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# EFFECTS OF RANCIDITY IN CHOICE WHITE GREASE ON GROWTH PERFORMANCE AND NUTRIENT DIGESTIBILITY IN WEANLING PIGS

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## Summary

Our data suggest that adding slightly rancid choice white grease with peroxide values of 40 mEq/kg and less and p-anisidine values of 10.6 and less to diets will not decrease growth performance in nursery pigs. However, reduced feed intake and, thus, reduced rate of gain occurred at greater peroxide and p-anisidine values.

(Key Words: Pigs, Fat Quality, Rancidity.)

## Introduction

The addition of fat to nursery diets is a common practice. Research efforts about fat utilization by weanling pigs mainly has been focused on the effects of essential fatty acids, unsaturated:saturated ratios, chain length of the fatty acids, and age of the pigs when fat was added to the diet. Unfortunately, little attention has been given to the effects of fat quality, such as rancidity, on nursery pig performance. Our objective was to determine the effects of rancidity in choice white grease on growth performance and nutrient digestibility in weanling pigs.

## Procedures

One hundred fifty (lines C 22 × 326, PIC, Franklin, KY) weanling pigs (average initial BW of 15.0 lb) were used in a 35-d assay. The pigs were weaned and allotted by BW, sex, and ancestry to six treatments. Initial BW was the blocking criterion. There were five pigs per pen with six pens per treatment. The diets (Table 1) were formulated to 1.70% lysine for d 0 to 7, 1.55% lysine for d 7 to 21, and 1.40% lysine for d 21 to 35 and met or exceeded all nutrient requirements as defined by NRC (1998). Treatments were a corn-soybean meal-based control with no added fat, 6% choice white grease, and 6% choice white grease heated at 176°F with $O_2$ gas bubbled through fat at a rate of 849 mL/min for 5, 7, 9, and 11 d. After exposure to the various degrees of thermal and oxidative stress, aliquots of the fat were stabilized with an antioxidant at 1 g/kg of fat. Also, fat was stored in a cool room (50°F) to help ensure the desired development of rancidity for each fat treatment. Chemical analyses of the grease were conducted to determine changes over the 11 days of stress.

The pigs were housed in an environmentally controlled building. Each pen had a self-feeder and nipple water to allow ad libitum consumption of feed and water. Pigs and feeders were weighed on d 7, 21, and 35 to allow calculation of ADG, ADFI, and F/G.

Statistical analyses were performed using the GLM procedure of SAS. Polynomial regression was used to determine shape of the response to increasing rancidity with pen used as the experimental unit.

## Results and Discussion

Analyses of the choice white grease (Table 2) indicated that thermal and oxidative stress increased the peroxide value until d 7 (105 mEq/kg), and then the hydroperoxides decomposed to concentrations similar to that of the untreated fat (i.e., 1 mEq/kg). The p-anisidine test was used to determine the aldehyde content of the choice white grease. This value also increased until d 7 and then decreased as thermal and oxidative exposure was increased to 9 and 11 d. Therefore, peroxide and p-anisidine determi-

nations are reliable indicators of fat quality only with low to moderate levels of auto-oxidation.

Moisture, insoluble impurities, and unsaponifiable matter were not changed as the fat became more rancid. However, iodine values and unsaturated:saturated fatty acid ratios decreased with increasing rancidity, indicating that as fats become rancid, their fatty acids become more saturated. Among the fatty acids, the percentage of C16:0 increased most, whereas percentages of C18:1 and C18:2 decreased the most.

In the pig growth assay (Table 3), no differences (P>.14) were detected in growth performance for d 0 to 7. However, for d 21 to 35 and overall (d 0 to 35), efficiency of gain was improved when fat was added to the diets (P<.04). Also, for d 7 to 21, 21 to 35, and overall, ADG (P<.01) and ADFI (P<.09) were decreased as rancidity of fat was increased. These reductions in feed intake and rate of gain were pronounced only with more than 5 d of thermal and oxidative stress (i.e., peroxide values >40 mEq/kg).

Digestibility of DM decreased for diets containing grease exposed to 5 and 7 d of stress and then increased for diets containing grease exposed for up to 11 d (quadratic effect, P<.04). Furthermore, digestibilities of GE and N were unaffected (P>.13) as the added fat became more rancid. Thus, rancidity of the fat did not appear to affect digestibility of major nutrient classes.

Digestibilities of long-chain unsaturated fatty acids, long-chain saturated fatty acids, and total fat were greater (P<.001) for the fat-added treatments compared to the no-added fat control. However, no differences (P>.10) for fatty acid digestibility occurred among the fat-added treatments, even with the greatest thermal and oxidative challenge (i.e., 11 d). Thus, the negative effects of rancidity on piglet growth do not appear to result from decreased nutrient digestibility or utilization. Rather, the effect seems to result from decreased feed intake.

