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Livestock Research

Apple Cider Vinegar Supplementation in Feeder Pigs

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Cooperators:

- **Tom and Irene Frantzen - New Hampton**

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In a Nutshell

- Apple cider vinegar has been long advocated for its health benefits and is gaining recognition as a health supplement for livestock.
- Apple cider vinegar is held to being a health tonic that promotes beneficial gut bacteria, improves digestion of feedstuffs, enhances performance, and helps decrease parasite load.
- Tom Frantzen supplemented three groups of pigs with apple cider vinegar and measured feed intake, average daily gain, feed efficiency and return over feed costs compared to pigs not supplemented.

Key findings:

- Pigs supplemented with apple cider vinegar were observed to have a sleeker coat, improved vitality and looked healthier than those not receiving apple cider vinegar.
- Pigs supplemented with apple cider vinegar tended towards increased feed intake and average daily gains, higher carcass yields, better feed efficiency, and higher profits.

Project Timeline:

September 2014 – November 2015

Two groups of pigs, one supplemented with apple cider vinegar and one not supplemented. The split feeder in the center allowed Tom to conduct the trial. Photo taken November 17, 2015.

Background

Apple cider vinegar (ACV) is an acidic fermentation product which has seen increased interest recently as a healthful supplement for both humans and animals. It is mostly made up of acetic acid, along with trace amounts of vitamins, mineral salts, some amino acids, polyphenols, and other organic compounds (Johnston and Gaas 2006). The benefits of ACV are often seen as "folk wisdom", therefore limited research on studies have been conducted on its affects (Winter, 2013).

Among livestock farmers, ACV is held to have multiple medicinal purposes, including improved haircoat, greater milk and butterfat production, lower somatic cell count, reduced mastitis and the removal of parasites (Winter, 2013). Specific to pigs, observed benefits include decrease in piglet scouring, increases in litter size, improved piglet survival and increased weight gain. ACV has been used as an alternative to antibiotic treatment for mastitis and diarrhea in pigs, yielding positive results (Buessing, 2015).

ACV is also known to aid in digestion. In ruminants, acetic acid, which is a volatile fatty acid, stimulates rumen microbes to digest fibers and turn them into energy. Acetic acid also helps to stabilize pH and improves mineral assimilation. A researcher at the University of Wisconsin reported that when ACV was added to ground corn in a pig ration, the vinegar began to digest away to prolamines, the protein of the endosperm, releasing at least 20% more starch (energy) for the animal to use (Winter, 2013). This could prove very beneficial for animals consuming grain heavy rations, like pigs.

Cooperator Tom Frantzen designed a feed trial to evaluate the effect apple cider vinegar had when added to a grow-finish pig diet. Over one year, Tom fed three groups of pigs diets supplemented with ACV or not supplemented with ACV and measured intake and weight gain, feed efficiency and carcass yield.

Methods

This research project was conducted by Tom and Irene Frantzen, organic crop and livestock farmers located near New Hampton in Chickasaw County. Pigs were

split into two groups. One group received a ration mixed with apple cider vinegar (ACV), and the other (control) group did not receive any ACV (No ACV). Pigs selected for the trial were recently weaned and were similar in size and performance. All pigs were Chester White and Duroc crossbreeds. The trial was repeated three times, from September 2014 to November 2015 (Round 1: Sept. 11 to Dec. 22; Round 2: Feb. 9 to July 7; Round 3: July 15 to Nov. 20). Seventeen to 25 pigs were selected for each round before being split into the two treatment groups. Pigs were fed from 8 weeks old until harvest. Pigs were harvested at 24 to 29 weeks of age.

Tom mixed organic, raw apple cider vinegar into the pig feed at a rate of 5 gallons per ton.

The two groups were housed in adjacent pens with access to outdoor concrete pads. An outdoor feeder shared by the pens was partitioned so that feed for both groups could be kept separate. The control and treatment groups alternated pen and feeder sides with each repetition. Both groups received organic corn and soybean-meal based starter diets until weaning, and then received the feed ration with or without ACV. Unpasteurized and organic ACV was used; purchased from The Vinegar Guys. Raw ACV contains the "mother", which is made of proteins, enzymes and friendly bacteria that aid in fermentation and is said to provide the health benefits. Vinegar was added to the ration at a rate of five gallons per ton of feed. On average, pigs received 1.5 oz/head/day. The recommended dosage is 0.5-2 oz/head/day (The Vinegar Guys, 2015).

