

RESPONSE OF GROWING SWINE TO STARTER RATIONS
WITH SKIM MILK, WHEY AND VARYING AMOUNTS OF FAT

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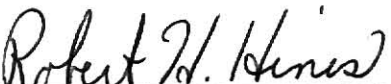
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INTRODUCTION

One of the major problems facing the swine industry is that of getting baby pigs off to a vigorous, healthy, fast growing start. Pigs that are eating a dry feed at weaning time have an advantage over those pigs which are still dependent upon milk as their sole source of nutrition. A good creep ration can be valuable to supplement the pigs needs as the sows milk production begins to decline. At this young age the pig is growing most efficiently and gains made at this time can reduce the time required to reach market weight.

Although creep rations may seem expensive, the small amount of feed consumed and the efficiency with which the young pig utilizes this feed can well justify the cost. Pigs that are consuming considerable quantities of a dry ration should also be better prepared to adapt to the stresses placed upon him at weaning time and should continue to grow and gain better at this time than those pigs which are consuming only milk.

Several factors become important in obtaining maximum use of the efficiency and gains that can be produced in the young pig. First and most important, the ration must be consumed in order to obtain any benefits. Secondly, the fastest gains can be obtained on a complete ration that supplies the required nutrients for the growth of the young pig. Thirdly, the ration should be placed where it is readily accessible to the pig at all times. It should be in a place which is warm, dry, well lighted and where the pig can readily find it.

Palatability of the ration is of major importance. Feed ingredients that have proven to be palatable to the baby pig are hulled oats or oat groats, rolled oats, dried skim milk, shelled corn, coarsely ground corn, protein supplements, sugar and saccharin.

Physical form of the ration also plays a role in that pelleted and crumbled type rations are preferred to a meal-type ration. Also, pigs do not like a dusty feed and meal-type rations can be made more acceptable by the addition of 2.5 to 5.0 percent fat.

The use of various types of dairy by-products in the baby pigs' ration has been shown to be beneficial. The economic factor, however, plays an important part in the decision to use these products. Except in a few isolated areas where they are readily available as by-products of dairy processing, these products are seldom used. The merits of these products may make them desirable ingredients for pre-starter and starter rations.

As mentioned previously, fat added to a dusty meal-type ration will greatly improve its acceptability by the baby pig. It would seem logical that this added fat should be valuable as a source of energy which should produce increases in daily gains and thus reduce the feed required to produce a pound of gain. This, coupled with the inherent efficiency of the young growing pig, could be valuable from the standpoint of the economics of production. Many researchers, however, have indicated that the baby pig can not utilize supplemental sources of fat to any great extent and it therefore is of little value as an energy source. On the other hand, some workers believe this to be invalid, based upon the baby pigs' efficient utilization of sows milk, which does contain a considerable amount of fat. They contend that certain other nutrients may not have been present in sufficient quantities and in the proper proportion to allow

proper utilization of the increased amount of energy. They further feel that the deficiency lies in the category of amino acids as the limiting factor.

The following research was conducted to determine the value of three ingredients in a creep ration during the suckling period and a post weaning period. Dried skim milk was compared with dried whey and two levels of added edible fat were evaluated for the young pig. A major aspect of this study was to determine the effect of a ration during the suckling period upon the subsequent performance of pigs and to detect any interaction between pre and post weaning rations as it related to later performance. Little research has been conducted on this aspect of nutrition for the young pig. This information could be valuable in obtaining maximum performance from the pig.

LITERATURE REVIEW

The Value of Fat in Swine Rations

Research conducted to determine the value of added fat in swine rations has produced variable results, but in general, added levels of fat to finishing rations show increases in the rate of gain and improved feed efficiency. However, many of the articles reviewed indicate that the young pig, when given added dietary fat, is unable to efficiently utilize this energy. This is difficult to interpret based on data that sows milk, when analyzed, was found to contain 30-40% fat on a dry matter basis. Many of the studies conducted to analyze fat utilization by the young pig may have confused these results by differences in intake of some of the other essential nutrients.

Levels of 10 and 15 percent fat were fed successfully in a mixed ration for finishing pigs with improved efficiency of gain but no consistent increase in average daily gains (Kropf et al., 1954). In trials using 5 and 10% stabilized rendered tallow and 10% stabilized lard, Heitman (1956) noted improved feed utilization, however, it was no more than the difference in calculated total digestible nutrient content due to the increased fat content.

The addition of 5% corn oil to a 3% ether extract ration fed to baby pigs resulted in some increase in gain but had no appreciable effect on feed intake. Consequently feed efficiency was improved considerably (18%), which can be explained largely by the higher caloric value of the ration. This difference in efficiency on a caloric basis between the two fat levels

was only about a third of that calculated on the basis of weight of feed eaten (Crampton and Ness, 1954). Smith and Lucas (1956) also found a similar improvement in feed efficiency and rate of gain with young pigs fed higher levels of added fat, but those differences were not statistically significant.

Kennington et al. (1958) reported a linear improvement in both growth rate and feed efficiency in weanling pigs fed 14 to 20% protein and 0 to 20% added fat (stabilized lard). In general, feed consumption decreased with increasing levels of fat. He noted no fat-protein interaction, thus, it would appear the effect of fat was the same at all protein levels.

Barrick et al. (1953) reported similar performance for pigs fed several types of fat (peanut oil, beef fat, soybean oil, coconut oil and a commercial grease) as 10% of the ration. However, pigs receiving fat added diets performed superior, in both rate of gain and feed utilization, to pigs receiving the basal diet.

Asplund et al. (1960) observed no improvement in performance of baby pigs fed a ration containing added white grease and high in available nutrients. Utilizing 8 week-old pigs in a digestion trial, he noted an increased apparent digestibility of ether extract and protein when 10 to 20 percent grease was added to the ration. Interestingly, he noted a depression in performance when corn oil was added to the diet.

