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 digestibility, in common feedstuffs. A. Offner* and D. Sauvant, *INA 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 + NDICP); with PAF, the processing adjustment factor, and NDICP, 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, correlation: *NS*) or soluble NFC (-17.4, r = 0.62). In addition, the CB1 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 differences ranging from 1.5 to 31 % of DM among the three systems. The NRC significantly overestimated dNFC compared to CNCPS (+10.8, r = 0.88) and INRA (+12.0, r = 0.93). Moreover, the NRC and the CNCPS did not take into account all the variability observed in NFC digestibility when various processing treatments were applied. Differences 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

600 Near infrared reflectance spectroscopy prediction 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 require 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, 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 calibrate spectral data against gas production rates. Two calibration models were developed with the same data set. In the first model, 189 samples were used to develop the calibration model; the coefficient of determination was 0.89, and standard error of cross-validation (SECV) was 0.023 h^{-1}. In the second model, 98 samples were used to develop the calibration model, the remaining samples (n= 91) were used as a validation set. The coefficient of determination was 0.84, and standard error of validation (SEV) was 0.03 h^{-1}. For the validation set, SEV was partitioned into three orthogonal components: lack of correlation, bias, and non-unity slope. The error distribution was 88.8 % for lack of correlation, 11.2 % for the bias component and 0 % for the non-unity slope. The coefficients of determination of the models suggest that NIRS had the ability to predict digestion rates. However, the ratio between SD and SECV (2.8) indicated lower prediction ability of the equations compared with NIRS models for chemical fractions.

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

Contemporary Issues Symposium: Designing animal experiments for power

601 Designing trials to test the bio-equivalency 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 compare treatments, it is usually the desire of the researcher to demonstrate a significance result for the contrasts of the group means that are of interest. This is certainly the case when an improved product is desired. However, in establishing the bio-equivalence of a test product to a standard, the objective is usually to conclude, with reasonable justification, 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 maximum 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 receiving the treatment. If animals are treated individually they may each represent a unique experimental unit. If they are exposed to the treatment as a group at the same time, for example animals housed together in a pen, such that they do not represent independent, random observations, 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 under 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. Tozer[2], [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 experimental 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 sufficiency 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 reported 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

603 How many pigs? Statistical power considerations in swine nutrition experiments. D. K. Aaron* and V. W. Hays, *University of Kentucky, Lexington*.

Replication refers to the assignment of more than one experimental unit (EU) to the same treatment. Each replication of a treatment is an independent observation; thus, each replication involves a different EU. In swine nutrition research, the EU may be an individual animal, as in sow reproduction experiments, or a group of animals, as in growing-finishing pig experiments. In either case, calculation of the number of replicates needed to give an accurate and reliable outcome is an important step in a pre-experiment protocol. Although investigators often appear to choose replication arbitrarily on the basis of cost or availability of animals, convenience, or tradition, the question of "how many pigs" (i.e., how much replication is necessary) is a statistical one that has a statistical answer. A power analysis, performed while in the process of designing an experiment, will provide an investigator with the number of replicates needed for an experiment of known power and sensitivity. This *a priori* power analysis ensures that an investigator does not waste time and resources carrying out an experiment that has little chance of finding a significant effect, if one exists. It also makes sure resources are not wasted by including more EU than are necessary to detect an effect. A second type of power analysis may also be useful. If no significant effects are found in an experiment, the investigator can assess *post-hoc* the actual power of the experiment, or may determine the size of treatment effect that could have been detected using the standard deviation and number of replicates in the experiment. This *a posteriori* or retrospective power analysis can be very useful in explaining results. If the actual power to detect an effect of the size found in the experiment is high, it can be safely concluded the treatment has no effect. If the actual power is low, results will not be sufficient to say there is no effect. The objective of this paper is to discuss *a priori* and *a posteriori* power analyses as they relate to the kinds of experiments typically conducted in swine nutrition research.

Key Words: Power, Replication, Swine Nutrition

604 Experimental design in companion animal and equine nutrition: issues and insights. C. M. Grieshop* and E. A. Flickinger, *University of Illinois*.

