

ACID-V

An Acidifying Complex Active In The Gut



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ACID-V

Acid-V is a combination of organic and inorganic acids utilized to decrease the buffering capacity of feed for greater feed digestion and less digestive upsets in immature animals.

Acid-V is a blend of Citric, Malic, Tartaric and Phosphoric acids that reduces pH increases caused by feed in the digestive tract.

MODE OF ACTION

Acid-V increases diet digestion and feed utilization in immature animals by:

1. Combining four acids, each with multiple pKa's (pH's resistance to change) which dissociates throughout gastrointestinal tract for reduced pH
2. Decreasing the buffering capacity of feed
3. Increasing the available hydrochloric acid (HCl) of the stomach for diet digestion
4. Increasing the HCl available for enzyme activity
5. Improving protein digestion for greater animal utilization and less digestive upsets
6. Promoting lower pH in the intestinal tract for lactic acid producing bacteria proliferation

BUFFERING CAPACITY

- It is the ability of feed to neutralize the hydrochloric acid (HCl) in the stomach. Feeds that contain higher levels of fishmeal, vegetable proteins and minerals have greater buffering capacity.
- By neutralizing HCl in the stomach, feeds high in buffering ability decrease the animal's ability to activate enzymes for digestion. Optimum stomach pH for enzyme activity is 2.5.
- Immature animals with newly developing digestive tracts for dry feed are limited in both HCl produced and digestive enzyme activity.
- Decreased protein digestion in the immature animal results in increased feed cost, increased diarrhea problems and decreased animal performance.
- Feeds high in buffering ability also increase pH in the intestinal tract reducing lactic acid producing bacteria growth.



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ACID-V ADDITIONS REDUCED BUFFERING CAPACITY OF FEED INGREDIENTS

Acid-V addition to pig, rabbit, lamb, veal and poultry diets have been shown to increase animal performance by increasing daily gains and feed intakes and improving feed to gain ratios. Acid-V reduces the buffering capacity of feed ingredients, making the ingredients more available for acid and enzyme digestion for immature digestion tracts.

To show this reduction of buffering effect, various feed ingredients were selected and pH determined with and without the addition of Acid-V.

Feed ingredients were mixed in water and pH determined. Acid-V was added to the ingredients at the levels of .15%, .30% and .50% and pH was again determined. The amount of .1 normal hydrochloric acid to reduce the pH to 3 was noted and buffering capacity was calculated.

Feed ingredients such as dicalcium phosphate, skimmed milk, whole soybean, whey, refatted milk, defatted soybean meal and fish meal are all extremely high in buffering capacity. Nearly all the products are used in weaned pig diets.

The results in Table 1 show that the addition of Acid-V reduces the buffering capacity of feed ingredients. These results explain the advantages that Acid-V provides in increased animal performance.

The use of Acid-V promotes better animal performance and provides production cost savings to the livestock producer by helping the animal to better utilize their diets.



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Table 1 – Ability of Raw Materials to Bind Acids (Buffer Capacity)

Material	% Acid-V	pH	ml HCL (0.1N)	Buffer Capacity (MEQ/kg)*
Salt	0.00	7.10	1.40	14.00
	0.15	3.55	1.00	10.00
	0.30	3.10	0.20	2.00
	0.50	3.00	0.00	0.00
Cereal By Products	0.00	6.30	37.80	378.00
	0.15	6.10	34.60	346.00
	0.30	6.00	33.60	336.00
	0.50	5.85	32.10	321.00
Dicalcium Phosphate	0.00	6.50	297.50	2975.00
	0.15	6.35	288.00	2880.00
	0.30	6.30	287.00	2870.00
	0.50	6.05	259.00	2590.00
Clay	0.00	5.60	6.60	660.00
	0.15	5.20	6.60	660.00
	0.30	4.25	6.30	630.00
	0.50	4.10	6.20	620.00
Flaked Corn	0.00	5.80	15.60	156.00
	0.15	5.70	15.50	155.00
	0.30	5.60	15.20	152.00
	0.50	5.00	12.00	120.00
Skimmed Milk Powder	0.00	6.30	119.10	1191.00
	0.15	6.25	116.70	1167.00
	0.30	6.20	116.70	1167.00
	0.50	6.20	119.80	1198.00
Whole Soybean	0.00	6.80	92.00	920.00
	0.15	6.65	89.50	895.00
	0.30	6.60	88.50	885.00
	0.50	6.60	86.00	860.00
Whey	0.00	6.00	81.00	810.00
	0.15	6.00	81.50	815.00
	0.30	5.95	79.50	795.00
	0.50	5.85	78.00	780.00
Refatted Milk Powder	0.00	6.50	79.50	795.00
	0.15	6.45	75.50	755.00
	0.30	6.35	73.50	735.00
	0.50	6.35	68.00	680.00
Lactose	0.00	6.05	4.10	41.00
	0.15	3.50	2.90	29.00
	0.30	3.40	2.60	26.00
	0.50	3.30	1.90	19.00
Defatted Soybean	0.00	6.50	95.00	950.00
	0.15	6.50	83.00	830.00
	0.30	6.50	81.00	810.00
	0.50	6.30	79.50	795.00
Fishmeal	0.00	6.05	148.00	1480.00
	0.15	6.10	140.00	1400.00
	0.30	6.05	138.00	1380.00
	0.50	6.05	136.00	1360.00

*MEQ/kg: Quantity of HCL added to 1 kg feed to reach a pH of 3 after one hour @ 37°C



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ACID-V BENEFITS & ADVANTAGES

In the very young animal the digestive system is stressed when transition is made from liquid to a solid diet. In the newborn pig, digestive acids, pH enzymes and microflora may not be adapted for conversion to solid feed at the time of weaning.

