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RATIOS OF DRIED SKIMMILK AND DRIED WHEY FOR PIG STARTER RATIONS [1]

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LACTOSE and sucrose were reported by Hudman (1956) to be preferred carbohydrates for pig starter rations. Lactose gave the best growth response when fed with soybean oil meal; sucrose with milk protein. From the analysis listed by Morrison (1956), both dried skimmilk and dried whey must be considered as a source of lactose since, on an average, these products contain 51.1 and 70.1% lactose, respectively. In addition, both contain a high quality protein.

In 1953, Crane observed that pigs gained more rapidly on a ration containing 40% dried skimmilk than on one containing 35% dried skimmilk and 10% dried whey. Hanson *et al.* (1957) reported that dried skimmilk improved a 50% dried whey diet for young pigs. Meade *et al.* (1957) when studying dry formulas for baby pigs used rations containing 10% sugar with dried whey at levels from 5 to 30%. The addition of whey increased weights of the pigs from 3 to 11%.

It was the purpose of this experiment to determine the effect of various combinations of dried skimmilk and dried whey on gains and feed efficiency of baby pigs and to determine the effect of these combinations on the subsequent performance of the pigs.

Experimental Procedure

Sixty Landrace x Yorkshire crossbred pigs, weaned at an average age of 15.8 days and weight of 9.5 lb., were allotted at random within weight outcome groups, within litters, to three replications of six experimental treatments. One replication consisted of four pigs per pen and two replications consisted of three pigs per pen.

The pens of the experimental unit were concrete-floored and were equipped with automatic waterers and self-feeders. The pens were cleaned daily and wood shavings were used for bedding. The experimental unit was equipped with a thermostatically-controlled heating system. Unit temperature was decreased approximately 5° F. each of four weeks from an initial temperature of 85° F. Prior to being started on test, the pigs were fed a pre-starter ration (composition, table 1) for a three-day period to initiate

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consumption of dry feed by all pigs before allotment to the experiment.

All experimental rations, except the corn basal ration, were formulated to contain lactose in an amount equivalent to that found in the 40% dried whey ration. Feed-grade lactose, ground yellow corn and soybean oil meal were varied to equalize the lactose and protein levels between treatments. The six rations contained equal amounts of sucrose; their respective compositions are shown in table 2.

The pigs were fed these rations for a 28-day period. At the end of this initial 28-day test period, one pig was removed from each of the pens in

TABLE 1. COMPOSITION OF PRE-STARTER RATION [a]

Ingredient	Percent in ration
Carbohydrate mix [b]	41.25
50% solvent soybean oil meal	7.00
Dried skimmilk (low heat, spray dried)	40.00
Fish meal (herring)	5.00
Lard (stabilized)	2.50
Dried brewers yeast	1.00
Trace minerals [c]	0.15
Dicalcium phosphate	0.35
Ground limestone	0.25
Salt (iodized)	0.50
Vitamin-antibiotic premix [d]	2.00

[a] Calculated content of protein, 22.1%; calcium, 0.8%; phosphorus, 0.65%.
[b] Includes 40 parts sucrose, 30 parts dextrose and 30 parts corn (finely ground).
[c] Calcium Carbonate Company, std. swine mix.
[d] Contributed the following amounts of vitamin and antibiotics per lb. of complete ration: vit. A, 1410 I.U.; vit. D_2, 450 I.U.; riboflavin, 1.0 mg.; niacin, 1.75 mg.; calcium pantothenate, 3.0 mg.; choline chloride, 80 mg.; pyridoxine, 2.0 mg.; thiamine, 2.0 mg.; menadione, 1.0 mg.; vit. E, 1.0 mg.; vit. B_{12}, 20 mcg.; butylated hydroxy toluene, 57 mg.; oxytetracycline, 30 mg.; bacitracin, 10 mg.; penicillin, 10 mg.

the replication consisting of four pigs per pen in order to avoid a shortage of pen space in the next test period. It was decided before the experiment was started that the lightest pig would be removed since larger, heavier pigs are usually stronger competitors for feed, water, and pen space. For the next 28 days, the pigs remaining on test were all fed the same grower ration (composition, table 3) so that an observation could be made on the effect of previous treatment upon subsequent performance. Pig weights and feed data were collected at weekly intervals throughout the test period. The pen-of-pigs was used as the experimental unit and the data were analyzed by analysis of variance (Snedecor, 1956). The Q-test was used to evaluate differences between treatment means. All statements concerning statistical significance are at a probability level of 5% or less.

