

Effect of an Exogenous Emulsifier on Growth Performance in Weanling Pigs

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ABSTRACT

A trial involving 1,885 weanling pigs (24 d of age) was conducted to determine if an exogenous emulsifier, glyceryl polyethyleneglycol ricinoleate (Bredol®), would improve growth performance and prevent deterioration of fat in the diets in a three-phase starter feeding regime. Creep diet was fed from d 0 to 7, Nursery 1 diet from d 7 to 21 and Nursery 2 diet from d 21 to 35 post-weaning. Five percents of crude soybean oil were added to all diets. Bredol® was homogenized with the fat source prior to mixing with the treatment diets. Diets were mixed every other day and samples were sent to the laboratory within 2 days after mixing for determination of lipid oxidation. Lipid oxidation was measured in mg malonaldehyde per g of sample. Pigs were randomly allocated into 145 pens, each of 13 pigs. Pen was considered the experimental unit. There were 73 pens for the control group and 72 pens for the treatment group. Pigs were fed to appetite 6-8 times per day using feed trough and had ad libitum access to one waterer per pen. The body weight of each pig was recorded when moving in (weaning weight) and out of the nursery and the feed intake was recorded daily on a pen basis. The average daily gain and feed conversion ratios of pigs fed Bredol® treated diets were improved by 19.65 gm/day ($P = 0.0129$) and 0.06 ($P = 0.0048$) respectively. Average lipid oxidations in the Bredol® treated diets measured 2 and 7 days after mixing were lower than in the control diets ($P = 0.0000$). These results demonstrated that addition of Bredol® to diets for weanling pigs improved growth performance and reduced deterioration of fat in the diets.

Key words: weanling pigs, emulsifier, growth performance, lipid oxidation

INTRODUCTION

Fat is an excellent source of energy in swine diets due to its high energy value which is approximately 2.25 times that of carbohydrates (Pettigrew and Moser, 1991). In order to counteract the effect of suboptimum feed intake of young pigs raised in the hot-humid condition, the use of fat

seems compulsory because the diet high in energy density is needed.

Since emulsification is required for micellar formation and absorption of fat, exogenous emulsifiers may enhance fat utilization by young pigs fed high-fat diets. Nevertheless, researches investigating the effect of emulsifying agents, particularly, lecithin and lysolecithin, yield

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inconsistent outcomes. Jones *et al.* (1992) reported that addition of emulsifiers increases digestibility of nutrients but has minimal effect on growth performance. Addition of lecithin to diet for young pigs also fails to demonstrate any beneficial effect on growth performance (Øverland *et al.*, 1993). Contradictory, Xing *et al.* (2004) reported improved average daily gain (ADG) but not average daily feed intake (ADFI) or gain/feed (G:F) in pigs 15-35 days post-weaning using lard and lysolecithin. The fat digestibility is also improved with 0.02 % lysolecithin. Similarly, Tokach *et al.* (1995) reported improved G:F in pigs fed diets containing soybean oil 14-35 days post-weaning. The reason for inconsistent results remains unclear but source and quality of fats may play a role. Animal fats are less digestible than those of vegetable origin (Jones *et al.*, 1992). Deterioration of fat in the diets stored at room temperature has been purported to be responsible for an unexpected outcome (Dierick and Decuypere, 2004).

Bredol®, glyceryl polyethyleneglycol ricinoleate, is an emulsifying agent according to EU-legislation. Besides the property of breaking down fat into fine particles, Bredol® may act as protective barrier to the diffusion of lipid oxidation initiators into the fat droplets, hence reducing deterioration of fats. The objectives of this trial were, therefore, to determine the effects of Bredol® on growth performance of weanling pigs fed high-fat diets and on deterioration of fat in the diets.

MATERIALS AND METHODS

This trial was conducted in a PIC (Pig Improvement Company) nucleus herd which was certified to be free of PRRS virus and Mycoplasma infections. A nursery building divided into 12 rooms, each of 14 pens with woven wire flooring and equipped with the evaporative cooling system was used. The air space of each room was

completely separated. There were 2 rows of 7 pens in a room. Each row in a room was assigned to either a control or a treatment groups. A total of 1,885 pigs weaned at 24 days was randomly moved to 145 pens each of 13 pigs. There were 73 pens for the control and 72 pens for the treatment. Pen was considered the experimental unit. The weekly room temperature was automatically controlled to be 32, 30, 29, 28 and 28°C during the 5 weeks of trial period.