For several years the feeding of acids has been used in feed to help assist with some of these digestive insufficiencies of young animals. They assist in maintaining a desirable pH in the intestinal tract and activate the gastric enzymatic functions. Research has also shown that the established microflora of the young animal may be dependent on pH of the gastric environment. Results in improved growth and feed efficiency and a reduction of digestive upsets are effected by all these factors.

One of the main parameters affecting the digestibility of diets is the buffering capacity: the ability of their components to bind acids. Skimmed milk powder, soya meal and fish meal, for example, have an acid binding capacity about 5 to 8 times stronger than maize or barley.

Reducing the acid binding capacity of diets, improves their digestibility for all animals. This is most important for acid-deficient animals like piglets, calves and lambs.

Supplementing diets with acids or acid mixtures able to interact with feed components is a way to modify their buffering capacity. However, it is critical to use acids, or better acid combinations having dissociation constants over a broad range of pH values. This dissociation scheme supports their activity at different places in the gastrointestinal tract, while favoring the optimal utilization of the biochemical and physiological functions of the digestive system.

ACID-V is a combination of acids selected to provide an optimal broad spectrum of buffering activity control. It has adequate particle size distribution for in-feed mixing, is not hygroscopic and is very stable. It does not require special handling precautions and is fully compatible with other premix and compound feed ingredients.

The composition of ACID-V allows a significant reduction of the in-feed use levels compared to single organic acid inclusions: 0.10% to 0.30% versus 1% to 2.50% respectively.

The in-vitro effect of ACID-V can be demonstrated by a reduction of the acid quantity, ie; HCl needed to titrate a 20% aqueous suspension of feed to pH 3. In this solution, 0.15% and 0.30% ACID-V reduces the pH to 2.6 and 2.3 respectively.

Experiments performed with piglet and pig feeds, milk replacers, calves and broilers have shown that ACID-V reduces the acid binding capacity of these diets in a range of about 5% to more than 25% according to the type of feeds considered and their composition. Experiments with piglet feed showed that 0.30% ACID-V provided the same effect at 1.50% fumaric acid.

Acid-V contains: Phosphoric Acid, Tartatic Acid, Malic Acid, Citric Acid



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ACID DISSOCIATION RANGE OF ACID-V COMPARED TO FUMARIC ACID AND CITRIC ACIDS (PK VALUES)

	0	1	2	3	4	5	6	7	8	9	10	11	12	13
Fumaric Acid				+	+									
Citric Acid				+	+									
Acid-V		+	++++	++++	+		++++	+		+			++++	

Stomach
Small Intestine

Large Intestine

ADVANTAGES:

Acids in Acid-V readily dissociate over a wide pH range to help provide an optimum pH throughout the gastrointestinal tract as compared with the use of a single acid.

BENEFITS OF ACID-V:

- Dissociates over a wide pH range to provide proper acidification throughout the gastro-intestinal tract.
- Assists in lowering the pH of the upper gastro-intestinal tract.
- Acidification of the gastro-intestinal tract produces an environment favorable for enzyme production necessary to feed digestion.
- Reduces the buffering capacity of feeds, particularly higher protein feeds, resulting in improved digestibility.

DIRECTIONS FOR USE:

SWINE: Preweaning to 6 weeks post-weaning - 4.5 to 7.0 pounds per ton of feed
 Growing phase - 2.5 to 4.5 pounds per ton of feed

Growing and finishing diets addition when feeds contain high buffering capacities.

POULTRY: Broiler diets - 4.5 pounds per ton of feed

Pullet, Layer and Breeder diet - 4.5 pounds per ton of feed for three week period when wet droppings occur

Breeder diets - 4.5 pounds per ton of feed between 20-28 weeks of age. Two pounds per ton of layer and breeder feed on continuous basis.



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ACID-V

PRODUCT INFORMATION SHEET

APPLICATION: An acidifier supplement for swine and poultry. The action of Acid-V is to reduce the buffering effect in animal feeds that contain acid-buffering ingredients. Test work has shown that the unique combination of four acids can have a positive effect on digestion and animal growth.

USE LEVEL: Swine and poultry: Add Acid-V at a rate of 2-7 lbs. per ton of complete feed. For animal use only.

APPEARANCE: Dry product in powder form with white color characteristics.

INGREDIENTS: Phosphoric acid, Citric acid, Malic Acid, Tartaric acid, and Sodium aluminum silicate.

All products are approved for use under U.S. Food and Drug Administration Regulations or are listed as Generally Recognized As Safe (GRAS) in applicable industry publications.

pH: 1.5 (10% solution)

BULK DENSITY: Approximately 53 lbs/ft.³

HANDLING: Acid-V is safe to use and does not require any special handling precautions.

STORAGE: Acid-V should be stored in a cool, dry area.

PACKAGING: Acid-V is available in 25 kg bags.



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SWINE RESEARCH - WHEN AND WHY TO USE ACID-V

- In pre-weaned and weaned pig diets for pigs up to 40 days of age to improve diet digestion and increase daily gains and feed efficiency and to decrease diarrhea problems when fed diets containing high levels of protein that promotes greater dietary buffer capacity.
- In growing pig diets to maintain feed intake and diet digestion during diet changes and reduce digestive problems caused by mixing feeder pigs from different sources.
- In starter turkey diets for the first 35 days to increase protein digestion of high protein diets and to decrease digestive upsets.
- Instead of single acids for greater animal performance and more flexibility in diet formulation due to lower inclusion rates.
- In immature pet diets for less digestive problems.



