RESEARCHABSTRACT

ANIMAL SCIENCE — Nutritional Efficiency Consortium

Title: Evaluation of lipid source and peroxidation level on digestible and metabolizable energy concentration, and the impact of lipid peroxidation on intestinal barrier function - **NPB #10-013**
Revised

Investigator: Brian J. Kerr, Ph.D.

Institution: USDA-ARS-NLAE, Ames, IA

Date Submitted: August 9, 2012

Scientific Abstract

Four lipids were obtained and peroxidized by a slow or rapid method, and subsequently characterized by various methods. Analysis showed that a high peroxide value accurately indicated the high degree of lipid peroxidation, but a moderate or low peroxide value may be misleading due to the unstable characteristics of hydroperoxides as indicated by the unchanged peroxide value of rapidly oxidized corn and canola oil compared to their original, unoxidized state. Additional tests which measured secondary peroxidation products (p-anisidine , thiobarbituric acid reactive substances, hexanal, 4-hydroxynonenal, and 2, 4-decadienal) were suggested to provide a better indication of lipid peroxidation than peroxide value for lipids subjected to a high degree of peroxidation. Similar to peroxide value analysis, it was suggested that these tests may also not provide irrefutable information regarding the extent of peroxidation due to the volatile characteristics of secondary peroxidation products and the ever changing stage of lipid peroxidation. For the predictive tests, active oxygen method stability accurately reflected the increased lipid peroxidation caused by the slow and rapid peroxidation treatments as indicated by the increased active oxygen method stability value in corn and canola oil, but not in poultry fat and tallow. This indicates a potential disadvantage of the active oxygen method stability test. The oxidative stability index assay successfully showed the increased lipid peroxidation caused by slow or rapid peroxidation treatments in all lipids, but it too may have disadvantages similar to anisidine , thiobarbituric acid reactive substances, hexanal, 4-hydroxynonenal, and 2, 4-decadienal, because the oxidative stability index assay directly depends on quantification of the volatile secondary peroxidation products. It was concluded that to accurately analyze the peroxidation damage in lipids, measurements may need to be determined at various time intervals by more than one test and include different types of peroxidation products simultaneously. At this time, however, we do not have data to recommend at what specific times these measurements should be taken or which peroxidation products should be measured.

Pigs fed diets containing lipids that were rapidly oxidized tended to have reduced average daily feed intake and body weight gains compared to pigs fed the unoxidized lipids. Pigs fed diets containing the rapidly oxidized lipids tended to have increased liver weight compared to pigs fed diets containing the unoxidized lipids. In contrast, liver triglyceride concentration in pigs fed the unoxidized lipids were greater than pigs fed the rapidly oxidized lipids, and tended to be greater than in pigs fed the lipids that had been slowly oxidized. The reduced

liver triglycerides were consistent with increased mRNA expression of peroxisome proliferator activated receptor-alpha factor target genes in pigs fed lipids that had been slowly or rapidly oxidized compared with pigs fed the unoxidized lipids. Lipid peroxidation had little effect on digestible or metabolizable energy values determined for any of the lipids tested, and did not appreciably affect total tract digestibility of dietary dry matter, lipid, nitrogen or carbon. Serum α-T concentration were decreased when pigs were fed corn and canola oil that had been slowly or rapidly oxidized, but not in pigs fed diets containing poultry fat or tallow. Lipid peroxidation had no effect on serum endotoxin, haptoglobin, immunoglobulin A, or immunoglobulin G, or on urinary thiobarbituric acid reactive substances and lactulose to mannitol ratio.

Overall the data suggested that feeding thermally-oxidized lipids to young pigs has little influence on gut barrier function or serum immunity parameters, but may decrease liver triglyceride concentrations, impair metabolic oxidative status, and reduce growth performance, especially for lipids containing high concentration of polyunsaturated fatty acids.