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SUPPLEMENTAL VITAMINS AND ANTIBIOTICS IN DRINKING WATER FOR SWINE

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Can a balanced diet be economically provided to swine by including certain nutrients in the drinking water? Traditionally swine diets have been developed by including the essential nutrients and growth additives to the air dry free-choice or self-fed rations. Water soluble microingredients have been added to drinking water for therapeutic treatment, but nutrients have not been commonly added to water under general feeding conditions. However, the same principle is applied when water is mixed with a ration and fed as a liquid. Theoretically, feeding water dispersible micronutrients and additives in water and macro-ingredients in a dry mixture should support good growth and feed utilization providing the nutrient stability is good in water.

Two trials have been conducted with baby pigs to determine the value of adding vitamins and an antibiotic to drinking water as a supplement to a complete starter feed for nursing and early weaned pigs. Two trials have been conducted to determine the effects of feeding vitamins and an antibiotic in water for growing-finishing pigs.

Experimental Procedure

Baby Pig Trials. Experimental treatments were as follows in trial 1:

Lot 1	Complete feed, no water treatment (control)
Lot 2	Complete feed + vitamins in the water
Lot 3	Complete feed + tylosin in the water
Lot 4	Complete feed + vitamins and tylosin in the water

In each of the two replicates, the most uniform pigs from three litters were weaned at 14 days of age and assigned to treatment according to litter and sex. Four pens of six pigs each were confined on concrete-floored pens for a 28-day period. Supplemental heat was provided in each pen by heat lamps. Feed was provided in self-feeders and water was available in 5 gallon waterers.

Vitamins were added to the water to provide 48,000 U.S.P. units vitamin A, 48,000 U.S.P. units vitamin D, 25.6 I.U. vitamin E, 2 mg. thiamine hydrochloride, 4 mg. riboflavin, 32 mg. niacin, 2.4 mg. pyridoxine hydrochloride, 20 mg. calcium pantothenate, 1.6 gm. choline chloride and 36 mcg. vitamin B_{12} per gallon of water.

Pigs in lot 3 were fed water with 41.6 mg. of tylosin per pound of water. Group 4 was given the same quantity of vitamins and antibiotics as lots 2 and 3, respectively. Three different rations were used for each group during treatment. Each group received 18 pounds of a commercial pre-starter and 10 pounds of a commercial starter ration. The third ration was a 16% crude protein grower ration, which is routinely fed to weanling pigs at this station. All rations were self-fed in the respective sequence. The rations contained recommended levels of protein, vitamins, minerals and antibiotics for weanling pigs.

In trial 2, a control group of nursing pigs was fed a complete commercial ration and a treated group was fed the same ration, plus vitamins and an antibiotic in the drinking water. Ten litters of pigs were assigned to a treatment or control group according to breed, number of pigs in the litter, and the number of previous litters a sow had farrowed. Pigs were fed the same commercial rations and combination of vitamins and antibiotic as in trial 1.

Growing-Finishing Trials

Trial 3. Twenty-four growing pigs were allotted into three treatment groups of eight pigs per group. Pigs in lot 1 were fed a complete mixed ration (table 1). Group 2 was fed the same ration as group 1, but the supplemental vitamins and antibiotic were omitted from the dry ration and the vitamins and antibiotic were added to the drinking water. Group 3 was fed free-choice a grain mixture of corn and soybean meal and a mineral supplement. Vitamins and an antibiotic were added to the drinking water. The corn-soybean meal mixture was 16% crude protein. The mineral mixture consisted of 40% ground limestone, 40% dicalcium phosphate and 20% trace mineralized salt. The vitamin-antibiotic mixture provided 2560 U.S.P. units vitamin A, 576 U.S.P. units vitamin D, 3.2 mg. thiamine hydrochloride, 7.6 mg. riboflavin, 38.4 mg. niacin, 32 mg. calcium pantothenate, 800 mg. choline chloride and 32 mcg. vitamin B_{12} per gallon of water. Tylosin was added in every other 50 gallons of water at the rate of .8 mg. per gallon. Based on water consumption of the pigs, the experimental plan was to include enough vitamins to meet their daily requirements.

Trial 4. Forty weanling pigs were allotted into four treatment groups. The treatments were:

Lot 1	Complete mixed ration (control)
Lot 2	Corn, soybean meal, mineral ration with vitamins and antibiotic in the water
Lot 3	As 2, except a commercial vitamin-antibiotic mixture (Tylocine) was added to the water
Lot 4	Shelled corn and protein supplement fed free-choice and vitamin-antibiotic mixture in the drinking water

The vitamin-antibiotic premix used in lots 2 and 4 was the same as used in trial 3. Tylocine was added to the water to provide 4800 I.U. vitamin A palmitate, 600 I.U. vitamin D, 1.2 I.U. vitamin E, 3.2 mg. thiamine mononitrate, 6.4 mg. riboflavin, 38.4 mg. niacin, 3.8 mg. pyridoxine hydrochloride, 24 mg. D-pantothenic acid, 24 mcg. vitamin B_{12} and .96 mg. folic acid per gallon of water. The complete mixed rations were the same as used in trial 3. The free-choice supplement is shown in table 1.