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ACID V SWINE TRIAL 113

METHODS AND MATERIALS

- Three studies conducted comparing Acid-V to control fed post weaned pigs
- Addition of Acid-V ranged from 0.22% to 0.30% of the diet
- Parameters measured include daily gains, feed intakes and feed efficiency

ACID-V IMPROVES PERFORMANCE OF POST-WEAN PIGS

Acid-V is a concentrated complex of organic and inorganic acids selected for the ability to dissociate over a wide range of pH values to assist in maintaining a proper gastrointestinal tract pH balance. By providing acidification throughout the digestive tract, Acid-V provides a more desirable environment for lactic acid producing bacteria, provides hostile environment for undesirable microorganisms, reduces buffering capacity of feed ingredients for improved digestion and reduced digestive upsets.

Three trials were conducted to determine the effects of adding Acid-V to post-weaned pigs diets on pig performance:

1. Trial 1 used 0.22% Acid-V per ton of feed
2. Trials 2 and 3 used 0.3% Acid-V per ton of feed

All trials showed increases in feed intakes with trial 2 showing greatest increase. All three trials showed increases in average daily gains ranging from nearly 1.5 to 22.50% improvement over Control fed pigs. Acid-V fed pigs were also 2 to 10% more efficient in diet utilization than Control pigs.

By feeding Acid-V, feed intakes, and feed efficiencies have been shown to improve over Control animals in post-weaned pigs. Providing Acid-V to swine diets, increases diet utilization and promotes better swine growth and performance and makes for more profitable production for swine producers.



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EFFECTS OF ACID-V ON GROWTH RATE AND FEED INTAKE OF POST-WEANED PIGS

Trial 1	Control	0.22% Acid V	% Improvement
Number of pigs	240	240	
Trial Duration (days)	22.5	22.6	
Average starting weight (lbs)	31.60	32.52	
Average trial end weight (lbs)	56.76	61.22	+7.86
Average daily gain (lbs)	1.12	1.27	+13.39
Average daily feed intake (lbs)	2.37	2.41	+1.69
Feed to gain ratio	2.12	1.90	+10.38

Trial 2	Control	0.30% Acid V	% Improvement
Number of pigs	48	47	
Trial Duration (days)	20	20	
Average starting weight (lbs)	31.87	32.34	
Average trial end weight (lbs)	55.73	61.80	+10.89
Average daily gain (lbs)	1.20	1.47	+22.50
Average daily feed intake (lbs)	2.06	2.29	+11.17
Feed to gain ratio	1.72	1.56	+9.30

Trial 3	Control	0.30% Acid V	% Improvement
Number of pigs	76	79	
Trial Duration (days)	20	20	
Average starting weight (lbs)	26.22	26.17	
Average trial end weight (lbs)	52.91	53.41	+0.94
Average daily gain (lbs)	1.34	1.36	+1.49
Average daily feed intake (lbs)	1.94	1.96	----
Feed to gain ratio	1.45	1.42	+2.07

SUMMARY OF RESULTS

- Addition of Acid-V to all Studies increased gains by 1.5 to 22.5% over control fed pigs
- Acid-V addition improved feed efficiency control fed of post weaned pigs over pigs



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ACID V SWINE TRIAL 114

METHODS AND MATERIALS

- Two studies were conducted to compare the effects of addition of Acid-V to other single acid additions on gains, feed intakes and feed efficiencies of starter pigs
- Trial 1 compared the addition of 1% fumaric acid to 0.3 and 0.5% Acid-V on weights and feed to gain ratios of starter pigs
- Trial 2 compares the addition of 0.3% propionic acid to 0.2% Acid-V on starter pig performance

COMPARISON OF ACID-V TO OTHER DIET ACIDIFIERS IN WEAN PIG TRIALS

It has been shown that adding an acidifier product to baby pig diets increases weaned pig performance. Acidifier addition to the diet decreases the buffering capacity of feed ingredients, making feed ingredients more digestible for the immature digestive tract of weaned pigs. Most acidifier products consist of a single organic acid which reduces the pH in the stomach, but does not change the pH in the rest of the digestive tract. Also, a single product may not remain effective for a prolonged period.

Acid-V is a concentrated complex of organic and inorganic acids which reduces pH in the stomach, small intestines and large intestines. The effects of Acid-V are:

- lower pH in the stomach for better acid and enzyme digestion of feed
- better enzyme digestion of feed in the small intestines
- generally lower pH in the intestinal tract for greater lactic acid bacteria production and feed digestion.

These studies were conducted to compare Acid-V to other acid products on the performance of weaned pigs.

Trial 1 compares .3% and .5% additions of Acid-V to 1% addition of fumaric acid per ton of feed.



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COMPARISON OF GROWTH RATES OF WEANED PIGS FED DIETS CONTAINING EITHER ACID-V OR FUMARIC ACID

TRIAL 1	1.0% FUMARIC	0.3% ACID-V	0.5% ACID-V
Starting Weight (kg)	7.2	7.2	7.2
2 Week Weights (kg)	10.7	10.8	10.8
Feed to Gain Ratio	1.507	1.468	1.450
4 Week Weights (kg)	16.8	17.2	17.2
Feed to Gain Ratio	1.595	1.550	1.556

Trial 2 compares .2% of Acid-V addition to .3% propionic acid addition per ton of feed.

