatments were arranged in a 3 x 5 factorial design with each hour of incubation analyzed separately. The experiment was repeated three times and ruminal fluid used was collected from two cows fed bermudagrass hay supplemented with 0.4 kg/d of soybean meal. The IVDMD of B (56, 58, 41, 75, and 63 g/kg) did not increase (C vs. T by linear interaction (P = 0.036). In conclusion, the enzyme enhanced the digestion of the hays but the pattern and extent of the improvement was forage specific.

**Key Words:** Enzymes, Digestibility, C4-grasses

### 593 Effects of dietary sodium bicarbonate and sodium chloride on ruminal pH and digesta characteristics in dairy cows. C. S. Mooney* and M. S. Allen, Michigan State University, East Lansing.

Six ruminally and duodenally cannulated, mid-lactation (176 ± 12 DIM, mean ± SD) Holstein cows were used in a duplicated 3 x 3 Latin square design to evaluate effects of sodium bicarbonate on ruminal characteristics. Periods were 28 d in length with the last 14 days for data and sample collection. Treatments were control, sodium bicarbonate at 1% of dietary DM, and an isomolar concentration of sodium chloride. Each diet contained a common base mix (95% of diet DM) to which treatment premixes (5% of diet DM) were added. The control premix was composed of 50% finely ground dry corn and 50% ground rice hulls on a DM basis. Sodium bicarbonate and sodium chloride were included in place of rice hulls in their respective premixes. Diets were formulated to 20% forage NDF and 17.5% CP. Ruminal pH was measured every 5 seconds for 5 days by indwelling pH probes. Mean ruminal pH was 6.2 and was not affected by treatment (P = 0.97), nor was any other measure of pH (minimum, maximum, range, standard deviation, or time or area under pH 5.5, 5.8, or 6.0; P > 0.28). Dry matter intake and 3.5% FCW were similar across treatments (P > 0.28 and 0.81 kg/d, respectively). Mean milk fat concentration was 3.51% and was not affected by treatment. Both sodium treatments increased water intake compared to control (103.8 vs. 98.6 L/d, italicize P = 0.05) but there was no difference between sodium treatments (P = 0.83). Volume of rumen contents was increased by sodium bicarbonate compared to control (102.8 vs. 90.3 L, P = 0.02) but not by sodium chloride (P > 0.50). Density of ruminal contents was greater for sodium chloride compared to sodium bicarbonate (0.87 vs. 0.81 kg/L, P < 0.01). Differences in effects of the two sodium treatments on ruminal digesta volume and density might be because of their osmotic effects on water and DM turnover in the rumen. Lack of effect of sodium bicarbonate on ruminal pH or milk fat concentration was probably because buffering capacity of bicarbonate was in excess for all treatments.

**Key Words:** Sodium bicarbonate, Sodium chloride, Ruminal characteristics


Forty-two multiparous Holstein cows (60-180 days in milk) housed in a free-stall barn were blocked by parity and previous 305-d mature equivalent milk production, and randomly assigned to a control TMR or a TMR containing fibrolytic enzymes in a study with a crossover design with two 28-d periods. The enzymes contained primarily cellulase, xylanase and neutral protease activities, and were added as a dry powder to the concentrates prior to addition of forages in the mixer wagon. Enzymes were applied at the rate of kg/kg of non-forage DM of the Enzyme Treatments were comprised of 45% forages and 55% concentrates, and contained 18% CP and 33-35% NDF. Cows were group-fed by treatment and DM intake for each pen was recorded. During the fourth week of each period, milk production was recorded from all cows, and total tract digestion measured from a subset of animals using chromic oxide as an external marker. Fibrolytic enzymes enhanced digestion of DM, OM, and non-fiber carbohydrates (P < 0.05), but had no effect on digestion of CP and fiber or milk yield and composition.
595 Effect of pH and enzyme supplementation to a total mixed ration on microbial fermentation in continuous culture. D. Colombatto1,2, G. Hervas1, W. Yang1, and K. Beauchemin1,2. 1Agroindustry and Agri-Food Canada, Lethbridge, Alberta, Canada, 2Facultad de Agronomia, Universidad de Buenos Aires, Argentina. 3Estacion Agricola Experimental (CSIC), Leon, Spain. 