Results

The results of baby pig feeding trials are shown in tables 2 and 3. Pigs fed the vitamins, antibiotic or combination of vitamin and antibiotic fortified water gained 2.96, 3.30 and 2.28 pounds per pig, respectively, more than the control pigs for the 4 week period. Pigs fed either vitamins or tylosin alone gained as fast as pigs given the combination of vitamins and antibiotic. The faster gains of pigs fed the water fortified diets were somewhat associated with greater feed and water intake, although there was some variation within trials and between

trials. In trial 1, a coagulant formed in the water with both vitamins and antibiotic. Coagulation was probably due to fungus and probably affected the palatability of the water. The coagulation did not form in the second replicate and the water consumption was normal for this group. Pigs fed the supplemental vitamins or tylosin required 14% less feed per pound of gain than the control pigs. Feed efficiency of pigs given the combination of vitamins and tylosin was only slightly better than the control pigs in trial 1 and they were similar in trial 2.

There was no advantage to feeding the combination of vitamins and antibiotic to the nursing pigs (table 3). Another trial involving 85 pigs, which is not shown in this report, was conducted and the results of weight gain were similar for both the control and vitamin-antibiotic groups. Feed data were not utilized because of extensive feed wastage.

These trials suggest that adequate nutrient fortification in the ration is more important for early weaned pigs than nursing pigs. Although the feeds were well fortified according to current standards, early weaned pigs gained some benefit by vitamin or antibiotic fortification in the drinking water.

Growing-Finishing Pigs. The summary of these trials is reported in tables 4 and 5. In trial 3, pigs fed the vitamins and tylosin in water gained 5% slower, but required 4% less feed per pound of gain than pigs fed a complete mixed ration. Pigs fed a mixture of corn and soybean meal free-choice, a mineral mixture free-choice and vitamins-tylosin in the water gained slowly and required more feed for weight gain. Consumption of mineral was very low, so this combination of free-choice feeding was unsatisfactory. Our experience has been that free-choice mineral mixtures are not well consumed by swine. While feeding minerals free-choice is a common recommendation and perhaps it is better than no mineral, mineral consumption fed free-choice is often low.

In trial 4 average daily gain and feed efficiency were similar between all treatment groups. Pigs given the same premix as pigs in trial 3 required more feed and gained slightly slower than the control pigs, but all pigs gained well. Pigs fed a commercial mixture of vitamins and tylosin (Tylocine) had the same growth rate and feed efficiency as the control pigs. The method of free-choice feeding incorporated in this trial proved satisfactory. The slightly slower gain and better feed utilization was typical of free-choice and complete ration comparisons.

Control pigs had the lowest feed cost per hundred weight gain. Since some of the other treatment groups gained as efficiently as the control pigs, the primary difference was due to the quantity of vitamins fed and the cost of the vitamins. Vitamins were fed to meet the daily requirement of the pig (ignoring feed content), so the quantity fed may have been more than necessary. Also, the purchase price of the individual vitamins was rather high and these prices would be less if purchased in quantity and perhaps as a premix. If the pigs gain as fast and efficiently on vitamins and antibiotic in the water and if the nutrients do not break down in the water, then the cost of production by water treatment should not be greater than a complete ration. More research is needed to determine the quantity of nutrients needed per gallon of water and ways of providing an economical premix.

Water consumption was not affected by adding the vitamins and antibiotic to the water for growing-finishing pigs. Water was not wasted by the pigs.

Discussion

The results of these trials showed early weaned pigs may benefit by supplementing a good starter ration with vitamins or antibiotics in the water. Nursing pigs probably do not benefit from the same additions to water. Growing-finishing pigs fed vitamins and an antibiotic in water gained as fast and required approximately the same quantity of feed as pigs fed a complete mixed ration. It should be kept in mind that vitamin and antibiotic levels were added to provide approximately the suggested daily needs of the pig. More research on various levels of the micronutrients is necessary to determine the best levels in the water.

Since the microingredients were dispersed in the water, there was no problem of thoroughly mixing these ingredients into the complete ration. The pure undiluted vitamins can be added to the water, whereas their addition in the dry rations required premixing and then extensive mixing in the complete ration. In the growing-finishing pig trials the vitamins and antibiotic were mixed with sugar and then a given quantity of this premix was added to the water. While this method was easy, the carbohydrate permitted extensive fungus growth, which caused the solution to coagulate and clog the waterers. Elimination of the carbohydrate from the premix greatly minimized fungus growth in the water tank reservoir. The solution to the fungus problem is the low-carbohydrate mix or to maintain the vitamin-antibiotic solution mix in an air tight container and meter the solution into an automatic water line.

The dispersion and stability of products in water needs extensive research. The B vitamins are theoretically soluble in water and should become dispersed in the solution. Vitamins A and D, which are added to rations, are not soluble in water; however, water dispersible vitamin A and D and antibiotic tylosin were used in these trials. Analyses of water samples are in progress to determine the degree of separation (if any) of the nutrients in solution. Also, the shelf life of these products in solution is being determined. Results of the trials do not suggest a problem in physical separation or breakdown of the nutrients in solution, but chemical or biological assays will be used as the more informative test.