COMPARISON OF GROWTH RATE AND FEED INTAKES OF WEANED PIGS FED DIETS CONTAINING EITHER ACID-V OR PROPIONIC ACID

TRIAL 2	0.3% PROPIONIC	0.2% ACID-V	% IMPROVEMENT
Initial Weight (kg)	5.38	5.37	---
42 Day Weight (kg)	19.6	20.8	+6.12
Avg Daily Gain	338.57	367.38	+8.51
Feed Intake/day (g)	542	567	+4.61
Feed to Gain Ratio	1.601	1.543	+3.62

In Trial 1, pigs fed Acid-V additions to diets had slightly heavier weights at 2 weeks and by 4 weeks had heavier weights by 400 grams over fumaric acid fed pigs. Feed efficiencies were improved for Acid-V fed pigs when compared to fumaric acid fed pigs. Acid-V fed pigs outperformed fumaric acid fed pigs with Acid-V fed at lower levels than fumaric acid.

As noted by the usage rate table, fumaric acid must be fed at greater levels than Acid-V to get similar pig performance. At these lower levels, Acid-V is a cost saving to the producer.

No differences were noted between the Acid-V treatments in pig weight gain. The .5% Acid-V addition had slightly better feed efficiencies in the first 2 weeks of the weaning period than the .3% Acid-V addition. The best management practice would be to use .5% Acid-V in a preweaned diet and the first two weeks of the weaning phase, then drop the level of Acid-V to .3% through the rest of the weaning phase and into the growing phase.

Trial 2 shows that 0.3% propionic acid addition to pig diets was compared to .2% Acid-V addition to wean pig diets. Acid-V addition at lower level, increased pig feed intake by nearly 5%, increased pig daily gains by 8.5% and decreased feed to gain ratio by nearly 4% when compared to propionic acid addition. The addition of Acid-V to wean pig diets promotes better pig feed intakes, improved pig growth rates and provides more cost efficient feed to gain ratios.



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**COMPARISON OF USAGE RATES OF ACID-V AND
FUMARIC ACID FOR SWINE FEED**

	ACID-V %	COST @ \$2.10/lb	FUMARIC %	COST @ 0.80/lb
Post Weaning Pig	0.3	\$12.60	1.8	\$28.80
Weaning Pig	0.2	\$8.40	1.5	\$24.00
Growing Pig	0.15	\$6.30	1.0	\$16.00
Finishing Pig	0.15	\$6.30	1.0	\$16.00

SUMMARY OF RESULTS

- In Trial 1, starter pigs fed either level of Acid-V had greater feed efficiencies at two and four weeks and had greater four week weights than did fumaric acid fed pigs
- In Trial 2, Acid-V increased gains by 8.5%, increased feed intakes by 4.6% and improved feed efficiencies by 3.6% over starter pigs fed diets containing propionic acid



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ACID-V SWINE TRIAL 115

METHODS AND MATERIALS

- 72 starter pigs averaging 12.8 lbs. (5.8 kgs) weight were divided into two treatments of 36 pigs per treatmentw
- Treatments consisted of Control (no acidifier) and Acid-V added at the rate of 4.5 lbs. (2 kg) per ton of complete feed
- Trial was conducted for 28 days
- Parameters measured include daily gains, feed intakes and feed efficiency

ACID-V FOR STARTER PIG DIETS

The need for greater gains and improved feed efficiencies during the starting period of pigs has increased starter diet complexity from simple corn-soybean diets to diets containing fish meal, porcine plasma products and dairy products such as dried whey. The problems with these complex diets are incomplete diet digestion and digestive upsets in the starter pigs. Acid-V (a complex low inclusion acidifier that combines both organic and inorganic acids) has when added to starter pig diets been shown to provide greater gains and better feed efficiencies in young pigs. This study was conducted determine the effects of adding Acid-V to a control diet that is a premier complete starter diet from a major feed corporation on starter pig performance.

This study, conducted at Animal Technautics in Terre Haute, In., consisted of 72 male starter pigs weighing on average 12.8 pounds divided by weight into two treatments with 36 pigs per treatment. Treatments consisted of:

1. Control - a premier pig starter from a major feed corporation
2. Acid-V - the same control feed with the addition of 2 Kg of Acid-V per ton of feed.

The trial lasted for 28 days with feed intakes and average daily gains determined and feed efficiencies calculated at days 14 and 28. Results are shown in table 1.

The addition of Acid-V increased daily gains over Control fed pigs by 20.3%. The addition of Acid-V has been found to increase gains in starter pigs in other research studies. Acid-V increased feed intake by 10.75% over Control fed pigs. Acid-V improved feed efficiency by over 6% when compared to Control fed pigs.

With simple or complex diets, the addition of Acid-V helps improve the ability of the starter pig to utilize their diets. This is seen by increased daily gains and by improved feed efficiencies. Acid-V provides more pounds of starter pig at less cost.



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SUMMARY OF RESULTS

The addition of Acid-V to the diet increased gains by 18% and feed efficiency by 16% over Control within the first 14 days.

From days 14-28, Acid-V fed pigs had improved gains by 21%, feed intake by 16% and feed to gain ratio by 4% over Control fed pigs.

Overall, Acid-V increased daily gains by 20%, increased feed intake by nearly 11% and improved feed efficiency by 6.9% over Control fed pigs.