The effects of pH and enzyme addition were examined in continuous culture using a 4 x 4 Latin square design, with four 9-d periods consisting of 4 d for adaptation and 3 d for measurements. The buffer pH was adjusted to 100% (high) or 60% (low) of the normal concentration of artificial saliva. Fermenters were fed twice daily a diet consisting of 30% alfalfa hay, 30% corn silage, and 40% rolled corn (DM basis). The silage was milled fresh and the TMR was fed fresh to the fermenters (64% DM). The EM was a protease containing no other major activities, and was applied daily to the TMR, at least 12 h before feeding. Treated feed was stored at 4°C until fed. Ranges of pH were 6.0-6.6, and 5.4-6.0 for high and low, respectively. Degradability of OM, NDF, ADF, and cellulose were reduced (P < 0.05) by low pH, but hemicellulose and protein degradation were not affected. EM addition increased (P < 0.01) NDF degradability (by 43% and 25% at high and low pH, respectively), largely due to an increase in hemicellulose degradation (by 79% and 51%, respectively). Total volatile fatty acids (VFA) and its molar proportions were decreased (P < 0.05) by low pH, but were not affected by EM. Protein degradation was only numerically (P = 0.17) increased by EM. Total N flow tended (P = 0.07) to be reduced with EM, but neither bacterial nor dietary N flow was affected by the treatments. Microbial protein synthesis was not affected by either pH (P = 0.29) or EM (P = 0.86). Methane production, expressed as a proportion of total gases, was decreased (P < 0.001) at low pH, but was not affected by EM. It is concluded that it is possible to adapt the CC system to use fresh feeds instead of dried feeds. Overall, the results indicate that the EM used in this study has significant potential to increase fiber degradability without increasing methane production.

Key Words: Continuous culture, Digestion, Enzymes

596 Effect of the sequence of fat and antibiotic-ionophores on ruminal fermentation and microbial lipids. M. G. Daves* and V. Feltner. North Carolina State University, Raleigh, NC. 

Rumen inoculum was obtained from a fistulated cow, filtered, and incubated in duplicated fermentors. The basal diet consisted of 100% alfalfa pellets and was offered twice daily (14g DM/d). Cultures were allowed two days of adaptation and then used to test the sequence effects of fat, monensin, and bacitracin addition. On day 3, two fermenters received monensin, two received bacitracin, and the other four received fat. On day 6, fat was added to the cultures receiving monensin and bacitracin, and two of the four fermenters fed fat were offered monensin and the other two bacitracin for an additional three days. A total of four replicates were conducted. Data were analyzed using the Mixed procedure of SAS for repeated measurements. Monensin reduced methane 15% and 23% when compared to fat and bacitracin, respectively. Adding monensin prior to fat lowered methane by 22% compared to the addition of fat prior to monensin. Monensin increased (P < 0.01) propionate compared to bacitracin but increased valerate (P < 0.03) and iso-valerate (P < 0.001) compared to fat. Addition of monensin prior to fat increased (P < 0.03) valerate when compared to cultures that received fat prior to monensin. Fat increased (P < 0.003) isobutyrate compared to monensin. Isobutyrate was higher in cultures that received bacitracin prior to fat than those that received fat first. Monensin increased (P < 0.01) C16:0 compared to fat. Levels of C18:0 ranged between 23mg/g of total FA (monensin) to 30 mg/g of total FA (fat), but the difference was not significant. Cultures receiving monensin had lower concentrations of C18:0 than those receiving bacitracin, but the sequence of fat addition had no effect. The addition of additives and their sequences did not alter total or trans-C18:1 levels. Monensin increased (P < 0.05) cis-C18:1 bacitracin or fat. Monensin added prior to fat cis-C18:1 was higher (P < 0.05) than when fat was added prior to monensin. Monensin, either alone or when added prior to fat, was more effective in altering fermentation compared to bacitracin. Inclusion of fat prior to monensin or bacitracin altered the response to the ionophore-antibiotics.

Key Words: Dairy cow, Fibrolytic enzymes, Digestion and milk yield

597 Comparison of different starch analysis methods for feedstuffs. K.-H. Suedekum1, M. B. Hall2, and G. Paschke-Beese1. 1University of Kiel, Germany, 2University of Florida, Gainesville. 

The official EU method for starch analysis on feedstuffs is a polarimetric procedure utilizing the optical activity of dispersed starch. For pure starches and high-starch commodities, this method provides reliable and accurate results. When applied to feedstuffs low in starch and high in fiber or protein, reliability is considerably reduced and values often overestimate true starch values. The objective of this work was to compare the polarimetric method with different enzymatic procedures. All enzymatic procedures involved a preliminary digestion step with a heat-stable α-amylase (Termamyl 120 L), dissolved either in a Na-citrate buffer at pH 5.8, or in water, and release of glucose by action of amyloglucosidase in a Na-acetate buffer at pH 4.6. Glucose was quantified subsequently using either phosphorylation or oxidation to gluconic acid. Free glucose was determined in a separate assay to yield unbiased estimates of glucose from starch. Eleven test samples were utilized comprising low-starch (distillers' grains, soybean meal, citrus pulp, total mixture with 25% citrus pulp) and high-starch (corn starch, potato starch, hominy feed) commodities. As a general observation, starch values determined polarimetrically (mean, 48.9% of dry matter) were higher (P < 0.0001) than those determined enzymatically (mean, 43.1% of dry matter). Comparisons among enzymatic procedures showed that Na-citrate buffer as an incubation medium for the α-amylase yielded higher starch values than water (44.4 versus 40.5% of dry matter; P < 0.0001). Type of quantification of glucose (phosphorylation versus oxidation to gluconic acid) gave the same average starch concentration (43.1% of dry matter; P = 0.7846). Results from this study indicate that Na-citrate buffer was better than water as an incubation medium for α-amylase, and that glucose released by α-amylase plus amyloglucosidase action can be quantified by phosphorylation or oxidation. Differences between polarimetric and enzymatic methods, and variation among enzymatic procedures require further investigation.