Isonitrogenous growing-finishing rations containing a grease, a tallow, or lard at levels of 5 and 10%, improved gain and feed efficiency of pigs significantly with increasing levels of fat. Although there was a slight reduction in feed intake with increasing levels of fat, pigs receiving fat consumed more total calories, but required fewer calories per pound of gain. Fat source resulted in non-significant differences (Thrasher et al., 1959).

Bayley and Lewis (1963), with finishing rations of 0, 2.5, 5 and 10% added fat, used a feeding scale to insure pigs received the same daily intake of protein and energy, observed a slightly more rapid growth rate with fat supplemented diets and improved feed utilization when fat was included. Sewell and Carmon (1959) evaluated variations in dietary energy density through manipulation of stabilized tallow and ground oats and found that pigs receiving high energy rations throughout the growing-finishing period gained at a significantly faster rate and showed greater efficiency of feed utilization than pigs receiving any other treatment.

Frobish (1969) noted the apparent digestibility of fat increased from 69% at 3 weeks of age to 84% at 7 weeks, while source of fat did not differ in digestibility. Fat impaired both growth and efficiency, although better growth was obtained from purified diets containing casein than diets with isolated soya protein when fat was added. On the other hand, he noted the fat of sow's milk is 95% digestible by the young suckling pig.

Frobish et al. (1969) further reported "In general, the addition of fat to the diet decreased rate of gain and increased the feed or energy required per unit of gain. Addition of emulsifying agents did not improve fat utilization. Digestibility of fat increased from 25 to 43 days of age, but the difference was not statistically significant. Although weight gain and feed efficiency were improved with liquid diets, incorporation of fat into a liquid diet did not improve fat utilization. Equalizing nutrient intake, other than energy intake, demonstrated that protein and other nutrient intakes were not limiting efficient utilization of fat."

Frobish et al. (1970) reported the apparent digestibility of fat increased significantly between 10 and 28 days on experiment, however, fat addition failed to consistently improve either gain or feed efficiency.

They concluded that young pigs cannot utilize efficiently the fat sources tested and further suggest that protein source may influence the efficiency with which fat is utilized.

In early weaned pigs the apparent digestibility of dry matter, energy, crude protein and ether extract was higher for 7- than for 3-week old pigs. The greatest difference was in the ether extract fraction with no significant effect of age on carbohydrate digestibility. Apparent digestibility of fat decreased with the increase in mean molecular weight of the contained fatty acid, especially in the younger pig (Lloyd et al., 1957). When lard, tallow, soybean oil and coconut oil were added in levels up to 38% of the diet, the digestibility of fat, protein and dry matter by the baby pig increased significantly from 3 to 6 weeks of age and was unchanged between 6 and 9 weeks of age. Fat did not improve feed efficiency and tended to decrease rate of gain indicating relatively inefficient utilization of the fats tested (Eusebio et al., 1965).

Frobish et al. (1971) found age had little effect on lipase activity. Addition of tributyrin to the diet resulted in a significant reduction in gains, significant improvement in fat digestibility, but had little effect on feed per unit of gain or serum lipase activity. Apparent digestibility of fat increased significantly with increasing levels of fat in the diet and with increasing age. Serum lipase activity increased significantly only with increasing fat levels. Plasma fatty acids were not appreciably affected by source or level of fat or by age.

Bayley and Lewis (1965) using beef tallow, H.E.F. (a partially hydrolyzed mixture of plant and animal fats supplied by Procter and Gamble), soybean oil and purified fatty acids, demonstrated in newly weaned pigs, that although the digestibility of each fatty acid is to some extent a

characteristic of the acid, the extent of absorption can also be modified by the other acids in the diet. They found no clear difference between fatty acids in the free form or as the triglyceride. Carlson and Bayley (1968) reported digestibility of corn oil, lard and beef tallow to be 86, 81 and 56% respectively in young pigs. In comparing conventional and germ free pigs they found digestibility of the various fatty acids appear to be the result of micro floral activity rather than the direct result of the pigs ability to absorb these fatty acids. Data was obtained by gas-liquid chromatography at 6 different levels of the digestive tract. Sewell and Miller (1965) using a purified diet with 0.41% total lipid to study utilization of corn oil, beef tallow and lard by young pigs found no differences in performance. However in digestion trials absorption of 18:0 fatty acids were significantly higher than 16:0, 18:1 and 18:2 acids. Also, absorption of 16:0 fatty acids were poorer than the unsaturated acids 18:1 and 18:2. Lloyd and Crampton (1957) found a highly significant inverse relationship between mean molecular weight (chain length) of fatty acids of the various fats and oils and their apparent digestibility by suckling pigs and guinea pigs. They attributed approximately 30% of the variability in apparent digestibility to chain length and indicated degree of saturation to be only of minor importance.

Pond et al. (1960) reported significant improvement in the gains of growing-fattening pigs fed 10% added stabilized beef tallow to high protein diets (18-20%), but no improvement when added to low protein (10-12%) rations. There was a decrease in average daily feed consumption, but daily TDN was increased. The average TDN and protein required per pound of gain were reduced by adding fat at both protein levels. Peo et al. (1957) fed baby pigs rations of varying protein (15, 20, 25 or 30%) and added fat (0, 2.5, 5.0 or 10%). Response to protein levels produced a linear regression

during the first two-week period with maximum gains on 30% protein, while over the total four week period, at all fat levels, gains were maximum at 20% protein. Fat levels did not effect gains but improved appearance of pigs and physical character of the ration. Increasing protein levels improved feed efficiency throughout the four-week period. Although fat levels showed little effect upon feed efficiency over the entire period, increased fat levels reduced efficiency during the first two weeks.

Abernathy et al. (1958), using 0, 5 and 10% added tallow for growing finishing pigs, noted significant linear increases in gains obtained by fat addition to increase the caloric density of isonitrogenous diets. Feed consumption was reduced with increasing caloric density and a corresponding decrease in the growth-inhibitory effect of lysine supplementation was also apparent with increasing dietary energy levels. Efficiency of feed utilization progressively improved with increasing caloric density.