Table 1
Daily Gains, Feed Intakes And Feed Efficiencies Of Starter Pigs Fed Either Control Diets Or Diets Containing Acid-V

		Control	Acid-V	% Change
0-14 Days	Av Daily Gain, lbs.	0.39	0.46	18.0
	Feed Intake, lbs.	0.55	0.56	1.8
	Feed Efficiency	1.24	1.24	-16.2
14-28 Days	Av Daily Gain, lbs.	0.89	1.08	21.4
	Feed Intake, lbs.	1.30	1.51	16.2
	Feed Efficiency	1.46	1.40	-4.1
0-28 Days	Av Daily Gain, lbs.	0.64	0.77	20.3
	Feed Intake, lbs.	0.93	1.03	10.8
	Feed Efficiency	1.45	1.35	-6.9



ACID-V SWINE TRIAL 116

METHODS AND MATERIALS

- 144 starter pigs averaging 13.6 pounds (6.2 kg) weight were divided into four treatments of 36 pigs per treatment with two phase feeding.
- Treatments consisted of:

<u>TREATMENT</u>	<u>PHASE I</u>	<u>PHASE 2</u>
Control	No Acidifier	No Acidifier
Fumaric Acid	40 lb/ton	40 lb/ton
Acid-V I	4.5 lb/ton	2.25 lb/ton
Acid-V II	7.0 lb/ton	4.5 lb/ton

- Phase I was 1-9 days and Phase 2 was 10-24 days.
- Parameters measured included daily gains, feed intakes and feed efficiency.
- Also measured were cost and profit from using an acidifier.

ACID-V OUTPERFORMS FUMARIC ACID IN STARTER PIG RATIONS

The addition of Acid-V to starter diets has been shown to increase daily gains and improve feed efficiency of weaned pigs with little or no difference in feed intake when compared to non-acidified diets. These results have been noted for starter pigs fed either high or low quality starter feeds. Five pounds of Acid-V per ton of feed has also been shown to provide similar starter pig performance as 20 pounds of citric acid and at a lower cost per ton of feed. This study was conducted to compare Acid-V to fumaric acid, a high inclusion organic acid that is traditionally accepted as a feed acidifier in starter diets as noted by weaned pig performance.

This study was conducted at Animal Technautics in Terra Haute, In. The trial consisted of 144 starter pigs averaging 13.6 pounds divided into four treatments with 36 pigs per treatment. Diets fed were ground corn - soybean meal diets with the addition of a commercially available supplement supplied by a major U. S. feed manufacturer containing such ingredients as whey, fishmeal and porcine plasma. The trial period was divided into two phases. Phase I was the first 9 days on feed and Phase 2 consisted of days 10-24. Treatments were as follows:

	<u>PHASE I</u>	<u>PHASE 2</u>
Control	No acidifier	No acidifier
Fumaric Acid	40/lb ton of feed	No acidifier
Acid-V 1	4.5 lb/ton of feed	2.25 lb/ton of feed
Acid-V 2	7.0 lb/ton of feed	4.5 lb/ton of feed

Parameters measured were daily gains, feed intakes, feed efficiencies and body weights.



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Phase 1(1-9 days)

The results for this early phase show Acid-V added at a rate of 4.5 pounds per ton to be more effective than fumaric acid added at the rate of 40 pounds per ton. Gains for both treatments were identical and very similar to the control group. However, feed efficiency was improved by 14.4% for the Acid-V (4.5 pounds/ton) treatment while the fumaric acid fed pigs showed an improvement in feed efficiency of 9.4%.

The addition of Acid-V at the rate of 7.0 pounds per ton provided even better results with marked improvements in both daily gains and feed efficiency when compared to the control and fumaric acid treatments. Daily gains were improved by Acid-V by 10.6% and 13.2% while feed efficiency was 20.1% and 11.9% better when compared to control and fumaric acid, respectively.

Phase 2 (10-24 days)

In Phase 2, Acid-V continued to produce better diet digestion and utilization. The addition of Acid-V 1 and Acid-V 2 (both lower levels than in Phase 1) increased feed intakes by 1.9% and 3.8% and increased gains by 3.3% and 4.4%, respectively, when compared to Control fed pigs.

Some concern has been reported in the palatability of feeding acidified diets to young pigs. In Phase 1, acidification did decrease feed intake, however this was more than overcome by better diet digestion as noted by similar or greater gains with marked improvements in feed efficiency for acidification compared to Control fed pigs. In Phase 2, the Acid-V fed pigs however, maintained or increased feed intake and increased daily gains over Control fed pigs, showing that Acid-V addition to the diet provides no palatability problem, but does provide advantages in performance for older pigs.

Overall (1-24 days)

Fumaric acid fed pigs had 5.6% less feed intakes, 1.1% lower gains and 5.0% improved feed efficiency. Acid-V 1 and Acid-V 2 increased overall gains by 1.1% and 5.6%, respectively and improved feed efficiency by 5.6% over Control fed pigs. The addition of Acid-V acid to the diets at either 4.5 pounds or at 7.0 pounds per ton of feed (Phase 1) and at 2.25 pounds or 4.5 pounds per ton of feed (Phase 2) increased profit per pig over fumaric acid or Control fed pig (Table 3).

These results again show the benefits of feeding Acid-V to improve diet digestion by young pigs. Acid-V produced improvements in performance throughout the trial when compared with pigs fed diets without an acidifier. When compared with fumaric acid in the early phase, Acid-V proved to be superior.



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TABLE 1 - PHASE I AND PHASE 2 DIETS

	Control	Fumaric Acid	Acid-V 1	Acid-V 2
<u>Phase 1</u>				
Premix	650.0	650.0	650.0	650.0
44% Soybean Meal	333.7	333.7	333.7	333.7
Fumaric Acid		40.0		
Acid-V			4.5	7.0
Ctc-50	8.0	8.0	8.0	8.0
Corn	1008.3	968.3	1003.8	1001.3
<u>Phase 2</u>				
Premix	150.0	150.0	150.0	150.0
44% Soybean Meal	569.2	569.2	569.2	569.2
Acid-V			2.25	4.5
Ctc-20	4.0	4.0	4.0	4.0
Corn	1276.8	1276.8	1274.55	1272.3