In summary, fat that is added to diets for nursery pigs should be monitored for rancidity to avoid decreased feed intake and, thus, decreased ADG. However, our data demonstrate that commonly used measures of rancidity (i.e., peroxide and p-anisidine values) are unreliable indicators of rancidity in substantially damaged fats. Thus, it is essential to know the history of your fat source and the reliability of your supplier to have confidence in the quality of fat that is fed.

**Table 1. Compositions of Diets[a]**

| | d 0 to 7 | | d 7 to 21 | | d 21 to 35 | |
|---|---|---|---|---|---|---|
| Item, % | Control | Fat Added | Control | Fat Added | Control | Fat Added |
| Corn | 22.84 | 22.84 | 44.10 | 44.10 | 47.81 | 47.81 |
| Soybean meal (46.5% CP) | 26.36 | 26.36 | 31.52 | 31.52 | 41.86 | 41.86 |
| Dried whey | 20.00 | 20.00 | 10.00 | 10.00 | — | — |
| Lactose | 10.00 | 10.00 | — | — | — | — |
| Cornstarch | 6.00 | — | 6.00 | — | 6.00 | — |
| Choice white grease[b] | — | 6.00 | — | 6.00 | — | 6.00 |
| Spray-dried wheat gluten | 4.00 | 4.00 | — | — | — | — |
| Spray-dried plasma protein | 4.00 | 4.00 | 1.00 | 1.00 | — | — |
| Fish meal (menhaden) | 2.00 | 2.00 | 3.00 | 3.00 | — | — |
| Monocalcium phosphate (21%) | 1.28 | 1.28 | .85 | .85 | 1.32 | 1.32 |
| Limestone | .89 | .89 | .84 | .84 | 1.17 | 1.17 |
| L-lysine·HCl | .32 | .32 | .25 | .25 | .05 | .05 |
| DL-methionine | .19 | .19 | .14 | .14 | .05 | .05 |
| L-threonine | .08 | .08 | .10 | .10 | — | — |
| Salt | .25 | .25 | .30 | .30 | .35 | .35 |
| Vitamin premix | .25 | .25 | .25 | .25 | .25 | .25 |
| Mineral premix | .15 | .15 | .15 | .15 | .15 | .15 |
| Antibiotic[c] | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Zinc oxide | .32 | .32 | .25 | .25 | — | — |
| Copper sulfate | — | — | — | — | .09 | .09 |
| Chromic oxide | — | — | .25 | .25 | — | — |

[a]Diets were formulated to: 1.7% lysine, .9% Ca, and .8% P for d 0 to 7; 1.55% lysine, .8% Ca, and .7% P for d 7 to 21; and 1.4% lysine, .8% Ca, and .7% P for d 21 to 35. [b]Choice white grease with 0, 5, 7, 9, and 11 d of thermal (heated at 176°F) and oxidative stress ($O_2$ gas at 849 mL/min). [c]Provided 150 g of apramycin per ton of feed for d 0 to 21 and 50 g of carbox per ton of feed for d 21 to 35.

**Table 2. Chemical Analysis of Choice White Grease**

| | Day of Thermal and Oxidative Exposure | | | | |
|---|---|---|---|---|---|
| Item | 0 | 5 | 7 | 9 | 11 |
| Peroxide value, mEq/kg | 1 | 40 | 105 | 1 | 1 |
| p-anisidine value | 2.5 | 10.6 | 20.5 | 11.1 | 7.5 |
| Free fatty acids, % | 2 | 2 | 2 | 3 | 3 |
| Total M.I.U., %[a] | 1.34 | 1.09 | 1.30 | 1.33 | 1.26 |
| Moisture, % | .14 | .06 | .13 | .11 | .24 |
| Insoluble impurities, % | .01 | .01 | .01 | .01 | .01 |
| Unsaponifiable matter, % | 1.19 | 1.02 | 1.16 | 1.21 | 1.01 |
| Iodine value | 63.5 | 60.9 | 58.7 | 54.6 | 55.2 |
| Unsaturated:saturated ratio | 1.51 | 1.28 | 1.28 | 1.15 | 1.19 |
| Fatty acids, % of sample[b] | | | | | |
| C8:0[c] | .00 | .00 | .00 | .00 | .00 |
| C10:0 | .00 | .00 | .00 | .00 | .00 |
| C12:0 | .08 | .06 | .02 | .05 | .04 |
| C14:0 | 1.50 | 1.45 | 1.40 | 1.55 | 1.45 |
| C16:0 | 30.30 | 32.50 | 32.56 | 35.98 | 34.19 |
| C16:1 | 3.68 | 3.33 | 3.37 | 3.23 | 3.38 |
| C18:0 | 7.54 | 9.28 | 9.44 | 8.49 | 9.44 |
| C18:1 | 46.02 | 44.01 | 43.78 | 43.40 | 43.46 |
| C18:2 | 9.71 | 8.35 | 8.00 | 5.92 | 6.12 |
| C18:3 | .35 | .28 | .58 | .60 | .64 |