Tom with the split feeder used in the trial.

Tom would crawl on top of the feed mill and dump in the liquid while the feed was mixed. In the very first batch of feed, Tom accidently dumped the vinegar at a rate of 10 gal/ton, a double dose, into the feed mix. To stay consistent, the first batch of feed in all three repetitions was mixed with 10 gallons of vinegar per ton of feed. The newly weaned piglets are not eating much during this time, but influences in the gut may happen during the first week of consuming vinegar, so vinegar dosage remained the same throughout the study (10 gal/ton the first batch, 5 gal/ton all subsequent batches).

Group weights were taken at the beginning and end of each trial and feed intake was determined by weighing feed before delivery, and noted the dates feeders were refilled. From this information, average daily gain (ADG) and feed per pound of gain was calculated. Carcass weights and carcass yield were recorded at harvest. Feed costs and carcass value was recorded to calculate return over feed costs.

In the third repetition, Tom took fecal samples at the beginning and end of the trial for parasite analysis by the College of Veterinary Medicine at Iowa State. The McMaster Fecal Egg Count procedure was used.

Data were analyzed using JMP Pro 12 (SAS Institute, Inc., Cary, NC). Rounds were treated as replications (n = 3). Means separations between treatments are reported using the least significant difference (LSD) generated from a t-test. Statistical significance is reported at the $P \leq 0.05$ level.

Results and Discussion

Mean monthly temperatures in 2014 and 2015 near Tom's farm compared to the long-term averages are presented in **Table 1**. Any differences between the two treatment groups were not attributed to the temperature, as the pigs had barn access at all times.

Table 1 **Mean monthly temperature for 2014-2015 and long-term average.**

Month	Temperature (˚F)[a]	
	2014-2015	*Avg.*
Sep '14	60	62
Oct	47	50
Nov	25	34
Dec	25	21
Jan '15	17	16
Feb	8	20
Mar	32	32
Apr	47	47
May	57	59
Jun	67	68
Jul	70	72
Aug	67	70
Sep	67	62
Oct	50	50
Nov	39	34

[a] Mean monthly temperature for 2014 and 2015 and the long-term average at the New Hampton (120 years, approx. 15 mi. from Tom's) weather station (Iowa Environmental Mesonet, 2015).

Tom's feed trial records are reported for each replication and the mean in **Table 2**. All variables are reported on a per pig basis. Feed intake, ADG, feed per pound of gain, and carcass yield results, with statistical analysis, are elaborated on in the following sections. Feeding rounds were considered as replications. Statistical analysis was performed on the treatment means generated from the three rounds (replications).

Table 2

Feed intake, gain and carcass characteristics in pigs supplemented with apple cider vinegar (ACV) and those not supplemented with apple cider vinegar (No ACV).

	Rep 1		Rep 2		Rep 3		Mean	
Treatment	ACV	No ACV	ACV	No ACV	ACV	No ACV	ACV	No ACV
Number of pigs	9	9	8	9	13	12	10	10
Days in trial	141	141	149	149	127	127	139	139
Total feed intake (lb/hd)	637	741	679	607	671	585	662	644
Total gain (lb/hd)	175	182	196	172	200	147	190	167
Average daily gain (lb/hd/day)	1.24	1.29	1.32	1.15	1.57	1.16	1.38	1.20
Carcass weight (lb/hd)	173.00	177.40	179.07	155.99	187.69	165.42	179.92	166.27
Carcass yield (%)	78.3	74.0	76.2	73.9	74.2	74.5	76.2	74.1
Feed per lb of gain	3.65	4.07	3.46	3.53	3.36	3.98	3.49	3.86

Feed Intake

Tom recorded the weight and number of batches of feed the pigs consumed throughout each replication. The total feed offered to the group of pigs was then divided by the number of pigs in that group to get an average feed intake per pig. Feed intake for each of the three replications and the means are presented in **Figure 1**. When averaging all three replications, pigs fed ACV consumed 18 more pounds of feed, however, this was not statistically significant.

During the first replication, the No ACV pigs each consumed 104 more pounds of feed; an average of 5.2 lb more per week than the ACV pigs. In turn, the No ACV pigs gained more weight but ended up yielding a lesser percentage of carcass. The ACV pigs also had a lower feed per lb of gain ratio; 3.65 versus 4.07 for the No ACV pigs (**Table 2**). Tom wonders if this was the result of a digestion boost from ACV that helped to convert feed into meat, resulting in better carcass yield and better feed efficiency.