TABLE 2 - GAINS, INTAKES AND FEED EFFICIENCIES OF STARTER PIGS

Treatments	Control	Fumaric Acid	Acid-V	Acid-V 2
Usage Rate Phase 1	0	40 lbs/ton	4.5 lbs/ton	7.0 lbs/ton
Starting Weight, lbs	13.6	13.6	13.6	13.6
Daily Feed Intake, lbs/day	1.14	1.02	0.98	1.05
Daily Gain, lbs/day	0.85	0.83	0.83	0.94
Feed to Gain Ratio	1.39	1.26	1.19	1.11
Usage Rate Phase 2	0	0	2.25 lbs/ton	4.5 lbs/ton
Starting Weight, lbs	21.33	21.15	21.08	22.17
Daily Feed Intake, lbs/day	1.60	1.56	1.63	1.66
Daily Gain, lbs/day	0.92	0.92	0.95	0.96
Feed to Gain Ratio	1.74	1.70	1.70	1.78
Final Weights, lbs	35.19	34.97	36.36	36.50
Overall Feed Intake, lbs/day	1.43	1.35	1.39	1.43
Overall Daily Gains, lbs	0.90	0.89	0.91	0.95
Overall Feed to Gain Ratio	1.61	1.53	1.52	1.52



TABLE 3 - THE COST AND PROFIT OF STARTER DIET ACIDIFICATION

Treatment	Fumaric Acid	Acid-V	Acid-V 2
Cost per Pound, \$	0.80	2.10	2.10
Cost per Pig Phase 1	0.16	0.04	0.07
Cost per Pig Phase 2	0.16	0.06	0.12
Total Cost per Pig	-0.22	0.10	0.19
Increased Pounds of Weight	-0.18	1.17	1.31
Value of Weight at \$0.80/lb	-0.34	0.94	1.05
Increased Profit per Pig		0.84	0.86

**Cost of acidifier per pound based on list price.*

SUMMARY OF RESULTS

- In Phase 1, Acid-V 1 improved feed efficiency (14.4% vs 9.4%) over Fumaric acid. Acid-V 2 increased gains by 10.6% and 13.2% and improved feed efficiency by 20.1% and 11.9% over Control and Fumaric acid respectively.
- In Phase 2, Acid-V 1 and Acid-V 2 increased feed intakes by 1.9% and 3.8% and increased gains by 3.3% and 4.4%, respectively when compared to Control.
- Overall, Acid-V 1 and Acid-V 2 increased gains, improved feed efficiency and improved profit per pig over Fumaric acid and Control.



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ACID-V SWINE TRIAL 117

METHODS AND MATERIALS

- 72 starter pigs averaging 14.8 pounds (6.7 kg) weight were divided into four treatments of 24 pigs per treatment with three phase feeding.
- Treatments consisted of:

<u>TREATMENT</u>	<u>PHASE 1</u>	<u>PHASE 2</u>	<u>PHASE 3</u>
Control	No Acidifier	No Acidifier	No Acidifier
Fumaric Acid	40 lb/ton	40 lb/ton	40 lb/ton
Acid-V	7.0 lb/ton	7.0 lb/ton	7.0 lb/ton

- Phase 1 was 1-9 days and Phase 2 was 10-24 days.
- Parameters measured included daily gains, feed intakes and feed efficiency.
- Also measured were cost and profit from using an acidifier.

UNIVERSITY SHOWS BENEFITS OF ACID-V

Acid-V has been proven extremely effective at overcoming the buffering effects of starter diets allowing weaned pigs to utilize these diets more efficiently as noted by greater gains and improved feed to gain ratios when compared to Control diets. Other studies have also shown that Acid-V fed at the rate of 3 to 7 pounds per ton of complete feed will improve diet utilization at levels similar to or better than 25 to 40 pounds of citric or fumaric acid per ton of feed. This study was conducted at Oklahoma State University comparing the effects of Acid-V and fumaric acid to control on gains, intakes and feed efficiencies of weaned pigs.

It was noted that as the trial when from Phase 1 to Phase 3, pigs fed the fumaric acid diet decreased animal performance when compared to Control and Acid-V fed pigs. This may be due to decreased feed intakes for pigs fed diets containing fumaric acid as noted by Figure 3. Overall the addition of Acid-V to starter pigs diets increases diet digestion for greater gains and as noted in Table 3 Acid-V is very cost effective.

EFFECT OF ACID-V ON STARTER PIG PERFORMANCE

There has been a considerable amount of research on the use of organic acids to promote acidification of the intestinal tract in young pigs. Acidification of feeds results in improved digestibility of nutrients in young pigs (Kirchgeßner and Roth, 1982) and reduces proliferation of coliform bacteria (Scipioni et al, 1978). These effects have been shown to improve weaned pig performance. This study was conducted to determine the effect of dietary acidification on nursery pig performance and to compare efficacy of a complex of organic and inorganic acids (Acid-V) at a lower inclusion level with fumaric acid.



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METHODS – ACID V SWINE TRIAL 118

Seventy-two pigs (Hampshire and/or Yorkshire) were group weaned (from on farrowing room) when the oldest pigs were 26 days old, and the youngest pigs were 20 days old. Pigs were blocked by age group (36 pigs in each of 2 groups) and stratified by litter, weight and sex (Boars and Gilts) into 6 pens with 6 pigs per pen in each weight group. Pens from each weight group were randomly allotted to one of three treatments (4 pens/treatment) consisting of a basal Phase 1 prestarter diet (Treatment 1, Table 1), the Phase 1 prestarter diet + .35% Acid-V (Treatment 2) or the Phase 1 prestarter diet + 2.0% fumaric acid (Treatment 3). The Phase 1 prestarter diet was fed for a two week period (Period 1) when the diets were changed to a Phase 2 starter diet (Table 1, Treatment 1), the Phase 2 starter diet + .225% Acid-V (Treatment 2) or the Phase 2 starter diet + 2.0% fumaric acid (Treatment 3). The Phase 2 starter diets were continued for a two week period (Period 2) when the diets were changed to a Phase 3 starter diet (Table 1, Treatment 1), the Phase 3 starter diet + .10% Acid-V (Treatment 2) or the Phase 3 starter diet + 2.0% fumaric acid (Treatment 3). The Phase 3 starter diets were fed for a two week period (Period 3). The trial was conducted in an environmentally controlled nursery with temperatures initially maintained at 86°F and decrease 2°F weekly until the temperature reached 78°F. Both feed and water were available on an ad libitum basis. Interim gain and efficiency of gain estimates were obtained weekly.