Clawson et al. (1962), using rations with graded levels of protein (10 to 18%) and formulated so similar ratios of amino acids were maintained, reported feed consumption to be influenced by both calorie-protein ratios and fat levels. Gross energy intake was not increased by either of the treatments. Initially, growth rate was influenced by the energy-protein ratio, the narrower ratio supported the most rapid growth, but this was not noted at market weight. Added fat improved both rate of gain and feed utilization. Energy utilization was not influenced by either caloric-protein ratio or level of fat. Wagner et al. (1963) reported inconsistent effect on gains but less feed required per unit gain with higher energy rations in his evaluation of the protein energy relationship.

Baird et al. (1958) using 0, 5 and 10% tallow and high (20, 19 and 17%) and low (15, 13 and 11%) protein found no effect on rate of gain, but noted improved feed efficiency with increased caloric density. There

was also negative correlations between calorie-protein ratio and average daily gain and between average daily gain and feed efficiency. The addition of fat to the diets increased the cost of gain on low protein rations but reduced the cost of high protein ration gains. Noland and Scott (1960) used diets containing three levels of protein (12, 16 and 20%) each at three energy levels (950, 1050 and 1200 calories per pound) by adjusting added stabilized fat and rice hulls. They reported when protein and energy intake were varied, differences noted occurred between weaning and 75 pounds. A significant linear effect of protein was noted along with a protein by energy interaction. Calorie-protein ratios of 49 to 75 produced fastest gains early while a ratio of 100 resulted in faster gains later. More efficient gains and lowered daily feed intake resulted as increased levels of energy were consumed. Clawson et al. (1956) fed three levels (0, 10 and 20%) of added animal fat in each of three rations containing 8000, 9000 and 11000 calories per pound of protein. They also obtained faster gains at lower protein-energy ratios up to 75 pounds, but over the entire fattening period attributed little difference to protein-energy ratios in relation to daily gains or feed required per pound of gain.

Boenker et al. (1960) used rations containing three levels of protein (13, 16 and 19% reduced to 10, 13 and 16% after pigs reached 125 pounds) and three levels of metabolizable energy (1266, 1430 and 1592 calories per pound) which were adjusted by additions of ground corn cobs and stabilized animal grease. They found calorie-protein ratios had no effect on growth, feed efficiency or digestibility of the ration. From weaning to 125 pounds, gain and feed efficiency improved as the level of energy in the ration, but protein had little effect on either gain or efficiency. From 125 to 200 pounds the pigs gained faster with increased levels of energy and only when protein was reduced to 10% did slower gains occur. Feed efficiency

improved linearly with energy levels. Ether extract digestibility increased with the addition of fat while increased fiber caused a decrease in digestibility of ration nutrients.

The protein requirement for baby pigs on a high fat diet (21%) to produce optimum growth and economy of feed conversion was found to be 30.8% (Manners and McCrea, 1963). By replacing carbohydrates with fat both feed conversion and growth were depressed. In agreement with other research, the optimum ratio of energy-protein was always found to be narrower than that of sows milk.

Kurgvial et al. (1962) utilized stabilized beef tallow supplemented at 0, 15 and 30% (gross energy levels of 4.0, 4.8 and 5.4 k cal/g.) and 14, 18 and 22% protein in rations for growing-finishing pigs and weanling rats. They noted fat supplementation decreased feed consumption, increased average daily gain and improved efficiency of digestible energy and feed utilization in pigs. In general, higher protein levels resulted in increased feed consumption, increased rate of gain, and improved efficiency of digestible energy and feed utilization.

Other research indicating poor utilization of fat by young pigs is hard to interpret since pigs utilize sows milk well which is 30-40% lipid on a dry matter basis. Previous responses may have been compounded by differences in intake of other nutrients. Allee (1970) demonstrated isocaloric addition of fat to diets of both young and finishing pigs significantly improved the gain/feed ratio and tended to increase daily gain. Young pigs were able to utilize fat calories as well as carbohydrate calories.

Sources of Milk and Their Value in the Young Pig Ration

Dairy products of various types are an excellent source of many nutrients, including high quality protein, vitamins, a good mineral balance and the beneficial effect of lactose. The value of dairy products in swine rations in general is one of economics and thus are very seldom used except for a few isolated areas. Based on the merits of these milk products, however, it may be desirable to include them in pre-starter and starter rations.

Jones and Pond (1964) using 18 or 21% protein rations or a similar ration containing 12% added corn oil, reported significantly faster gains from 3-9 weeks of age with dried whole milk compared to soybean meal in the ration. Gains were improved with the addition of dried skim milk to the ration, however, the difference only approached significance while fat added to soybean meal had little effect. From 9 weeks of age to market weight, dried whole milk and soybean meal plus fat promoted faster gains due to their high fat content. In general, diets with dried whole milk produced fastest gains and greatest digestible energy intake, but digestible energy per pound of gain was almost identical for all groups.

Kotal (1969) found 55% spray-dried skimmed milk best met the requirements for a pre-starter, however, dried whole milk was superior to spray-dried skimmed milk for performance. Up to 15% soybean oil meal could be included in the milk substitute, but dried yeast was superior to oil meal. A ratio of between 1:3.3 and 1:4.6 crude protein to total digestible nutrients was best.

Schendel and Johnson (1953) reported normal weight gains in baby pigs when fed reconstituted skim milk diets, supplemented with vitamins A, D, E and K as well as the minerals iron, copper and manganese. Marked improvement in feed efficiency was obtained with 30% added fat.