[a]Total moisture, insoluble impurities, and unsaponifiable matter. [b]Determined as derivatized fatty acid methyl esters by gas chromatography. [c]Number of carbon atoms and double bonds designated to the left and right of the colon, respectively.

**Table 3. Effects of Rancidity on Growth Performance and Digestibility of Nutrients for Weanling Pigs[a]**

| | | Days of Thermal and Oxidative Stress | | | | | | Probability | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Rancidity Effects | | | |
| Item | No Added Fat | 0 | 5 | 7 | 9 | 11 | SE | No Added Fat vs Others | Linear | Quadratic | Cubic | Quartic |
| d 0 to 7 | | | | | | | | | | | | |
| ADG, lb | .54 | .55 | .55 | .57 | .57 | .52 | .03 | —[c] | — | — | — | — |
| ADFI, lb | .63 | .69 | .68 | .65 | .67 | .66 | .03 | — | — | — | — | — |
| F/G | 1.17 | 1.25 | 1.24 | 1.14 | 1.18 | 1.27 | .05 | — | — | .15 | .14 | — |
| d 7 to 21 | | | | | | | | | | | | |
| ADG, lb | .96 | 1.08 | 1.08 | .99 | .99 | .94 | .03 | .13 | .003 | — | — | — |
| ADFI, lb | 1.34 | 1.45 | 1.45 | 1.31 | 1.28 | 1.28 | .05 | — | .01 | — | — | — |
| F/G | 1.39 | 1.34 | 1.34 | 1.32 | 1.29 | 1.36 | .05 | — | — | — | — | — |
| d 21 to 35 | | | | | | | | | | | | |
| ADG, lb | 1.56 | 1.54 | 1.54 | 1.49 | 1.53 | 1.46 | .04 | — | — | — | — | — |
| ADFI, lb | 2.46 | 2.33 | 2.33 | 2.16 | 2.15 | 2.13 | .04 | .001 | .001 | — | .07 | — |
| F/G | 1.58 | 1.51 | 1.51 | 1.45 | 1.41 | 1.46 | .04 | .03 | .09 | — | .13 | — |
| d 0 to 35 | | | | | | | | | | | | |
| ADG, lb | 1.12 | 1.16 | 1.16 | 1.11 | 1.12 | 1.05 | .03 | — | .01 | — | — | — |
| ADFI, lb | 1.64 | 1.65 | 1.62 | 1.52 | 1.50 | 1.50 | .03 | .03 | .001 | — | — | — |
| F/G | 1.46 | 1.42 | 1.40 | 1.37 | 1.34 | 1.43 | .03 | .04 | — | — | — | — |
| Apparent digestibility, % | | | | | | | | | | | | |
| DM | 82.9 | 83.6 | 81.9 | 79.6 | 79.6 | 83.3 | 1.2 | — | — | .04 | .06 | — |
| GE | 82.6 | 81.8 | 80.5 | 79.5 | 78.4 | 82.2 | 1.5 | — | — | — | — | — |
| N | 75.5 | 76.1 | 78.0 | 74.1 | 74.9 | 78.3 | 2.1 | — | — | — | .13 | — |
| Total fat[b] | 72.6 | 84.5 | 81.3 | 84.9 | 81.8 | 84.5 | 1.7 | .001 | — | — | — | .10 |
| Long-chain unsaturated fatty acids | 78.5 | 89.3 | 87.8 | 88.8 | 87.6 | 89.5 | .9 | .001 | — | — | — | — |
| Long-chain saturated fatty acids | 54.7 | 76.0 | 70.6 | 78.5 | 74.0 | 76.5 | 2.8 | .001 | — | — | — | .10 |
| Medium-chain fatty acids | 93.4 | 91.7 | 91.0 | 92.6 | 89.0 | 93.6 | 1.2 | — | — | — | — | .03 |

[a]A total of 150 pigs (five pigs per pen and five pens per treatment) with an average initial BW of 15.0 lb.

[b]Determined as derivatized fatty acid methyl esters by gas chromatography.

[c]P>.15.