Results and Discussion

As shown in table 4, the greatest total gain (6.1 lb.) for the first 14-day period was made by the pigs fed the ration containing 30% dried skimmilk

TABLE 2. PERCENTAGE COMPOSITION OF STARTER RATIONS

Treatment no.[a]	1 (Pos. control basal)	2	3	4	5	6 (Neg. control basal)
Dried skimmilk (low heat, spray dried) (DSM)	40.00	30.00	20.00	10.00	.....	.....
Dried whey (roller dried) (DW)	.....	10.00	20.00	30.00	40.00	.....
Ground yellow corn	30.45	27.50	24.54	21.47	18.35	52.85
Lactose (feed grade)	7.15	5.37	3.58	1.79	.....	.....
Sucrose	10.00	10.00	10.00	10.00	10.00	10.00
50% solvent soybean oil meal	3.10	7.73	12.33	17.04	21.85	26.30
Fish meal (herring)	2.50	2.50	2.50	2.50	2.50	2.50
Lard (stabilized)	2.50	2.50	2.50	2.50	2.50	2.50
Dried brewers yeast	1.00	1.00	1.00	1.00	1.00	1.00
Trace minerals[b]	0.15	0.15	0.15	0.15	0.15	0.15
Dicalcium phosphate	0.20	0.30	0.35	0.50	0.55	1.35
Ground limestone	0.45	0.45	0.55	0.55	0.60	0.85
Salt (iodized)	0.50	0.50	0.50	0.50	0.50	0.50
Vitamin-antibiotic premix[c]	2.00	2.00	2.00	2.00	2.00	2.00

[a] For all rations, calculated content of protein, 20%; calcium, 0.80%; phosphorus, 0.60%.
[b] Calcium Carbonate Company, std. swine mix.
[c] Contributed the following amouts of vitamins and antibiotics per pound of complete rations: vit. A, 1695 I.U.; vit. D_2, 400 I.U.; riboflavin, 1.0 mg.; niacin, 7.0 mg.; choline chloride, 86 mg.; thiamine, 1.0 mg.; menadione, 1.0 mg.; vit. E, 5.0 mg.; vit. B_{12}, 20 mcg.; butylated hydroxy toluene, 57 mg.; oxytetracycline, 25 mg.

(DSM) and 10% dried whey (DW). Gains decreased when the level of dried whey was increased above 10% in the ration. Regression analysis of the effect of DW levels on gain revealed that the linear component was significant. There was no significant difference in gain between the 30–10 (DSM–DW) treatment and the 40% DSM basal diet. The least gain (2.8 lb.) was made by the pigs fed the corn basal ration.

TABLE 3. COMPOSITION OF GROWER RATION[a]

Ingredient	Percent in ration
Dried whey (roller-dried)	5.00
Ground yellow corn	71.80
Fish meal (herring)	2.50
50% meat and bone meal	2.50
50% solvent soybean oil meal	14.25
Lard (stabilized)	1.50
Ground limestone	0.65
Dicalcium phosphate	0.20
Salt (iodized)	0.50
Trace minerals[b]	0.10
Vitamin-antibiotic premix[c]	1.00

[a] Calculated content of protein, 16.1%; calcium, 0.70%; phosphorus, 0.50%.
[b] Calcium Carbonate Company, std. swine mix.
[c] Contributed the following amounts of vitamins and antibiotics per pound of complete ration: vit. A, 1700 I.U.; vit. D_2, 180 I.U.; riboflavin, 2.3 mg.; niacin, 13.7 mg.; calcium pantothenate, 11.3 mg.; choline chloride, 113.5 mg.; vit. B_{12}, 10 mcg.; oxytetracycline, 20 mg.

TABLE 4. EFFECT OF DRIED WHEY LEVELS ON PIG GAINS AND FEED EFFICIENCY

Treatment and ration designation	1 40% DSM basal	2 30% DSM 10% DW	3 20% DSM 20% DW	4 10% DSM 30% DW	5 40% DW	6 Corn basal	Q $s\bar{x}$ [a] treatments 1 through 6
Pigs per treatment, no.[b]	10	10	10	10	10	10	...
Av. initial wt., lb.	9.4	9.5	9.4	9.4	9.5	9.5	...
Av. gain (first 14 days), lb.[c, d]	5.2	6.1	4.8	4.1	3.6	2.8	3.2
Av. feed per lb. gain (first 14 days), lb.[d, e]	2.05	2.00	2.23	2.85	3.22	4.19	2.21
Av. gain (28 days), lb.	16.3	17.7	16.0	17.0	14.1	10.8	9.9
Av. feed per lb. gain (28 days), lb.[d, e]	1.70	1.94	1.88	2.01	2.29	2.51	0.46
			Subsequent performance[f] (28 days)				
Av. total gain, lb.	33.2	33.6	36.0	38.4	34.1	33.4	14.4
Av. feed per lb. gain, lb.	2.17	2.10	2.11	2.16	2.15	2.21	0.38

[a] Difference required between the six treatment means for significance at P=0.05 or less.
[b] Four pigs per pen replicate 1; 3 pigs per pen replicates 2 and 3.
[c] Linear regression of dried whey levels on first 14-day gain significant at P=0.05 or less.
[d] Error mean squares, treatments 1–5. Gain=1.5373, 14.9952; Feed=0.3280, 0.0252, for 14 and 28 days, respectively.
[e] Linear regression of dried whey levels on feed required per pound of gain significant at P=0.05 or less.
[f] Average of 9 pigs per treatment.