Becker et al. (1954) found during the first four weeks of age, growth, feed intake and efficiency of gain, gradually improved with increased protein from 10.2 up to 22.4% when dried skim milk was the sole source of protein. At this age, pigs required 22% milk protein in the synthetic milk diets of the caloric density used. Pigs from 5-9 weeks of age required a minimum of 12 percent milk protein for satisfactory performance. Regardless of whether dry fed or gruel fed, results were similar, but gruel feeding tended to increase intake and thus greater gains were obtained. Sewell et al. (1953) reported growth was slow at 16 and 20% protein and maximum at 30% protein, but 24 and 28% protein gave relatively satisfactory results in pigs from 2 to 30 days of age, fed a casein and an isolated soybean protein diet supplemented with methionine. Reber et al. (1953) found maximum performance from 12 to 24 days of age on 41% protein when casein was the sole protein source, and 8 week old pigs needed 20% protein. Becker et al. (1954) reported a decrease in protein required during the normal suckling period and attributed the above differences to the quality of protein.

Greatest gains and feed efficiency were found in starter rations containing 30% dried skim milk and 10% dried whey (Danielson et al., 1960). Gain and feed efficiency were both depressed with levels of dried whey above 10%. Gains of older pigs were greater if they had previously received dried whey compared to a 40% skim milk ration but feed per gain was not affected.

Lantzsch and Schneider (1969) in comparison of digestibility of roller-dried sweet whey, sour whey and skimmed milk reported digestibility of sour whey nutrients and energy to be about 10% lower than the other products. Protein digestibility was 82.8% for sour whey, 99.7% for skimmed milk and 95.7% for sweet whey; however, in another trial, sweet whey was only 70% digestible. No digestive upset was noted.

Crane (1953) using a diet of dried skimmed milk and 10% whey found optimum growth rate and efficiency for pigs fed 40% skimmed milk. Also he noted the most rapid growth rate with a level of 10% added fat.

When high levels of dried whey (35 and 70%) were fed, the addition of lactase did not improve either growth rate or feed efficiency. With 25 and 50% dried whey, gains were improved by the addition of dried skimmed milk in one trial while adding soybean meal and meat and bone scraps, promoted the most rapid efficient gains in another trial. Adding NaCl tended to depress both gains and efficiency (Hanson et al., 1957).

Krider et al. (1949) reported the addition of various whey products as a source of water soluble vitamins, tended to produce a laxative effect due to the lactose content. No detrimental effect to rate and economy of gain was noted. At low levels, less scouring occurred and the non-lactose constituents, probably the B₂ vitamins contributed to nutrition and improved gains when compared to higher levels. Efficiency was improved due to some unidentified essential nutritional factors supplied by the whey. Vohs et al. (1951), also found more rapid growth with the addition of whey and indicated it supplied growth factor(s) other than or in addition to vitamin B₁₂.

Becker et al. (1957) in using high levels (30 and 60%) of dried whey to replace carbohydrates, reported no diarrhea in suckling pigs when substituted for dextrose. In finishing pigs, high levels (60%) produced diarrhea and depressed gains although efficiency was not affected. At lower levels (0, 5, 10, 20%) performance was satisfactory and only a slight diarrhea was evident at 40%. In weanling pigs, 20 or 30%, whey decreased rate of gain and feed intake and a moderate diarrhea occurred. Roller-dried whey produced faster gain and greater feed intake in weanling pigs

than spray-dried whey in a casein plus methionine protein diet, but the drying method had no effect on efficiency.

Miller (1972) reported for early weaned pigs (3 or 4 weeks of age) the incorporation of up to 20% dried whey in a grower type ration improved growth rate. Superior growth rate was obtained on a more expensive ration containing 10% dried skimmed milk. He found maximum growth, efficiency and economy of gain and maximum nitrogen retention with 15% dried whey.

Palatability Factors

Palatability of a feed is one of the most important, if not the single most important factor in feeding swine. Carroll, Krider and Andrews (1962) stated in their book: "Best gains of young pigs are obtained when a palatable complete ration is fed. Some of the feed ingredients which have proved to be palatable to baby pigs are hulled oats or oat groats, rolled oats, dried skim milk, shelled corn, coarsely ground corn, protein supplements, sugar and saccharin. 'Crumbled' and pelleted feeds are preferred over meal type rations."

Lewis et al. (1955) reported the addition of sugar in starters of either the meal or pelleted form significantly improved feed efficiency. Pelleting alone also significantly improved feed efficiency. The addition of sugar within the pelleted starter was preferred to sugar coating and increased early starter consumption. Lewis et al. (1953) earlier noted with the inclusion of sugar in the diet an improved gain and efficiency of young pigs.

Diaz et al. (1956) reported improved gains and feed efficiency of pigs with the addition of refined cane sugar and unrefined cane sugar but not sugar from invert cane molasses to the ration. No differences in caloric or ash values would explain the trend, therefore, the increased

daily intake, improved metabolism of other nutrients or both must be due to increased levels of refined sugar.

Aldinger et al. (1959) noted pigs generally prefer a ration that contains some level of saccharin as compared to no saccharin and this was especially pronounced when the feed was in a pellet or crumbled form.

Jensen and Becker (1965) found no effect on rate of gain due to pelleting. Intake of pellets was variable with extreme hardness or powdery texture causing a reduction in voluntary intake especially for the first few days. In general, pelleting resulted in an improved gain-feed ratio. Pelleting and regrinding the cereal portion prior to mixing gave similar results to just pelleting the ration. This resulted in less crude fiber, more total nitrogen and the starch fraction was more susceptible to enzymatic action. Dinusson et al. (1951) increased the value of barley in a swine ration by first pulverizing it to minimize the effect of fiber and then pelleting to increase the palatability of a dusty mixture. The cost of pelleting was more than offset by increasing gains and feed efficiency. Thomas and Flower (1953) also found pelleted rations to out-perform meal types. Pigs on pelleted rations gained faster, required less feed to reach market weight and reached market weight sooner, more than absorbing the extra cost of pelleting.

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EXPERIMENTAL PROCEDURE

Two creep feeding trials, involving litters which were farrowed in July and September, and a nursery feeding trial were conducted to evaluate the usefulness of dried skim milk, dried whey and added animal fat in rations for the young growing pig. The same starters were used in all three trials. The nursery phase was conducted on pigs from the July farrowing.

