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**Research Report**

# Digestibility of energy and concentrations of digestible and metabolizable energy in a cheese co-product, fish meal, and a HP 300 fed to weanling pigs

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## OBJECTIVE

It was the objective of this experiment to determine digestibility of energy and concentrations of DE and ME in a cheese co-product, fish meal, and in HP 300 when fed to weanling pigs.

## MATERIALS AND METHODS

The protocol for the experiment was reviewed and approved by the Institutional Animal Care and Use Committee at the University of Illinois at Urbana-Champaign.

A corn based basal diet and 3 diets containing a mixture of corn and cheese co-product, fish meal, or HP 300 were formulated. Thus, a total of 4 diets were used (Table 1). Vitamins and minerals were included in all diets to meet or exceed current requirement estimates (NRC, 2012).

Thirty-two weanling pigs with an average initial BW of 14.0 ± 1.1 kg were allotted to a randomized complete block design with 4 diets and 8 replicate pigs per diet. Pigs were housed individually in metabolism crates that were equipped with a self-feeder, a nipple waterer, and a slatted floor. A screen and a urine pan were placed under the slatted floor to allow for the total, but separate, collection of urine and fecal materials.

Feed was supplied in meal form and pigs were limit fed daily at 3.2 times the maintenance energy requirement (i.e., 197 kcal of ME/kg of $BW^{0.60}$; NRC, 2012) of the smallest pig in each replicate. Daily feed provisions were divided into 2 equal meals that were provided at 0800 and 1600 h. Water was available at all times. Pigs were fed experimental diets for 12 days. The initial 5 d were considered an adaptation period to the diet. Fecal markers were fed on d 6 (chromic oxide) and d 11 (ferric oxide) and fecal collections were initiated when chromic oxide appeared in the feces and ceased when ferric oxide appeared (Adeola, 2001). Feces were collected twice daily and stored at –20°C immediately after collection. Urine collections were

initiated on d 6 at 1600 h and ceased on d 11 at 1600 h. Urine buckets were placed under the metabolism crates to permit total collection. Buckets were emptied every morning and a preservative of 50 mL of sulfuric acid was added to each bucket when they were emptied. The weight of the collected urine was recorded and a 10% subsample was stored at –20°C. At the conclusion of the experiment, urine samples were thawed and mixed within animal and diet, and a sub-sample was lyophilized before analysis.

All samples were analyzed in duplicate. Fecal samples were thawed and mixed within pig and diet, and then dried at 65°C using a forced air drying oven. Samples were then ground through a 1-mm screen in a Wiley mill (Model 4; Thomas Scientific, Swedesboro, NJ) before analysis. Diets, ingredients, and fecal samples were analyzed for DM by using oven drying at 135°C for 2 h (method 930.15; AOAC Int., 2019). Ingredients, diets, fecal and urine samples were also analyzed for GE using bomb calorimetry (Model 6400; Parr Instruments, Moline, IL). Apparent total tract digestibility (**ATTD**) of GE and DM was calculated for each diet. The DE and ME of corn was calculated by dividing the DE and ME of the corn diet by the inclusion rate of corn in that diet. The contribution of DE and ME from corn to the DE and ME in the diets containing cheese co-product, fish meal, or HP 300 was subtracted from the DE and ME of these diets, and the DE and ME of each ingredient was calculated by difference (Widmer et al., 2007). The ATTD of GE and DM in cheese co-product, fish meal, and HP 300 was calculated using the same procedure.

Data were analyzed using the MIXED Procedure (SAS Inst. Inc., Cary, NC). Homogeneity of the variances among treatments was confirmed using the UNIVARIATE procedure and this procedure was also used to test for outliers. The fixed effect was diet or ingredient and replicate was the random effect. The LSMeans statement was used to calculate

treatment means, and the PDIFF option was used to separate means if differences were detected. The pig was the experimental unit and results were considered significant at $P \leq 0.05$ and considered a trend at $P \leq 0.10$.

## RESULTS

The daily DM intake was greater ($P < 0.01$) for pigs fed diets containing the cheese co-product, HP 300, or fish meal compared with pigs fed the corn diet (Table 2), and the daily GE intake was greater ($P < 0.01$) for pigs fed diets containing cheese co-product or fish meal compared with pigs fed the corn diet. Pigs fed the cheese co-product also had a greater ($P < 0.05$) GE intake than pigs fed the HP 300 diet. Likewise, GE excretion of feces and urine was greater ($P < 0.01$) for pigs fed diets containing cheese co-product, HP 300, or fish meal compared with pigs fed the corn diet.

The ATTD of DM was greater ($P < 0.01$) in the cheese co-product diet and the corn diet compared with the fish meal diet, but, the ATTD of GE was not different among experimental diets. Digestible energy and ME were greater ($P < 0.01$) in the cheese co-product diet than in the other diets, and DE in the HP 300 diet and the fish meal diet was greater ($P < 0.05$) than in the corn diet. The ME in the fish meal diet was also greater ($P < 0.05$) than ME in the corn diet.

The ATTD of DM was greater ($P < 0.05$) in cheese co-product and corn compared with fish meal, and DE and ME were greater ($P < 0.05$) in the cheese co-product than in the other ingredients. On an as-fed basis DE and ME in HP 300 and fish meal were greater ($P < 0.05$) than in corn, and on a DM-basis DE and ME in HP 300 were greater ($P < 0.05$) than in corn.

## REFERENCES


Adeola, O. 2001. Digestion and balance techniques in pigs. Pages 903-916 in Swine Nutrition. 2nd ed. A.J. Lewis and L.L. Southern, ed. CRC Press, New York, NY.