There were 3 diets namely creep (CR), nursery I (N1) and nursery II (N2). The CR diet was fed from d 0 to 7 postweaning and formulated to contain 1.5 % lysine, .85 % Ca and .7 % P. The N1 diet was fed from day 7 to 21 postweaning and was formulated to contain 1.35 % lysine, 0.85 % Ca and .7 % P. The N2 diet was fed from day 21 to 35 and was formulated to contain 1.25 % lysine, .95 % Ca and .7 %P. The energy density of all diets were held constant at 3,500 kcal ME/kg. The basic ingredients were broken rice, soybean meal, full-fat soybean, edible grade dried whey and fish meal (70 % crude protein). Five percents of crude soybean oil were added to all diets. The soybean oil used for mixing diets fed to pigs in treatment group was homogenized with the emulsifier prior to mixing such that the final concentration of Bredol® 683 in oil was 1 %. Nursery diets were in 3.5 mm pellet and CR diet was crumbled. Because freshness of diets was a primary concern due to hot-humid condition, a small batch of diets was made every other day. A sample drawn from each batch was submitted to the laboratory for the analysis of lipid oxidation. Diets were packed in 30 kg bags and colors of feed tags were used to differentiate between control and treatment diets.

Thirty eight feed samples (19 samples each from control and treatment diets) were sent to the laboratory within 2 days after mixing for determination of lipid oxidation using the modified extraction 2-thiobarbituric acid method as described by Salih *et al.* (1987). All samples were

analyzed at 2 and 7 days after collection. Briefly, 10 g of feed samples were homogenized in 35 ml of 3.86% perchloric acid in a homogenizer for 1 min, and were filtered. Five ml of the filtrate were mixed with 5 ml of in a screw-capped test tube and were incubated in boiling water for 30 min. The absorbance was determined at 531 nm against a blank containing 5 ml of distilled water and 5 ml of 0.02 M 2-thiobarbituric acid. Lipid oxidation was expressed in mg malonaldehyde (MDA) per g of sample known as thiobarbituric acid (TBA) value.

Pigs were fed to appetite 6-8 times per day using feed trough and had ad libitum access to one waterer per pen. The body weight of each pig was recorded when moving in (weaning weight) and out of the nursery. Feed intake was recorded daily on a pen basis. During the trial, mortality was not a major concern since only 23 pigs died (1.2 %). The ADG and feed conversion ratio (FCR) were the responses of interest.

Thiobarbituric acid values were analyzed in a context of repeated measure design (Montgomery, 1984). Other variables were analyzed using Student's T-test. Since growth performance of nursery pigs might be influenced by weaning weight (Ilsley et al., 2003), the linear response model (Ott, 1984) were generated to estimate the effects of Bredol® treatment on ADG and FCR. Let Y_i be a continuous random variable (ADG or FCR) where $i = 1, 2, \dots, 145$. The model was:

$$Y_i = B_0 + B_1X_{i1} + B_2X_{i2} + E_i$$

where

X_{i1} = weaning weight

$X_{i2} = 1$ if Bredol® treatment, $X_{i2} = 0$ otherwise;

E_i = random error term.

With this model, the effects of Bredol® treatment on ADG and FCR were adjusted for possible effect of weaning weight. The B_2 regression coefficients gave the predicted differences of ADG and FCR between treatment and control groups.

RESULTS AND DISCUSSION

Pigs fed emulsifier tended to grow faster and utilized feed more efficiently. The addition of Bredol® 683 to the treatment diet significantly improved the performance of 3-8 week-old weanling pigs as measured by ADG and FCR (Table 1). Feed intakes between groups were similar ($P = 0.81$). Lipid oxidation in the treatment diets measured 2 and 7 days after mixing were also significantly lower than that in the control diet (Table 3).

Research investigating the effect of emulsifiers on performance of weanling pigs was inconsistent (Øverland *et al.*, 1993; Xing *et al.*, 2004). The primary reason for inconsistency was attributable to the fat sources in that vegetable fats were more digestible than animal fats (Jones *et*

Table 1 Comparison of performance indices between control and treatment groups (mean±stdev).