The initial phase, involving two trials with suckling pigs, was conducted in an environmentally modified farrowing house with a total slotted floor and a circulating oxidation ditch below. All litters were weighed at 14 days of age to obtain a beginning weight for each individual pig. On day 14, a small creep feeder was placed near the rear of the farrowing crate in a dry, well-lighted area. A small amount (.23 kg) of the assigned, pelleted ration was placed in the feeder. Feeders were checked twice daily to assure there was fresh, dry feed available at all times. Feed was added as needed and any wet feed or meal was removed and weighed. If feed was not consumed by the third day, it was removed, weighed and replaced with fresh feed. A complete record of feed additions and removals was maintained to determine consumption. At the end of two weeks, as litters reached 28 days of age, each pig was weighed to obtain a final weight and feed consumption was determined. Pigs had access to fresh water at all times.

To obtain a balance, litter groupings were randomized within breed of dam and number of litters previously farrowed. Litter groups were then randomly assigned to the rations.

As litters reached 28 days of age, the intake of the sow was limited to 1.82 kg of feed per day. This practice was followed in an attempt to limit milk production of the sow and in so doing, gradually convert pigs to eating more dry feed.

The second phase, a feeding trial involving weanling pigs, was conducted with the July litters. These pigs were weaned at approximately 5 weeks of age and housed in the nursery wing. This wing consisted of a series of pens along each side, with a total slotted floor and a circulating oxidation ditch below. Each 1.83 x 3.35 m pen contained an automatic waterer and a 2-hole self-feeder. Pigs were allotted to pens to balance breed, litter, weight and sex. As litters were weaned, they were moved to the nursery and divided into the appropriate pens. Each pen contained 10 pigs and there were four replicates on each ration. A one week period of adjustment followed and at approximately 6 weeks of age, pigs were individually weighed to start a four week trial. A record of feed added and feed removed because of wet or mealed feed was kept to determine actual feed consumed. All pigs and feeders were checked twice daily.

All trials were conducted with five rations, based on a corn-soybean meal standard with 15% skim milk and 12% sugar. The experimental rations developed from this standard contained either 3 or 5% added fat in place of corn and dried skim milk was replaced with dried whey in the rations containing added fat. The rations were mixed and pelleted by the Department of Grain Science at Kansas State University. Composition of the basal ration is listed in Table 1. Table 2 contains the proximate analysis of the five rations.

The data were analyzed using analysis of variance and Duncan's new multiple range test for differences between means. In the first phase with suckling pigs, average daily gain per pig and average feed intake per pig were examined. In the second phase involving weanling pigs, average

daily gain, feed efficiency and average daily feed intake were of interest. The relationship between pre weaning rations and post weaning gains and the relationship between the interaction of pre and post weaning rations and post weaning gains was studied.

Phase I Trial 1

This trial involved July farrowed pigs from 24 litters; 8 Duroc, 2 Hampshire, 3 Yorkshire and 11 cross-bred, a total of 225 pigs. Small pigs from large litters were moved to sows with smaller litters of the same age to allow adequate nursing space. At two weeks of age, litters were started on a two-week creep feeding trial.

Pigs in this trial were also involved in an anemia experiment. This experiment consisted of various sources and amounts of supplemental iron. Micro hematocrits were determined on samples of blood obtained from pricking an ear vein. All values obtained were within the normal range and no significant differences were noted.

Phase I Trial II

A similar pre weaning trial was conducted utilizing 27 litters of September pigs (10 Duroc, 8 Hampshire, 8 Yorkshire and 1 cross-bred). The 198 pigs used in the trial were offered creep at 14 days of age with a two week observation period. No other research was in progress during this period for these pigs.

Phase II

Following weaning, 200 pigs from the July litters were allotted to a post weaning trial using the same five starter rations. Each treatment was replicated 4 times with 10 pigs in each replicate. A four week feeding

trial was conducted. One pig developed posterior paralysis 5 days before the trial was finished and was removed. A weight was recorded at the time of removal and computations were based on pig days for that pen.

RESULTS

Phase I Trial I

Five pelleted rations were used in this creep feeding trial. As presented in Table 1, the standard ration contained dried skim milk with no added fat. Experimental rations contained dried skim milk with 3% added fat; dried skim milk with 5% added fat; dried whey with 3% added fat; and dried whey with 5% added fat. All rations were very similar in crude protein as shown in Table 2, varying from 19.1 to 20.1 percent.

This trial showed no significant difference ($p < .05$) in average daily gain for any of the rations. Table 3 shows the average gain for pigs during the 14 day trial. The average daily gain over all treatments was .21 kg per day. The average daily gains by treatment are as follows: dried skim milk with no added fat, .21 kg; dried skim milk with 3% added fat, .20 kg; dried skim milk with 5% added fat, .21 kg; dried whey with 3% added fat, .22 kg; and dried whey with 5% added fat, .20 kg.

No significant differences, ($p < .05$), between average feed intake of the five treatments were noted. The average intake per pig over all treatments was .57 kg of feed. Average intake per pig for each ration is shown in Table 3.

Phase I Trial II

The second trial was conducted in the same manner with the same rations as the first. Pigs from the September farrowing were used. The same variables as the previous data were analyzed.

Table 1. Composition of Basal Starter Ration

<u>Ingredient</u>	<u>Percent</u>
Ground yellow corn	35.15
Rolled oat groats	15.00
Soybean meal (50%)	19.00
Sugar	12.00
Dried skim milk	15.00
Ground limestone	.40
Dicalcium phosphate	1.20
Salt	.50
TNT ¹	1.25
Vit-min premix ²	.50

1

Contains 4 grams oxytetracycline hydrochloride, 2.8 grams neomycin and 400,000 U.S.P. units Vit. A palmitate per pound.

