Title: Improving the economic efficiency of fat utilization in pig diets by better quantifying the energy value of fat sources based on their chemical composition, **NPB #16-010**

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Abstract:
The objective was to determine the energy concentration for a diverse array of dietary fat sources and from these data, develop regression equations that explain differences based on chemical composition. A total of 120 Genetiporc 6.0 × Genetiporc F25 (PIC, Inc., Hendersonville, TN) individually housed barrows were studied for 56 d. These barrows (initial BW of 9.9 ± 0.6 kg) were randomly allotted to 1 of 15 dietary treatments. Each experimental diet included 95% of a corn-soybean meal basal diet plus 5% either: corn starch or 1 of 14 dietary fat sources. The 14 dietary fat sources (animal-vegetable blend, canola oil, choice white grease source A, choice white grease source B, coconut oil, corn oil source A, corn oil source B, fish oil, flaxseed oil, palm oil, poultry fat, soybean oil source A, soybean oil source B, and tallow) were selected to provide a diverse and robust range of U:S (unsaturated fatty acid:SFA). Pigs were limit-fed experimental diets from d 0 to 10 and d 46 to 56 providing a 7 d adaption for fecal collection on d 7 to 10 (13 kg BW) and d 53 to 56 (50 kg BW). At 13 kg BW, the average energy content of the 14 sources was 8.42 Mcal of DE/kg, 8.26 Mcal of ME/kg, and 7.27 Mcal of NE/kg, respectively. At 50 kg BW, the average energy content was 8.45 Mcal of DE/kg, 8.28 Mcal of ME/kg, and 7.29 Mcal of NE/kg, respectively. At 13 kg BW, variation of dietary fat DE content was explained by: DE (Mcal/kg) = 9.363 + [0.097 × (FFA, %)] – [0.016 × Omega-6:Omega-3] – [1.240 × (arachidic acid, %)] – [5.054 × (insoluble impurities, %)] + [0.014 × (palmitic acid, %)] (P = 0.008; R^2 = 0.82). At 50 kg BW, variation of dietary fat DE content was explained by: DE (Mcal/kg) = 8.357 + [0.189 × U:S] – [0.195 × (FFA, %)] – [6.768 × (behenic acid, %)] + [0.024 × (PUFA, %)] (P = 0.002; R^2 = 0.81). In summary, the chemical composition of dietary fat explained a large degree of the variation observed in the energy content of dietary fat sources. The Powles et al. (1995) equation accurately predicted the average DE content from the 14 sources (8.43 Mcal/kg), but underestimated the DE content of medium chain SFA sources and the negative impact of increased FFA level to a large degree. A further validation of this equation was conducted in a commercial scale research facility (Hanor Co.). Using choice white grease and corn oil it was found in Experiment 2 that the equation generated in Experiment 1 in 50 kg pigs had less prediction error (0.11) and bias

(0.33) than the equation reported by Powles et al. (1995).These regression equations were generated using apparent total tract digestibility of fat, but the novelty of this experiment was to investigate the impact endogenous losses of fat (ELF) had on the energy value of dietary fat sources. An additional 8 barrows (average initial BW of 9.9 ± 0.6 kg) were utilized to determine ELF. Pigs were housed individually throughout the 56 d experiment. Estimated ELF at 9 kg BW was 4.17 g/kg of DM intake ($P < 0.001$). Estimated ELF at 38 kg BW was 6.67 g/kg of DM intake ($P = 0.002$). Adding 5% dietary fat regardless of source compared to pigs fed 5% corn starch increased the ATTD and STTD of AEE at both fecal collection time points ($P < 0.001$). At 13 kg BW, the STTD of AEE was the greatest in barrows fed CANO-, CWGA-, and FISH-based diets and was the least in pigs fed PALM- and TAL-based diets ($P < 0.001$). The average STTD of AEE among the 14 dietary fat sources at 13 kg BW was 93.7% and the range was 3.20%. At 50 kg BW, ATTD and STTD of AEE was the greatest in pigs fed a CANO-based diet and the least in pigs fed a CORA-based diet ($P < 0.001$). The average of STTD of AEE among the 14 dietary fat sources at 50 kg BW was 96.8% and the range was 4.22%. On average ELF accounted for 43.1% and 68.0% of the fecal AEE both fecal collection points, respectively. The substantial proportion of AEE contained in feces that is of ELF origin and not of dietary origin implies that the current estimates of the DE content of dietary fat are underestimated. Not correcting for ELF, resulted in underestimating dietary fat DE content by 0.42 and 0.60 Mcal/kg at 13 and 50 kg of BW, respectively.
impact of increased FFA level to a large degree. Further research is needed to validate if the equations generated herein are more precise in predicting dietary fat DE variation among sources. This validation was done in a commercial scale research facility in collaboration with Hanor Co. Using choice white grease and corn oil it was found in Experiment 2 that the equation generated in Experiment 1 in 50 kg pigs had less prediction error (0.11) and bias (0.33) than the equation reported by Powles et al. (1995). These regression equations were generated using apparent total tract digestibility of fat, but the novelty of this experiment was to investigate the impact endogenous losses of fat (ELF) had on the energy value of dietary fat sources. Endogenous losses of fat, is the amount of fat that is present in the feces of non-dietary origin. An additional 8 barrows (average initial BW of 9.9 ± 0.6 kg) were utilized to determine ELF. Estimated ELF at 9 kg BW was 4.17 g/kg of DM intake ($P < 0.001$). Estimated ELF at 38 kg BW was 6.67 g/kg of DM intake ($P = 0.002$). Adding 5% dietary fat regardless of source compared to pigs fed 5% corn starch increased the ATTD and STTD of AEE at both fecal collection time points ($P < 0.001$). At 13 kg BW, the STTD of AEE was the greatest in barrows fed CANO-, CWGA-, and FISH-based diets and was the least in pigs fed PALM- and TAL-based diets ($P < 0.001$). The average STTD of AEE among the 14 dietary fat sources at 13 kg BW was 93.7% and the range was 3.20%. At 50 kg BW, ATTD and STTD of AEE was the greatest in pigs fed a CANO-based diet and the least in pigs fed a CORA-based diet ($P < 0.001$). The average of STTD of AEE among the 14 dietary fat sources at 50 kg BW was 96.8% and the range was 4.22%. On average ELF accounted for 43.1% and 68.0% of the fecal AEE both fecal collection points, respectively. The substantial proportion of AEE contained in feces that is of ELF origin and not of dietary origin implies that the current estimates of the DE content of dietary fat are underestimated. Not correcting for ELF, resulted in underestimating dietary fat DE content by 0.42 and 0.60 Mcal/kg at 13 and 50 kg of BW, respectively. In conclusion, the DE content of dietary fat can be predicted by the dietary fat source’s chemical composition. However, further work is needed on determining the NE content of dietary fat sources.