RESULTS

The effect of acidification on average daily gain, average daily feed intake, feed/gain ratio and pig weight are presented. Data from the two age groups were combined since no age x diet interaction was observed ($P > .10$). During Week 1, average daily gain was improved by 15% ($P < .15$) in pigs fed Acid-V and by 55% ($P < .05$) in pigs fed fumaric acid when compared to pigs fed the negative control diet. During Week 2, gain was improved by 34% ($P < .15$) and by 13% in pigs fed Acid-V or fumaric acid, respectively, when compared to pigs fed the negative control diet. For the two week Phase 1 period, the magnitude of improvement in pigs fed Acid-V or fumaric acid was 27% ($P < .1$) and 25% respectively, when compared to pigs fed the control diet devoid of acidifiers. Pigs fed Acid-V during weeks 3 and 4 and for the two week Phase 2 period continued to exhibit higher gains than pigs fed the negative control diet (22%, 2%, and 9%, respectively) although difference were not significant. During Phase 2, inclusion of fumaric acid did not improve gain when compared to pigs fed the negative control diet or those fed Acid-V. Average daily gain was not affected by either acidifier source during Phase 3 when pigs were fed a simpler corn-soybean meal diet.

Average daily feed intake was enhanced (19%, $P < .1$) during Week 1 by the inclusion of Acid-V or fumaric acid. During the remainder of the six week trial, average daily feed intake was similar among the dietary treatments.

Improvement in feed efficiency in pigs fed both acidifiers was similar to the improvements observed in average daily gain although differences were significant only during Week 1, Week 3 and Phase 1. During Phase 1 feed efficiency was improved by 16% ($P < .05$) in pigs fed Acid-V and by 14% ($P < .15$) in pigs fed fumaric acid when compared to those fed the negative control diet. During Phase 2 the magnitude of improvement in feed efficiency due to dietary



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acidification was reduced and during Phase 3 feed efficiency was similar among the dietary treatments.

Pig weight throughout the study was improved by the inclusion of Acid-V in the diet and pigs fed Acid-V weighed 2.12 pounds more than pigs fed the control diet devoid of acidifiers. While pigs fed fumaric acid had improved weight gain through weeks 1 and 2, the improvement in weight did not continue throughout the study.

This study suggests that the inclusion of Acid-V at a level of 7 pounds per ton in Phase 1 and 4.5 pounds per ton in Phase 2 improved performance. Acid-V at the lower inclusion level was more effective in improving performance than the inclusion of 40 pounds per ton of fumaric acid.

TABLE 3 - COST COMPARISON BETWEEN ACID-V AND FUMARIC ACID

	Cost/Pig/Day**	Average Daily Gain, lb.
Phase 1		
Control	0.00	0.40
Acid-V 7 lbs/ton	0.004	0.51
Fumaric Acid 40 lb/ton	0.010	0.50
Phase 2		
Control	0.00	0.99
Acid-V 4.5 lbs/ton	0.006	1.08
Fumaric Acid 40 lb/ton	0.027	0.96
Phase 3		
Control	0.00	1.34
Acid-V 2 lbs/ton	0.006	1.31
Fumaric Acid 40 lb/ton	0.041	1.27
	Cost/Pig/6 weeks	Total Gain, lbs/Pig/6 weeks
Control	0.00	38.76
Acid V	0.26	40.59
Fumaric Acid	1.09	38.38

**Represents additional cost of acidifier to diet based on daily consumption within the phase feeding period. Acidifier prices of \$2.20/lb. (Acid V) and 0.86/lb (fumaric acid)

SUMMARY OF RESULTS

- Acid-V improved animal performance over Control fed pigs.
- Acid-V was more effective than Fumaric Acid for increasing daily gains.
- Acid-V provided more total weight gain than Control and Fumaric Acid and was less expensive than Fumaric Acid to use.



ACID-V IN POULTRY DIETS

METHODS AND MATERIALS

- 1400 broilers per treatment
- Treatments consist of control and Acid-V (3 pounds per ton of complete feed)
- Parameters measured were 44 day weights, feed intakes and feed efficiency

ACID-V IMPROVES BROILER PERFORMANCE

Research and experience has shown that the addition of organic or inorganic acids to the diet can improve digestion of feed by animals. The use of such acidifiers to improve diet digestion has been shown to enhance animal growth and improve feed to gain ratio. This research was conducted to determine the effects of Acid-V, an acidifier for feed, on the performance on broilers.

A total of 2800 day old broiler chicks were randomly allotted to 10 pens of chicks fed a Control diet with no acidifier added while the other 10 pens were fed the Control diets with Acid-V at the rate of three pounds per ton of complete feed. Diets were normal production diets. Birds were fed for 44 days with weights, feed intakes and feed efficiency measured for the 44 days (Table 1).