2

Contains 900,000 I.U. of Vit. D₃, 48 grams of Niacin, 16 grams of Riboflavin, 32 grams pantothenic acid, 160 grams of choline chloride, 114 grams of santoquin, 40 milligrams of Vit. B₁₂, 88 I.U. of Vit. E, 100 ppm Mn, 100 ppm Fe, 50 ppm Zinc, 10 ppm Cu, 3 ppm Iodine and 1 ppm cobalt.

Table 2. Analysis of Starter Rations Fed

<u>Ration</u>	<u>Sk. milk</u> <u>+0% Fat</u>	<u>Sk. milk</u> <u>+3% Fat</u>	<u>Sk. milk</u> <u>+5% Fat</u>	<u>Whey</u> <u>+3% Fat</u>	<u>Whey</u> <u>+5% Fat</u>
Crude protein (%)	19.10	19.90	19.80	20.10	19.30
Ether extract (%)	3.02	4.87	7.17	3.63	5.54
Crude fiber (%)	1.69	1.76	1.67	1.65	1.74
Total ash (%)	5.17	5.06	5.10	5.65	5.40
Calcium (%)	.78	.71	.69	.68	.75
Phosphorous (%)	.70	.69	.69	.68	.68
Calculated D. E. for Swine (k cal/kg)	722.60	751.40	770.60	728.97	748.16

Table 3. Growth and Starter Ration Intake by Pigs
From 14 to 28 Days of Age

Ration	Sk. milk +0% Fat	Sk. milk +3% Fat	Sk. milk +5% Fat	Whey +3% Fat	Whey +5% Fat
July litters	5	4	5	5	5
No. pigs	46	33	50	47	49
Avg. gain/pig (kg)	3.02	2.83	2.98	3.15	2.75
Avg. feed intake/pig (kg)	.55	.45	.63	.43	.75
September litters	5	5	6	5	5
No. pigs	37	41	45	47	30
Avg. gain/pig (kg)	3.12 ^a	3.48 ^b	3.34 ^{ab}	2.95 ^{ac}	3.46 ^{ab}
Avg. feed intake/pig (kg)	.40	.30	.58	.47	.69
All litters	10	9	11	10	10
No. pigs	83	74	95	94	79
Avg. gain/pig (kg)	3.06	3.19	3.15	3.05	3.02
Avg. feed intake/pig (kg)	.47	.36	.60	.45	.72

abc

Means with different superscript letters on the same line are statistically different ($p < .05$).

A significant ($p < .05$) milk product by fat interaction was noted. The average daily gain over all treatments was .24 kg per pig per day. Average daily gains for each of the five treatments are as follows: dried skim milk with no added fat, .22 kg; dried skim milk with 3% added fat, .25 kg; dried skim milk with 5% added fat, .23 kg; dried whey with 3% added fat, .21 kg; and dried whey with 5% added fat, .25 kg. Table 3 shows average total gains over the period.

Dried skim milk with 5% added fat produced significantly faster gains than dried whey with 3% added fat. The ration containing dried whey with 5% fat also produced significantly higher gains than dried whey with 3% fat. In a third comparison, it was found that dried skim milk with 3% fat produced significantly faster gains than dried whey with 3% fat. The

final difference was found between dried skim milk with 3% added fat and dried skim milk with no added fat. In this case, dried skim milk with 3% added fat produced faster gains. All other comparisons were statistically not significant.

From Trial II data, no significant differences in feed intake were obtained. Average intake per pig over all treatments was .49 kg. Means for each treatment is shown in Table 3.

Table 3 also includes means for both Trial I and II. The gain per pig over the 14 day period for all treatments was 3.11 kg which is .22 kg per day. Intake over all treatments for the 14 day period was .53 kg of feed per pig. Average daily gains for each of the five treatments over both trials were: dried skim milk with no added fat, .22 kg; dried skim milk with 3% added fat, .23 kg; dried skim milk with 5% added fat, .23 kg; dried whey with 3% added fat, .22 kg; dried whey with 5% added fat, .22 kg.

Phase II

The second phase was conducted on weanling pigs previously used in Phase I Trial I. The same five rations used in the creep feeding trial were used as post weaning rations. A 28 day trial was conducted to evaluate the influence of these rations on average daily gain, feed efficiency and feed intake.

The average initial and final weights for pigs in all replicates of each treatment were very similar as shown in Table 4.

No significant differences were found ($p < .05$) in average daily gain between the various rations. Table 5 shows the mean for the replicates within each ration group and the average for each ration. The overall average daily gain in this post weaning trial was .46 kg per day.

Table 4. Phase 2 - Growth Performance of Nursery Age Pigs (6-10 Wks) on Starter Rations

Starter	Sk. milk +0% Fat	Sk. milk +3% Fat	Sk. milk +5% Fat	Whey +3% Fat	Whey +5% Fat
<u>Average initial weight (kg)</u>					
Rep. 1	17.41	18.41	17.64	18.00	18.41
Rep. 2	16.55	18.00	18.00	17.68	16.82
Rep. 3	14.86	16.64	15.14	15.18	15.50
Rep. 4	12.91	11.14	12.45	11.91	11.36
Avg.	15.41	16.05	15.82	15.68	15.55
<u>Average final weight (kg)</u>					
Rep. 1	31.32	31.27	32.23	32.32	33.64
Rep. 2	32.86	32.36	32.36	31.09	31.59
Rep. 3	26.05	30.41	29.91	28.05	27.95
Rep. 4	23.00	22.09	23.59	21.82	21.82
Avg.	28.32	29.05	29.55	28.32	28.77

Further analysis of these data indicated no differences in average daily feed intake between the various rations ($p < .05$). The summary of averages for each pen within the group and overall average is presented in Table 5. The average for all pigs was .94 kg of feed per head per day.

Feed efficiency for each treatment was similar, however a linear improvement in the feed/gain can be seen with the corresponding increase in caloric density of the ration. The average for all pigs was 2.04 kg of feed per kg of gain.