Key Words: Starch, Feed analysis, Methods

598 A novel technique to assess particle distribution of rations and forages using digital imaging. A. Bach1, A. Anglada1, X. Puigvert2, and L. Bosch2. 1ICREA-IRTA Dairy Systems, Spain, 2Universitat de Girona, Spain. 

The objective of this study was to develop a simple and efficient technique to determine particle size distribution of forages and total mixed rations (TMR) for dairy cattle using digital imaging. The particle size distribution of different rations from different dairy farms was evaluated using the Penn State Separator and the new digital image technique. The new technique is based on a digital picture from a small sample (about 500 g) of forage or TMR on a black surface. Afterwards, the picture is analyzed with software for digital measurements to determine the length and the area of most of the particles in the picture. Following the analysis, a distribution chart is constructed. The preliminary results indicate that both, the average area of the particles determined digitally and the average particle size determined with the Penn State Separator were correlated with milk fat percentage. However, the correlation was stronger when the particles were analyzed using digital measures (R2 = 0.78; P = 0.09) than when using the Pen State Separator (R2 = 0.70; P = 0.43). Therefore, digital imaging is a more precise method to estimate the consequences of particle size distributions of TMR on milk fat percentage. The advantage of using digital imaging vs the Penn State Separator is that the former provides reliable results even with wet TMR. In several occasions, the Penn State Separator failed with wet TMR because a fraction of the small particles remained attached to larger particles with greater water content. Therefore, to obtain reliable results with the Penn State Separator with high-silage TMR, the determination should be conducted on a dry sample. The use of digital imaging does not require drying the sample prior to particle evaluation. Also, digital imaging provides an entire distribution pattern of almost all the particles in the TMR, instead of only the three break points (1.18, 8, 19 mm) that the Penn State Separator yields. This technique
proved to be reliable, repeatable, and simple, and warrants future field
application.

Key Words: Particle size, Forage, Total mixed ration

599 Comparison of three systems to estimate the fraction of non-fiber carbohydrate, and its ruminal dige-
stibility, in common feedstuffs. A. Offner* and D. Sauvant, INRA P-G INRA, Paris, France.

The objective of this study was to compare the prediction of the non-
fiber carbohydrate content and ruminal digestibility by three systems for
the estimation of feed values (CNCPS, NRC, and INRA models). The
comparison was based on twenty common feedstuffs. The fraction of
non-fiber carbohydrate (NFC, % of DM) and the fraction of digestible
NFC (dNFC, % of DM) were determined with the three systems. The
NRC used an empirical approach to estimate dNFC: dNFC = 0.98 ×
PAF × (NFC + NDFC); with PAF, the processing adjustment factor,
and NDFC, the neutral detergent insoluble protein. The CNCPS and
INRA considered a more mechanistic approach of rumen digestion based
on the “competition” between degradation and passage; the fractional
passage rate was set at 6 % h⁻¹. The fractional degradation rates were
from in vitro (CNCPS) and in situ studies (Offner et al., 2003).

The results showed close correlations (r > 0.88) between the NFC fractions
predicted by the three systems. However, the CA fraction defined in
the CNCPs was not accurately linked to sugar (difference: +1.9, correla-
tion: NS) and soluble NFC (+17.4, r = 0.62). In addition, the CBI fraction
was not accurately linked to starch (-2.6, r = 0.92) or degradable NFC
(+15.9, r = 0.87). Results for the dNFC fraction outlined significant dif-
ferences ranging from 1.5 to 31 % of DM among the three systems. The
NRC significantly overestimated dNFC compared to CNCPS (+10.8,
r = 0.91), and INRA (+12.0, r = 0.93). Moreover, the NRC and the
NRC significantly overestimated dNFC compared to CNCPS (+10.8,
r = 0.91), and INRA (+12.0, r = 0.93). Moreover, the NRC and the
CNCPS and INRA did not take into account all the variability observed in NFC
digestibility when various processing treatments were applied. Differ-
ences among the three systems were surprising and indicated the need
for a more consistent estimation of NFC and dNFC. This will perhaps be
possible by integrating enough NFC sub-fractions, like those for starch,
into the systems.