Birds fed the diets with Acid-V had greater feed intakes and greater 44 day weights than did Control birds. In addition Acid-V also improved feed efficiency. These results demonstrate that Acid-V helps increase digestion of proteins, complex carbohydrates and mineral mixes by reducing the buffering capacity of these feed ingredients. The reduced buffering capacity of feed ingredients makes them more available for acid and enzyme digestion.

The use of Acid-V in poultry diets improves digestion and utilization of the feed by the bird. This will result in economically important improvements in growth and efficiency. In addition, by reducing the buffering capacity of the feed, digestive upsets by undesirable micro organisms can be expected to be reduced.

PERFORMANCE OF BROILERS FED EITHER CONTROL DIETS OR ACID-V DIETS

<u>44 DAYS</u>	<u>CONTROL</u>	<u>ACID-V</u>	<u>% IMPROVEMENT</u>
20 Pens/140 birds per pen	10 Pens	10 Pens	
Average Feed Intake (lbs)	9.466	8.576	+1.30%
Average Weights (lbs)	4.451	4.699	+4.45%
Feed efficiency	1.902	1.845	+3.00%



SUMMARY OF RESULTS

- The addition of Acid-V to the diet increased broiler weights by 4.45% over control fed broilers
- Acid-V addition increased feed efficiency of broilers by 3% over control fed broilers
- Acid-V addition did not change feed intake



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ACID-V ADDITION TO RABBIT DIETS

METHODS AND MATERIALS

- Two studies conducted
- Study one compared control vs Acid-V (6 pounds per ton of complete feed) with 30 rabbits per treatment (15 male and 15 female) for seven weeks
- Parameters measured in Study 1 were daily gains, feed intakes and feed efficiency
- Study 2 utilized 100 does per treatment with treatments consisting of control and Acid-V (4 pounds per ton of feed)
- Parameters measured in Study 2 were gains, feed intake, feed efficiency and mortality rate

ACID-V EFFECTS ON GROWING RABBITS

Acid-V is a blend of organic and inorganic acids designed to reduce feed buffering capacity when fed in livestock diets. The young growing animal, due to an immature digestive system, does not maximize diet digestion due to hard to digest proteins and complex carbohydrates fed to an underdeveloped enzyme system.

Acid-V, a feed acidifier helps to reduce intestinal pH and reduce buffering capacity of feed ingredients. This helps the immature enzyme system to increase feed digestion. Two studies were conducted in growing rabbits to determine the effects of adding Acid-V to diets on rabbit growth and feed intake.

The first study utilized 30 weaned rabbits, age 4 weeks with a sex ration of 15 males and 15 females per group (Table 2). The study was conducted for seven weeks and Acid-V was added at the rate of 6 pounds per ton of feed. The second study utilized 100 weaned breeding does housed in cages. Acid-V was fed at the rate of 4 pounds per ton of feed (Table 3).

In study one, addition of Acid-V to the diet of young rabbits increased daily feed intake over Control rabbits by 4.76%. The rabbits fed the diet containing Acid-V grew faster with average daily gains increased by 4.31% over rabbits fed the Control diet. In study two, gains were again increased by the addition of Acid-V. In addition feed efficiency was also improved with the addition of Acid-V. Mortality rate was decreased by 50% with addition of Acid-V to the diet.

These results demonstrate that the addition of Acid-V to rabbit diets assist in allowing the animals to improve diet digestibility. In both studies, rabbits had greater gains with the addition of Acid-V to the diet. With a decrease or no change in feed efficiency, faster weight gains means less days to slaughter or better conditioning for breeding and less cost and more profit to the producer.



TABLE 1 - DIET COMPOSITION

Proteins	18.28%
Cellulose	10.18%
Minerals	8.17%
Calcium	1.60%
Phosphorus	0.80%
Nitrogen	0.24%
Moisture	12.30%

**TABLE 2
GAINS, INTAKES AND FEED EFFICIENCIES OF RABBITS FED EITHER CONTROL OR ACID-V DIETS**

	<u>CONTROL</u>	<u>ACID-V</u>	<u>%IMPROVEMENT</u>
Starting weight (g)	606	603	
7 week weight (g)	2277	2346	+3.03
Average daily gain (g)	34.10	35.57	+4.31
Average daily feed intake (g)	105	110	+4.76
Feed Efficiency	3.08	3.09	

**TABLE 3
GAINS, INTAKES, FEED EFFICIENCIES AND MORTALITY RATE OF BREEDER DOES FED EITHER CONTROL OR ACID-V DIETS**

	<u>CONTROL</u>	<u>ACID-V</u>	<u>%IMPROVEMENT</u>
Number of does	100	100	
Starting weights (g)	600	600	
End weights (g)	2300	2410	+4.78
Trial gains (g)	1700	1810	+6.47
Feed intake/trial (g)	6392	6027	-5.71
Feed Efficiency	3.76	3.33	+11.44
Mortality rate	4.50	2.25	+50.00



SUMMARY OF RESULTS

- Addition of Acid-V to the diet in both studies increased gains
- The addition of Acid-V in Study 1 increased feed intake with no change in feed efficiency
- In Study 2, does fed diets containing Acid-V had better feed to gain ratios than did control fed does
- In Study 2, does fed Acid-V diets had lower mortality rates than did control fed does

ACID-V USAGE RATES

Species	Usage Rates
Pig	
Preweaned	2-3 Kg/ton of teed
Postweaned	2-3 Kg/ton of feed
Growing	1-2 Kg/ton of teed
Finishing	0.5-1 Kg/ton of feed
Rabbit	1-2 Kg/ton of feed
Poultry	
Broiler, Turkey	1-2 Kg/ton of feed
Pullet, Layer	1-2 Kg/ton of feed
Milk Replacer	
Piglet, Veal, Goat & Lamb	1 Kg/ton of milk replacer



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