Rations previously fed as creep significantly ($p < .05$) affected gains in the nursery. Pigs previously fed rations containing dried whey with 3% added fat, gained faster in Phase II than did pigs previously fed rations of dried whey with 5% added fat. If pigs were fed rations of dried skim milk with 3% added fat in Phase I, they gained faster in Phase II

than did pigs which had been fed dried whey with 5% added fat. Pigs fed rations containing dried whey with 3% added fat, when compared to pigs fed dried skim milk with no added fat, in Phase I gained faster during Phase II. When comparing gains in Phase II for pigs fed dried skim milk with 5% added fat, and dried whey with 5% added fat, in Phase I, faster gains were obtained from pigs fed dried skim milk with 5% added fat. Pigs which were on creep of dried skim milk with 3% added fat, also out-performed pigs which had been creep fed dried skim milk with no added fat. Nursery gains were higher if pigs had previously been fed dried skim milk with 5% added fat than if fed with no fat added. These data are summarized in Table 6.

Table 5. Phase 2 - Growth Performance of Nursery Age Pigs
(6-10 Wks) on Starter Rations

Starter	Sk. milk +0% Fat	Sk. milk +3% Fat	Sk. milk +5% Fat	Whey +3% Fat	Whey +5% Fat
<u>Average daily gain (kg)</u>					
Rep. 1	.50	.46	.52	.51	.55
Rep. 2	.49	.51	.51	.48	.53
Rep. 3	.40	.49	.53	.46	.45
Rep. 4	.36	.39	.40	.35	.37
Avg.	.44	.46	.49	.45	.47
<u>Average daily feed intake (kg)</u>					
Rep. 1	1.04	1.01	1.00	1.09	1.11
Rep. 2	1.01	1.00	.98	1.04	1.05
Rep. 3	.86	.90	.93	.99	.95
Rep. 4	.77	.75	.80	.74	.77
Avg.	.92	.91	.93	.96	.97
<u>Average kg feed per kg of gain</u>					
Rep. 1	2.08	2.20	1.92	2.14	2.02
Rep. 2	2.06	1.96	1.92	2.17	1.98
Rep. 3	2.15	1.84	1.75	2.15	2.11
Rep. 4	2.14	1.92	2.00	2.11	2.08
Avg.	2.09	1.98	1.90	2.13	2.06

Table 6. Post Weaning Performance Grouped
By Pre Weaning Ration

	Sk. milk +0% Fat	Sk. milk +3% Fat	Sk. milk +5% Fat	Whey +3% Fat	Whey +5% Fat
Avg. daily gains (kg)	.41 ^a	.50 ^b	.50 ^b	.49 ^b	.42 ^a

ab

Means with different superscript letters are significantly different
($p < .05$).

DISCUSSION

Phase I Trial I

During the first creep feeding trial no significant differences were noted in either average daily gain or feed intake per pig. These results are supported by literature reviewed reporting baby pigs could not utilize fat well (Asplund et al., 1960; Frobish et al., 1969; Eusebio et al., 1965 and Peo et al., 1957). Crampton and Ness (1954) similarly found little improvement in gains and no effect of fat upon intake. Frobish et al. (1970) reported inconsistent improvement in performance with fat additions suggesting that young pigs cannot efficiently utilize fat.

No noticeable difference was seen in the comparison of dried skim milk and dried whey. This would suggest dried whey, which is less costly, may be useful in creep rations. Becker et al. (1957) and Miller (1972) successfully fed dried whey in rations for young pigs. Danielson et al. (1960) and Crane (1953) obtained best results with combinations of dried skim milk and dried whey in rations for young pigs. One factor which may have influenced these results is the dams milk production, however, no means of accounting for this variable is present in the trial conducted.

Phase I Trial II

This trial consisted of the same procedure and analysis as the previous trial. There were no differences noted in feed intake per pig, thus agreeing with the first trial and the literature discussed.

From data compiled and analyzed for average daily gain, a milk

product by fat interaction was noted. The differences noted would logically seem attributable to increased energy content of the various rations. Energy calculations were made based upon digestible energy for swine and are shown in Table 2.

These data agree with the findings of Kennington et al. (1958); Abernathy et al. (1958); Boenker et al. (1960); and Allee (1970). Sewell and Carmon (1959) found that gains were fastest on high energy rations with growing-finishing pigs. Kurgvail et al. (1962) reported fat improved daily gain in growing-finishing pigs. Crane (1953) reported fastest growth rate when fat was added to rations containing dried skim milk or dried whey.

Increased energy is not totally responsible for the differences seen since no linear pattern was noted. The failure of the highest energy ration to perform more favorable is somewhat hard to explain, however, other nutrients may be the limiting factor, as suggested by Allee (1970).

Rations containing dried skim milk with no added fat and dried whey with 3% added fat were designed to have similar total fat content. Also, rations containing dried skim milk with 3% added fat and dried whey with 5% added fat were likewise designed for similar total fat content. As would be expected, performance on each of the similar pairs was comparable. However, performance on dried skim milk with 5% added fat was between these two pair and thus does not fit the pattern for total ether extract in relation to gain. This could be related to lack of some other nutrients needed for the full utilization of the extra energy, accounting for the slight depression in gains. Frobish et al., (1970) suggested protein source may influence the efficiency with which fat is utilized.

As noted in Table 3, there is the tendency for more feed to be

consumed by pigs which were on rations with the high levels of added fat. This trend was not significant ($p < .05$) in either trial, possibly because of improved palatability due to reduced pellet hardness with added fat. Jensen and Becker (1965) reported intake of pellets was variable with extreme hardness or powdery texture causing reduction in voluntary intake, especially for the first few days.