AOAC Int. 2019. Official methods of analysis of AOAC Int. 21th ed. AOAC Int., Rockville, MD, USA.

Ellis, R., E. R. Morris, and C. Philpot. 1977. Quantitative determination of phytate in the presence of high inorganic phosphate. Anal. Biochem. 77:536-539.

NRC. (2012), Nutrient requirements of swine 10th Ed. National Academy Press, Washington, DC.

Widmer, M.R., L.M. McGinnis, and H.H. Stein. 2007. Energy, phosphorus, and amino acid digestibility of high-protein distillers grains and corn germ fed to growing pigs. J. Anim. Sci. 85:2994-3003.

**Table 1.** Composition (as-is basis) of experimental diets

| Ingredient, % | Diet | | | |
|---|---|---|---|---|
| | Corn | HP 300 | Fish meal | Cheese product |
| Ground corn | 96.85 | 76.00 | 71.45 | 67.25 |
| HP 300[1] | - | 21.15 | - | - |
| Fish meal | - | - | 28.00 | - |
| Cheese product[1] | - | - | - | 30.00 |
| Dicalcium phosphate | 1.80 | 1.40 | - | 1.30 |
| Ground limestone | 0.80 | 0.90 | - | 0.90 |
| Sodium cloride | 0.40 | 0.40 | 0.40 | 0.40 |
| Vitamin micromineral premix [2] | 0.15 | 0.15 | 0.15 | 0.15 |
| Total | 100.00 | 100.00 | 100.00 | 100.00 |
| Analyzed composition | | | | |
| DM,% | 86.97 | 88.36 | 88.11 | 88.94 |
| GE, kcal/kg | 3,649 | 3,832 | 3,941 | 4,137 |

[1]HP 300 = enzyme-treated soybean meal (HP 300, Hamlet Protein, Finlay, OH); cheese co-product was sourced from Keys Manufacturing Co., Inc., Paris, IL.

[2]The vitamin-micromineral premix provided the following quantities of vitamins and micro minerals per kg of complete diet: vitamin A as retinyl acetate, 10,622 IU; vitamin $D_3$ as cholecalciferol, 1,660 IU; vitamin E as selenium yeast, 66 IU; vitamin K as menadione nicotinamide bisulfate, 1.40 mg; thiamin as thiamine mononitrate, 1.08 mg; riboflavin, 6.49 mg; pyridoxine as pyridoxine hydrochloride, 0.98 mg; vitamin $B_{12}$, 0.03 mg; $_{D}$-pantothenic acid as $_{D}$-calcium pantothenate, 23.2 mg; niacin, 43.4 mg; folic acid, 1.56 mg; biotin, 0.44 mg; Cu, 20 mg as copper chloride; Fe, 123 mg as iron sulfate; I, 1.24 mg as ethylenediamine dihydriodide; Mn, 59.4 mg as manganese hydroxychloride; Se, 0.27 mg as sodium selenite and selenium yeast; and Zn, 124.7 mg as zinc hydroxychloride.

**Table 2.** Apparent total tract digestibility (ATTD) of gross energy (GE) and dry matter (DM) and DE and ME in corn, cheese co-product, fish meal and HP 300[1,2].

| Item | Corn | HP 300 | Fish meal | Cheese product | SEM | *P*-value |
|---|---|---|---|---|---|---|
| DM intake, g/d | 584[b] | 692[a] | 696[a] | 716[a] | 22.15 | <0.001 |
| GE intake, kcal/d | 2,452[c] | 3,001[b] | 3,116[ab] | 3,331[a] | 96.98 | <0.001 |
| GE in feces, kcal/d | 262[b] | 338[a] | 366[a] | 356[a] | 24.54 | 0.002 |
| ATTD, % | | | | | | |
| DM | 90.88[a] | 90.08[ab] | 88.23[b] | 90.44[a] | 0.53 | 0.004 |
| GE | 89.39 | 88.74 | 88.34 | 88.34 | 0.65 | 0.545 |
| DE, diet, kcal/kg | 3,262[c] | 3,400[b] | 3,481[b] | 3,696[a] | 24.66 | <0.001 |
| GE in urine, kcal/d | 61[b] | 111[a] | 118[a] | 111[a] | 10.08 | 0.003 |
| ME, diet, kcal/kg | 3,161[c] | 3,258[bc] | 3,332[b] | 3,555[a] | 26.20 | <0.001 |
| Ingredient | | | | | | |
| ATTD of GE, % | 89.39 | 84.53 | 85.94 | 89.43 | 1.76 | 0.100 |
| ATTD of DM, % | 90.88[a] | 85.61[ab] | 81.76[b] | 89.65[a] | 1.48 | 0.004 |

| | | | | | | |
|---|---|---|---|---|---|---|
| As-fed basis | | | | | | |
| DE, kcal/kg | 3,369[c] | 3,873[b] | 3,841[b] | 4,772[a] | 73.90 | <0.001 |
| ME, kcal/kg | 3,203[c] | 3,905[b] | 3,733[b] | 4,676[a] | 91.62 | <0.001 |
| Dry matter basis | | | | | | |
| DE, kcal/kg | 3,882[c] | 4,209[b] | 4,117[bc] | 5,170[a] | 79.80 | <0.001 |
| ME, kcal/kg | 3,690[c] | 4,245[b] | 4,001[bc] | 5,066[a] | 99.89 | <0.001 |

[a-c]Least squares within a row lacking a common superscript letter are different ($P < 0.05$).

[1]Data are means of 7 or 8 observations per treatment.

[2]HP 300 = enzyme-treated soybean meal (HP 300, Hamlet Protein, Finlay, OH); cheese co-product was sourced from Keys Manufacturing Co., Inc., Paris. IL.