The practicality of this method of feeding is speculative. It must compete with current methods of feeding in maximum daily gain, feed utilization and economy of gain. Acceptance or rejection will depend on the advantages and disadvantages provided to the swine producer. Research of this type has not been conducted extensively and the possibilities of providing some nutrients in the drinking water needs to be explored.

TABLE 1. RATION COMPOSITION OF RATIONS USED IN GROWING-FINISHING TRIALS

	Grower	Finisher	Free-choice supplement
	%	%	%
Shelled corn	81.6	90.5	--
Soybean meal (50%)	14.0	5.5	64.0
Meat and bone scraps (50%)	2.5	2.5	20.0
Dehydrated alfalfa meal	--	--	10.0
Dicalcium phosphate	0.9	0.6	3.2
Limestone	0.4	0.3	0.3
T. M. salt (.8% zinc)	0.5	0.5	2.5
Vitamin-antibiotic premix[a]	0.1	0.1	--
	100.0	100.0	100.0

[a] Vitamin-antibiotic premix provided 1135 I.U. vitamin A, 340 I.U. vitamin D, 2 mg. riboflavin, 4 mg. pantothenic acid, 9 mg. niacin, 10 mg. choline chloride, 5 mcg. vitamin B_{12} per pound of ration. Fifty mg. chlortetracycline, 50 mg. sulfamethazine and 25 mg. penicillin per pound of ration were fed to 75 lb. body weight, thereafter 10 mg. chlortetracycline per pound of feed was fed. Hygromycin b was fed for 8 weeks (6 mg. per lb.).

TABLE 2. SUPPLEMENTAL VITAMINS AND ANTIBIOTIC FOR EARLY WEANED PIGS, TRIAL 1

Treatment		Control	Vitamins	Tylosin	Vitamins + tylosin
Lot[a]		1	2	3	4
Av. initial wt., lb.	1[b]	7.0	7.1	7.1	7.2
	2	8.5	8.5	8.5	8.5
Av. final wt., lb.	1	18.2	23.0	24.7	21.6
	2	22.4	23.2	22.8	24.2
Av. total gain, lb.	1	11.2	15.9	17.6	14.4
	2	13.9	14.7	14.3	15.7
	Av.	12.7	15.3	16.0	15.0
Av. total feed cons., lb.	1	18.2	24.2	25.8	21.7
	2	25.0	22.0	21.7	28.6
	Av.	21.9	23.1	23.8	24.8
Av. total water cons., lb.	1	50.0	70.0	88.3	25.8
	2	60.0	71.7	48.5	62.0
	Av.	55.5	70.8	68.4	42.3
Feed/lb. gain, lb.	1	1.62	1.46	1.46	1.51
	2	1.80	1.50	1.52	1.83
	Av.	1.73	1.48	1.49	1.66

[a] Six pigs were allotted to each treatment in each replicate. One pig in lot 1 of replicate 1 and one pig in lot 4 of replicate 2 died of unknown causes.
[b] Replicates are reported separately.

TABLE 3. SUPPLEMENTAL VITAMINS AND ANTIBIOTIC FOR NURSING PIGS, TRIAL 2

Treatment	Control	Vitamins and tylosin
No. of pigs	43	42
Av. initial wt., lb.	6.1	5.8
Av. final wt., lb.	26.0	27.6
Av. total wt. gain, lb.	19.9	21.7
Av. total feed consumption, lb.	6.1	7.7
Av. total water consumption, lb.	13.8	11.1
Feed per lb. gain, lb.	0.23	0.31

TABLE 4. SUPPLEMENTAL VITAMINS AND ANTIBIOTIC IN DRINKING WATER, TRIAL 3

Treatment	Control complete ration	Vitamins and antibiotic in water	Free-choice
Lot number	1	2	3
No. of pigs	8	8	7
Av. initial wt., lb.	56.6	57.5	56.6
Av. final wt., lb.	211.4	210.6	167.7
Av. daily gain, lb.	1.93	1.84	1.20
Av. daily feed, lb.	6.40	5.89	4.74
Feed per lb. gain, lb.	3.31	3.19	3.76

TABLE 5. SUPPLEMENTAL VITAMINS AND ANTIBIOTIC IN DRINKING WATER, TRIAL 4

Treatment	Control complete ration	Vitamins and antibiotic in water	Commercial Tylocine with vitamins in water	Free-choice vitamins and antibiotic in water
Lot number	1	2	3	4
No. of pigs	10	10	10	10
Av. initial wt., lb.	42.2	42.8	40.5	39.6
Av. final wt., lb.	202.0	199.0	205.0	195.7
Av. daily gain, lb.	1.55	1.50	1.59	1.47
Av. daily feed, lb.	5.00	5.21	5.10	4.68
Feed per lb. gain, lb.	3.22	3.46	3.20	3.17
Feed cost/cwt. gain, $	8.28	9.20	11.53	8.73