Phase II

This phase was conducted to determine the value of the milk products and fat levels for pigs after weaning, with no performance differences noted in average daily gain, feed efficiency or feed intake. Asplund et al. (1960) reported only slight improvement in ether extract and protein digestibility by adding 10-20% grease to rations of 8 week old pigs. Frobish et al. (1969) found improvement of digestibility of fat from 25 to 43 days of age to be non-significant. Frobish et al. (1970) again found increased digestibility of fat between 10 and 28 days on trial, however, performance was inconsistent. Eusebio et al. (1965) also reported no improvement in fat utilization from 6 to 9 weeks of age and thus no improvement in performance. Wagner et al. (1963) reported inconsistent effects upon gains with higher energy rations.

Dried whey and dried skim milk produced equal performance in this trial. This points favorably toward the use of dried whey to reduce feed cost. Miller (1972) obtained superior growth rate with 10% dried skim milk but maximum economy of gain was obtained with 15% dried whey in the ration.

A trend toward improvement in feed efficiency can be noted in Table 5, although it is not significant. This trend should be expected because

of the increased energy content of the feed consumed. These data agree with Frobish et al. (1970) in that protein may be a limiting factor.

Data were analyzed to determine if previous treatment had any effect upon later average daily gains or if there was an interaction between the pre and post weaning ration. Only differences in pre weaning ration were found with no influence from rations fed post weaning. Pigs which received dried skim milk with 3% added fat, dried skim milk with 5% added fat, or dried whey with 3% added fat during Phase I gained faster in Phase II than those which were fed dried skim milk with no added fat or dried whey with 5% added fat in Phase I. Danielson et al. (1960) suggested pigs which had received dried whey previously showed greater gains later when compared with those that had received a 40% skim milk ration. Pigs which were fed dried skim milk with no added fat and dried whey with 5% added fat in Phase I were slightly lighter initially at weaning. Pigs which were heavier at weaning would be expected to continue to gain faster and require less time to reach market weight.

SUMMARY

Two creep feeding trials involving separate farrowings and a subsequent post weaning trial involving the first farrowing were conducted to evaluate dried skim milk, dried whey and two levels of added fat as ingredients in a starter ration for the young growing pig. The relationship between pre weaning rations and post weaning gains and the relationship between the interaction of pre and post weaning rations and post weaning gains was examined. Five rations used included: a standard corn-soybean base with 15% skim milk and 12% sugar; adding 3 or 5% edible fat to the standard in place of corn; or substituting dried whey for the dried skim milk and adding 3 and 5% fat.

No significant differences ($p < .05$) were found in either gain or feed consumption when the two creep trials were combined.

Rations containing dried skim milk with 3% added fat, dried skim milk with 5% added fat and dried whey with 5% added fat produced faster gains than dried whey with 3% added fat. Pigs fed dried skim milk with 3% added fat also gained faster than those fed dried skim milk with no added fat. These results are not totally contributable to total energy content because a linear pattern was not present. Thus, other nutrients may have influenced these results. Rations containing dried skim milk with no added fat and dried whey with 3% added fat contained similar energy content as did rations containing dried skim milk with 3% added fat and dried whey with 5% added fat. Performance for each pair was very similar.

More feed tended to be consumed when higher fat rations were fed,

probably due to increased palatability with reduced pellet hardness.

During the post weaning trial no significant differences ($p < .05$) were noted in average daily gain, feed efficiency and feed intake. A trend for linear improvement in feed/gain with increases in caloric density was noted. No interaction was found between pre and post weaning rations as it related to daily gain. The creep ration significantly influenced subsequent average daily gain. When creep rations containing dried skim milk with 3% added fat, dried skim milk with 5% added fat and dried whey with 3% added fat were fed, post weaning gains were higher than those of pigs which had been fed creep rations with dried skim milk with no added fat and dried whey with 5% added fat. Pigs which received dried skim milk with 3% added fat, dried skim milk with 5% added fat and dried whey with 3% added fat were slightly heavier at weaning and thus maintained their advantage to gain post weaning.

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RESPONSE OF GROWING SWINE TO STARTER RATIONS
WITH SKIM MILK, WHEY AND VARYING AMOUNTS OF FAT

by

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ABSTRACT

Two creep trials with two farrowings (225 and 198 pigs) and a post weaning trial with 200 pigs from the first trial were conducted to determine the value of dried skim milk and dried whey with 3 and 5% added fat in rations for young growing pigs. The relationship between pre weaning rations and post weaning gains and the relationship between the interaction of pre and post weaning rations and post weaning gains was examined. The basal ration was a corn-soybean meal base with 15% dried skim milk and 12% sugar. Experimental rations consisted of the basal ration with either 3 or 5% added fat in place of corn or replacement of dried skim milk with dried whey and the addition of 3 or 5% added fat.

One creep trial produced no significant differences ($p < .05$) in either ADG or feed intake. Differences in ADG were noted in the other creep trial. Dried skim milk with 3% added fat, dried skim milk with 5% added fat and dried whey with 5% added fat produced faster gains than did dried whey with 3% added fat. Gains were also faster for dried skim milk with 3% added fat than those of dried skim milk with no added fat. Pigs fed rations with increased caloric density resulted in improved performance, however, this difference was not linear. A trend, in both trials, of increased feed consumption on higher fat diets was also noted, possibly due to improved palatability because of reduced pellet hardness.

The post weaning trial produced no significant differences ($p < .05$) in ADG, F/G or daily feed consumption. A trend was noted in F/G. Linear

improvement was found with increasing caloric density. No interaction between pre and post weaning rations was found as it related to post weaning gain. There were considerable differences in post weaning gains when analyzed for the effect of the pre weaning ration. Pigs fed creep rations of dried skim milk with 3% added fat, dried skim milk with 5% added fat and dried whey with 3% added fat subsequently out-gained those fed creep rations of dried skim milk with no added fat and dried whey with 5% added fat. Pigs which received rations of dried skim milk with 3% added fat, dried skim milk with 5% added fat and dried whey with 3% added fat were slightly heavier at weaning and thus maintained their advantage to gain post weaning.