Figure 1

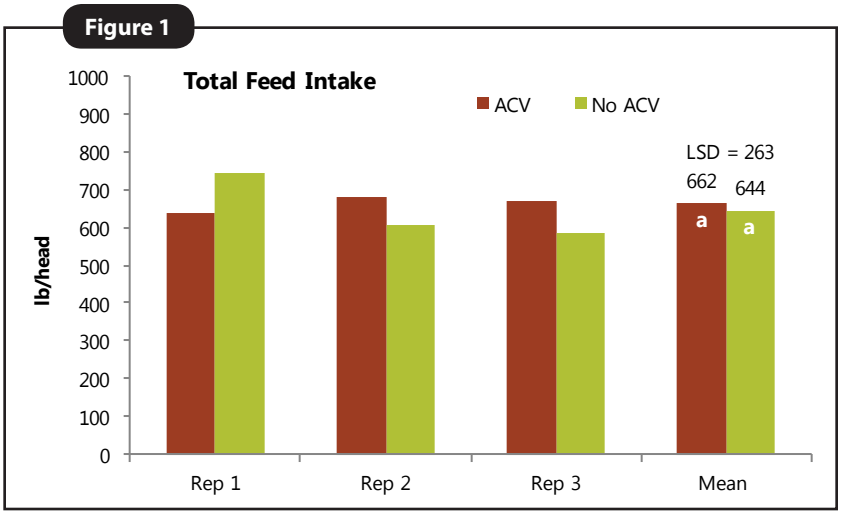

Figure 1. Total feed intake for each rep as well as the means for pigs fed apple cider vinegar (ACV) and those not (No ACV). For the mean, columns with same letters are not significantly different at $P \leq 0.05$. The least significant difference (LSD) is indicated above the mean column.

Figure 2

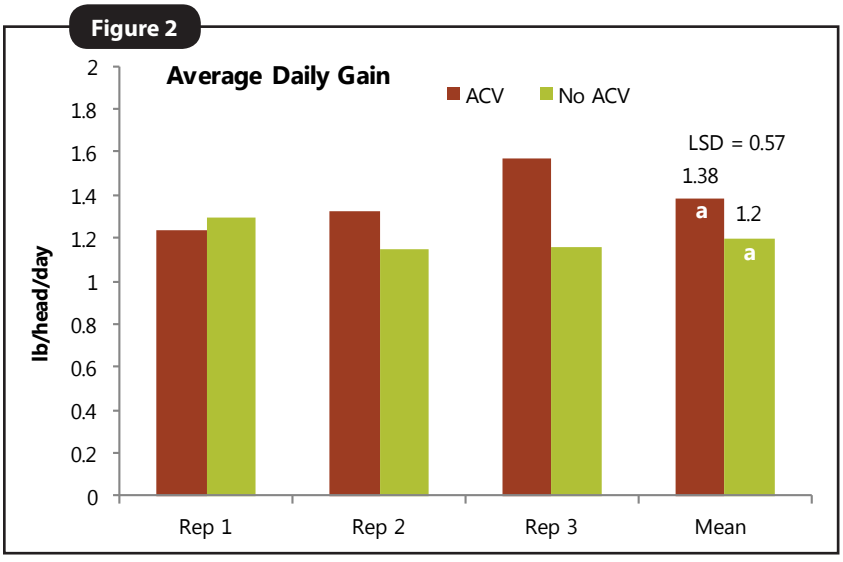

Figure 2. Average daily gains for each rep as well as the means for pigs fed apple cider vinegar (ACV) and those not (No ACV). For the mean, columns with same letters are not significantly different at $P \leq 0.05$. The least significant difference (LSD) is indicated above the mean column.

Intake was reversed during the second and third replications; the ACV pigs ate 72 and 42 more pounds of feed (3.38 lb and 2.32 lb more per week), respectively, than the No ACV pigs. This difference in feed intake between replications emphasized the importance of replicated trials to generate reliable data. Tom considers feed intake for Rep 1 an outlier. "Does ACV make feed more palatable? Or does it aid in digestion, making the pigs feel better and prompting them to eat more?" Tom asked. Simply put, Tom thinks that ACV promotes health and healthy pigs eat more.