During the first 14-day period, the pigs fed the 30–10 (DSM–DW) ration treatment required only 2 lb. of feed per pound of gain which was less than that required by the pigs fed the other ration treatments. The amount of feed required per pound of gain increased as the level of DW was increased above 10%. This linear effect of DW levels on feed required per pound of gain was significant. The pigs fed the 40% DW and the corn basal rations required 3.22 and 4.19 lb. of feed per pound of gain, respectively. This was considerably greater than that required by the pigs fed the other ration treatments although the differences were not significant.

For the 28-day test period, the pigs fed the 30–10 (DSM–DW) treatment gained 1.4 lb. more than those fed the 40% DSM diet. This differs from the study by Crane (1953) who observed that pigs fed a ration containing 40% DSM made more rapid and efficient gains than those fed a basal ration containing 35% DSM and 10% DW. In the present study, gains were reduced with the 40% DW diet. The difference between the gain of the pigs fed the 40% DW diet and those fed the 30–10 (DSM–DW) ration (3.6 lb.) was significant. Again, the least gain was made by the pigs fed the corn basal ration.

Except for the 20–20 (DSM–DW) treatment, the amount of feed required per pound of gain increased as the level of DW was increased in the ration. Even though the 20–20 (DSM–DW) treatment deviated, regression analysis showed that the linear effect of DW levels on feed required per pound of gain was significant. The pigs fed the corn basal ration required 2.51 lb. of feed per pound of gain which was the most feed required per pound of gain for any of the ration treatments.

As previously mentioned, at the end of the initial 28-day test period, all pigs were fed the same 16% protein grower ration for an additional 28 days in order to study the effect of previous treatment upon subsequent performance of the pigs. From the data shown in table 4, pigs which were fed rations containing dried whey during the initial 28-day period made greater gains during the subsequent period than those which had been fed the ration containing 40% DSM. The greatest total gain was made by the pigs which had been fed the 10–30 (DSM–DW) ration treatment during the initial 28-day period. Pigs fed the corn basal diet made the least gain during the initial period but made gains comparable to the other pigs during the subsequent period. However, these pigs did not weigh as much at the end of the 56-day test period as the pigs fed the other rations. There was no significant difference in the amount of feed required per pound of gain by the pigs fed the various rations. The pigs fed the corn basal ration required the most feed per pound of gain throughout the experiment.

Discussion. Lactose, a major carbohydrate source furnished by treatments 1 through 5, was probably a more acceptable digestible substrate for the enzymes elaborated by the baby pig than was that furnished by the corn (negative control) diet. This is suggested by the work of Bailey *et al.* (1956) who observed, when measuring the activity of intestinal lactase,

sucrase and maltase of suckling pigs, that lactase had the highest activity from birth to weaning. It would appear then that lactose contributed to the improvement in gains and feed efficiency shown by the pigs fed diets containing milk products as compared to those fed the corn basal diet.

However, not all of the improvement can be attributed to lactose. Protein source also appears to be involved. This is apparent from the reduction in gains and feed efficiency observed when dried whey levels were increased above 10%. Since all rations (except the corn basal) were formulated with equivalent amounts of lactose, gains and feed efficiencies should have been the same on treatments 1 through 5 if lactose were the only factor involved. It is obvious from the data that this was not the result. When whey was used to replace dried skimmilk in the rations, soybean oil meal was used to maintain a constant protein level. Thus, as the whey level was increased in the ration, total ration protein from soybean oil meal increased. According to the work of Lewis *et al.* (1955), baby pigs can not fully utilize soybean oil meal. Thus, the reduction in gains and feed efficiency observed when dried whey levels were increased above 10% may have been caused by the decrease in total protein coming from milk sources.

Other factors such as minerals (other than calcium and phosphorus) should not be ignored. However, at no time during this study was there any evidence of a whey-induced diarrhea. This is in agreement with a study conducted by Becker *et al.* (1957) who found no evidence of a whey-induced diarrhea when dried whey was substituted for dextrose at levels of 30 and 60%.

The dried skimmilk and dried whey used in this experiment were of excellent quality. Considering the wide variation in samples of these two products, it is possible that other sources might produce different results.

Summary

Sixty Landrace x Yorkshire crossbred pigs were used to evaluate ratios of dried skimmilk and dried whey for pig starter rations. In addition, the effect of starter treatment upon the subsequent performance of the pigs was studied. The greatest gain and feed efficiency was made by the pigs fed a ration containing 30% dried skimmilk and 10% dried whey during the starter period. Gains and feed efficiency decreased when the dried whey level was increased above 10%.

Pigs fed starter rations containing dried whey made greater gains during the subsequent period than those fed a 40% dried skimmilk starter ration. There was no significant difference in the amount of feed required per pound of gain by the pigs during the subsequent feeding period.

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