Numerous challenges exist in designing experiments for companion animals and horses including the small number of animals available, subjective response criteria, and high variability in most responses of interest. One of the greatest challenges in companion animal research is the inability to use large numbers of animals due to lack of availability or prohibitive costs. Experimental designs such as the Latin square and crossover design can be used to maximize power for detecting differences while minimizing the number of animals required. These designs allow animals to serve as their own baseline or controls, thus reducing variation among treatments. Another challenge that exists in designing experiments for companion animals is the subjectivity for many response criteria. Responses such as longevity, quality of life, and palatability are difficult to assess in a quantifiable and objective manner. Various defined experimental protocols have been designed in an attempt to decrease subjective variability in these measurements, but often it remains difficult to detect and interpret statistical differences. A high level of variation exists naturally for most of the responses of interest. Sources of this variation can be both within and between herds or colonies. Significant differences in genetic backgrounds and in management practices exist that can result in large differences in many different response criteria. Due to the challenges outlined, designing experiments for companion animals is a complex task. Specialized statistical designs and defined experimental protocols are necessary to minimize variability and maximize the ability to detect statistical differences in biologically significant responses in companion animal and equine experiments.

Key Words: Experimental design, Equine, Companion animals

605 Design of experiments for bioequivalence testing of biotechnology derived crops as feeds for dairy cattle. R. J. Tempelman*[1] and M. A. Faust[2], [1] *Michigan State University,* [2] *Iowa State University*.

Experiments for dairy feed product testing have been primarily designed for the purpose of providing sufficient power of test to detect economically important differences in various performance measures, e.g. milk production. The emerging importance of biotechnology derived feed crops have led to their recent comparisons with conventional feedstuffs for their effects on dairy cattle performance. A current or future goal of these studies may be to assess bioequivalence of hybrids or feedstuffs. However, experimental designs that are appropriate for testing bioequivalence may be subtly different from designs for detecting mean differences. We discuss experimental designs that may be more suitable for the purpose of bioequivalence testing in dairy cattle nutrition studies, noting that the crossover design has been already widely advocated for bioequivalence testing in clinical research studies. We further discuss the design issues pertinent to dairy nutrition studies such as group-fed versus individually fed animals and multiple testing and data reduction concerns surrounding the collection of many different performance measures. Literature estimates of mean differences and variability are used to derive representative sample size requirements for dairy bioequivalence studies.

Key Words: Dairy nutrition, Bioequivalence testing, Biotechnology crops

680 Power of the test considerations for beef cattle experiments. C. R. Richardson*[1], G. A. Nunnery[1], D. B. Wester[1], N. A. Cole[2], and M. L. Galyean[1], [1] *Texas Tech University, Lubbock, TX,* [2] *USDA-ARS-CPRL, Bushland, TX*.

The inherent value of evaluating the power of a test procedure in beef cattle experiments is similar to that for other species; however, because of major differences in the methods and conditions involved compared with other species, considerations for the use of power test procedures are distinct and specific for beef cattle experiments. Some of these major differences include: 1) lack of similar research facilities, which leads to wide fluctuations in the number of animals used per experimental unit (pen) by researchers; 2) variation in types of pens (totally or partially enclosed indoor pens, open outdoor pens, enclosed fields, or open ranges); 3) use of individual animal data from Pinpointers, Calan gates, and metabolism studies; 4) seasonal effects by region on animals housed outside; and 5) variation in the performance of control groups among locations because of differences in diet composition and animal genetics. When power tests are used in the planning and experimental design phase of a research study, they provide critical information on sample sizes necessary to detect a treatment effect at a predetermined α level. In using power tests across different experimental designs, attention should be given to the consequences of both Type I and Type II errors. Lowering the Type I error rate increases the Type II error rate and vice versa. For several common statistical procedures and experimental designs, power tables are available; however, none specifically addresses beef research, and software is not readily available. Data will be reviewed from published beef cattle research in which comparisons can be made to determine the effects that experimental design, numbers of animals within the experimental unit, number of replications, type of housing, regional effects, feed composition, and genetics have on power tests. Estimation of power in beef cattle experiments is important.

Key Words: Beef cattle, Statistics, Power test

Lactation Biology Symposium: Altering the lactation cycle in dairy cows

606 Why re-evaluate length of dry period? R. R. Grummer* and R. R. Rastani, *University of Wisconsin, Madison*.

Possible advantages of reducing length of dry period include increased income from milk production, simplified dry cow management, and alleviation of over-crowded dry cow facilities. The traditional recommendation is a 60-d dry period. Physiologists describe the dry period as consisting of three phases: active involution, steady state involution or rest phase, and redevelopment of secretory tissue. The importance of a rest phase has never been established. There are abundant data in the literature to support a 6 to 8 week dry period. However, interpretation of the data is difficult. The great majority of data is from studies using farm records (e.g., DHI data). In these data sets, cows with less than 6 to 8 wk dry periods probably were not intended to have short dry periods and consequently were not managed for short dry periods.