Key Words: Non-fiber carbohydrate, Rumen digestion, Feeding systems

Contemporary Issues Symposium: Designing animal experiments for power

600 Near infrared reflectance spectroscopy predic-
tion of digestion rates for cereal grains. C. Lanzas* and A. N.
Pell, Cornell University, Ithaca, NY.

Near infrared reflectance spectroscopy (NIRS) is used for commercial feed
analysis because of its speed and precision. NIRS calibrations for
digestion rates would be a step towards the field use of models that re-
quire digestion rates as inputs. Our objective was to assess the accuracy
of NIRS in predicting digestion rates of dried cereal grains obtained by
measurement of gas production. Eighteen barley, 99 corn, 23 sorghum,
and 57 wheat samples were collected from 22 countries. Samples were
ground to pass a 4-mm screen and fermented in vitro with rumen fluid
for 48 hours. Gas production was measured with a computerized system
and the data were fit to an exponential model to derive the fractional
rates. The mean and SD of gas production rates were 0.24±0.029 h⁻¹
for barley, 0.14±0.025 h⁻¹ for corn, 0.06±0.015 h⁻¹ for sorghum,

The mean and SD of gas production rates were 0.24±0.029 h⁻¹
for barley, 0.14±0.025 h⁻¹ for corn, 0.06±0.015 h⁻¹ for sorghum,
and 0.26±0.038 h⁻¹ for wheat. Samples were scanned from 1100 to 2498
nm with a visible/near-infrared scanning monochromator machine at 1
nm intervals. Modified partial least squares regressions were used to

Key Words: Near infrared reflectance spectroscopy, Digestion rates, Gas production

601 Designing trials to test the bio-equival-
enci of treatments for animal performance. Ian McMillan*¹,¹
University of Guelph, Animal and Poultry Science.

When analyzing the results of a trial that has been conducted to com-
pare treatments, it is usually the desire of the researcher to demonstrate
a significance result for the contrasts of the group means that are of in-
terest. This is certainly the case when an improved product is desired.
However, in establishing the bio-equivalence of a test product to a stan-
dard, the objective is usually to conclude, with reasonable justifica-
tion, that no difference has been detected. In making such determinations,
the probabilities of accepting false hypotheses of equality, or those of
rejecting correct hypotheses of difference must be taken into account.
Prior to beginning the trial, the researcher should have a good estimate
of the power that will be associated with the detection of a given max-
imum acceptable difference. The required sample size for achieving the
desired power for these tests depends, among other things, upon the
coefficient of variation (CV) in the data collected. The lower the CV,
the smaller the detectable difference becomes. A reduced CV can be
achieved, in some cases, by using an appropriate experimental design
to account for elements such as variation in either moisture or fertility
of the soil on which a crop is grown. A Latin Square design adds another
dimension of control for bias and variance. Regardless of the design
chosen, it is imperative to identify the proper experimental unit receiv-
ing the treatment. If animals are treated individually they may each
represent a unique experimental unit. If they are exposed to the treat-
ment as a group at the same time, for example animals housed together
in a pen, such that they do not represent independent, random obser-
vations, the group may be the correct experimental unit to consider.

There are many considerations to take into account when planning a
bio-equivalence trial, or any other trial for comparing performance un-
der different treatments. This talk will discuss some of these items that
are often overlooked and will attempt to make suggestions on how they
may be handled.

Key Words: Bio-equivalence, Power of test, Sample size

602 The power of tests for feed experiments with
poultry. W. B. Roush*¹ and P. Tozer², ¹ USDA-ARS Mississippi
State, MS, ² Penn State University, University Park, PA.

The power of tests can be used to determine the ability of an experimen-
tal design to detect treatment differences. The power of tests is rarely
formally considered in poultry research. The definition of statistical
power is the probability of rejecting the null hypothesis when it is, in
fact, false and should be rejected. The complement of statistical power
is the Type II error. That is, accepting the null hypothesis that there
is no difference in treatments when, in fact, there is one. With power
analysis, the sample size that is needed can be calculated to detect a
given change. A priori power analysis can indicate the probability at
which the sampling regime or experiment can actually detect an effect
if a difference exists. Post hoc power analysis indicates either the suf-
ficiency or the sample size needed for an experiment that has already
been conducted. Because the sample size for a priori and post hoc power
analyses can be larger than may be considered practical, a compromise
power analysis can be conducted that calculates sample size based on a
ratio of beta and alpha errors (Erdfelder, 1984). In the current study,
examination was made of the power of tests for experiments published in
the literature where significant and non-significant differences were re-
ported between control birds and birds fed grains. Examination of the
power of tests was conducted with G*Power, a readily available freeware
program.

Key Words: Statistical power, Poultry, Experimental design