Variable	Control	Treatment	P-value
Number of pens	73	72	
Weaning weight (kg)	7.42±1.29	7.44±1.32	0.9061
Weight moving out (kg)	24.85±3.50	25.72±3.96	0.1577
Days in nursery	38.00±3.12	38.11±3.13	0.8534
Average daily weight gain (g/d)	459.00±58.56	479.00±62.40	0.0442
Feed conversion ratio	1.35±0.13	1.29±0.12	0.0048

The soybean oil mixed in the diet fed to 3-8 week old weanling pigs in treatment group was homogenized with Bredol® 683 prior to mixing.

al., 1992). The positive effect of emulsifiers on growth performance may be more likely when animal fats which are less digestible are used (Øverland *et al.*, 1993). Nevertheless, Øverland *et al.* (1994) reported that there was no significant influence of lecithin on overall digestibility of rendered fat in 40-70 kg barrows while Xing *et al.* (2004) found that 0.02 % of lysolecithin improved the digestibility of lard. Interestingly enough Jones *et al.* (1992) reported significant improvement in ADG from day 0 to 7 post-weaning when tallow and lecithin were used but the positive effect seemed to diminish as pigs approached 35 days post-weaning.

It is quite common for 3-5 week-old nursery pigs to become infected with Mycoplasma and/or PRRS virus (Ross, 1986; Meulenberg, 2000). Inconsistent performance of nursery pigs due to infections should be kept in perspective since the negative effect of infections on growth performance may be larger than the positive effect of emulsifiers. Moreover, Heugten *et al.* (1996) reported that increasing the energy density of the diet did not reduce the performance depression associated with activation of the immune response. Highly significant improvement in growth performance of weanling pigs up to 5 week post-

weaning observed in this trial might be due to not only the emulsifying property of Bredol® 683 but also the disease-free status of weanling pigs.

The effect of Bredol® 683 on ADG was estimated using linear regression procedure (Table 2). Bredol® 683 mixed with soybean oil at 500 ppm prior to diet mixing improved ADG by 19.65 gm/day. The effect of weaning weight, as a covariate, on ADG was also significant similar to previous reports (Mahan and Lepine, 1991; Ilsley *et al.*, 2003). Minor difference in weaning weight (7.42 vs 7.44 kg) might have profound impact on ADG even though uniformity in terms of standard deviation was similar (1.29 vs 1.32). In this trial, however, weaning weight had no influence on FCR. Weanling pigs fed the Bredol® treated diet had 0.06 less FCR than those fed the control diet ($P = 0.0048$).

Average lipid oxidations in the Bredol® treated diets measured 2 and 7 days after mixing were lower than in the control diets (Table 3). Bredol®, as emulsifier, enhanced the fat stability by providing an effective membrane coating small fat droplets, which might result in prevention of lipid oxidation of fat portions in the diet (Fomusa *et al.*, 2002). In both groups, lipid oxidation of the diets increased progressively as time increased ($P = 0.0000$), and the results were consistent with

Table 2 Regression coefficients when average daily gain (g) of weanling pigs was a dependent variable, pen average of body weight when moving in was a covariate and Bredol® treatment was a dummy variable (F-ratio = 51.16, df = 142, $R^2 = 0.4188$).

Independent variable	Coefficient	P-value
Intercept	240.63	0.0000
Weaning weight	29.40	0.0000
Bredol® treatment	19.65	0.0129

Table 3 Effect of Bredol® treatment on lipid oxidation, with no interaction between time and treatment factor ($P = 0.3140$).

Variable	Control	Treatment	P-value
Number of feed samples	19	19	
TBA value 2 days after collection	2.21±0.58	1.67±0.48	0.0000
TBA value 7 days after collection	2.91±0.81	2.19±0.33	0.0000

Thiobarbituric acid (TBA) value is expressed in mg malonaldehyde per g of sample (mean± stdev).

previous report (Fumosa *et al.*, 2002).

CONCLUSION

An exogenous emulsifier mixed with soybean oil prior to mixing with diets significantly improved ADG and FCR of weanling pigs in a three-phase starter feeding regime and reduced deterioration of fat in the diets.

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