Average Daily Gain

ADG for each treatment group and the mean of the three replications are presented in **Figure 2**. Though not statistically significant, ACV pigs gained, on average, 0.18 lb more per day and 23 lb total (**Table 2**), than the No ACV pigs. Because ACV pigs gained more weight overall, this further validated Tom's thoughts that, "the improved digestibility of feedstuffs caused ACV pigs to gain more."

Results from replication one show slightly lower ADG for the ACV pigs while replications two and three favor ACV (**Table 2**; **Figure 2**). The ADG values appear

related to feed intake (**Figure 1**) – the more pigs ate, the more they gained on a daily basis. Tom does not have an average daily gain goal for his operation, because it changes depending on the temperature outside. He is more concerned with how efficient his pigs are at converting feed to meat.

Feed Per Pound of Gain

Feed per pound of gain for each of the three replications, as well as the means, are presented in **Figure 3**. Feed per pound of gain is a ratio measuring how many pounds of feed it takes to gain one pound of weight – so the lower the number, the more efficient. Though not statistically significant, the average feed per pound of gain for ACV pigs was 3.49 and 3.86 for No ACV pigs. Thus, the No ACV pigs required 0.37 lb more feed than the ACV pigs to put on one lb of weight.

Although the ACV pigs appeared to be consistently more efficient at converting feed to meat across the replications, Tom said both of these values are poor. The average feed per pound of gain on the farm is 3.4, but Tom would like to see values around 3.3. He attributes the low values to the 2013 and 2014 corn crop, which produced low quality corn and was fed in the ration during this study. "The corn looked pale and fluffy and had a low density. It contained 6% crude protein and ideally corn contains 8-9% crude protein," said Tom.

Carcass Weight and Yields

On average, carcass weight per head for ACV pigs was greater by 13.65 lb compared to No ACV pigs (**Table 2**). Carcass yields for each replication and the mean are presented in **Figure 4**. Carcass yields for ACV pigs ranged from 74.2% to 78.3%, with the average being 76.2%. Carcass yield for the No ACV pigs stayed near 74%. Tom said, "A yield of 73% to 74% is very common, anything below 73% is disappointing and anything above 75% to 76% is terrific. When you are paid on carcass weight, anything that improves carcass yields goes straight to your bottom line."

There is a caveat when reporting carcass yields. The results are not representative of all 60 pigs in the trial. Each trial came to an end when there were a significant number of pigs ready to be harvested; but not all pigs were ready at the same time. Pigs were harvested at Natural Food Holdings in Sioux Center and at a local locker in Protovin. Only the pigs harvested in Sioux Center were assigned carcass yields, which is the data reported. Tom would have liked to have a complete data set, and expressed, "If I could do the trial over, I would be very careful in selecting pigs that are as even as possible, so they could all be slaughtered at the same time."

Tom with some of his pigs, Chester White and Duroc crosses.

Figure 3

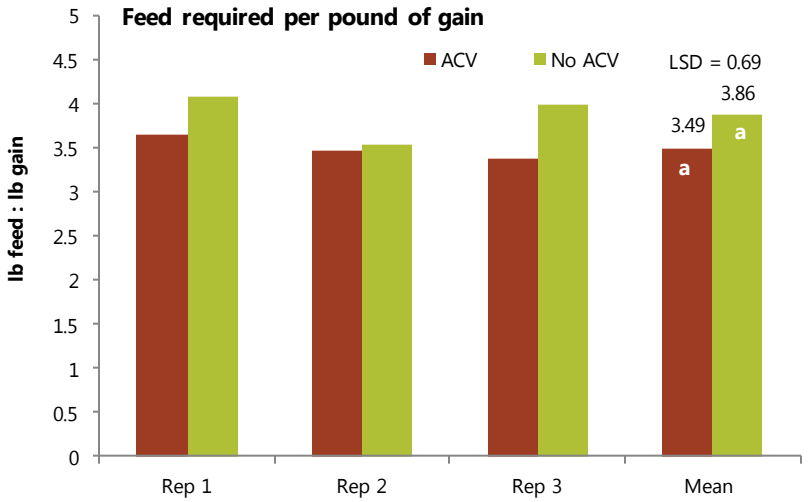

Figure 3. Feed per pound of gain for each rep as well as the means for pigs fed apple cider vinegar (ACV) and those not (No ACV). For the mean, columns with same letters are not significantly different at $P \leq 0.05$. The least significant difference (LSD) is indicated above the mean column.

Figure 4

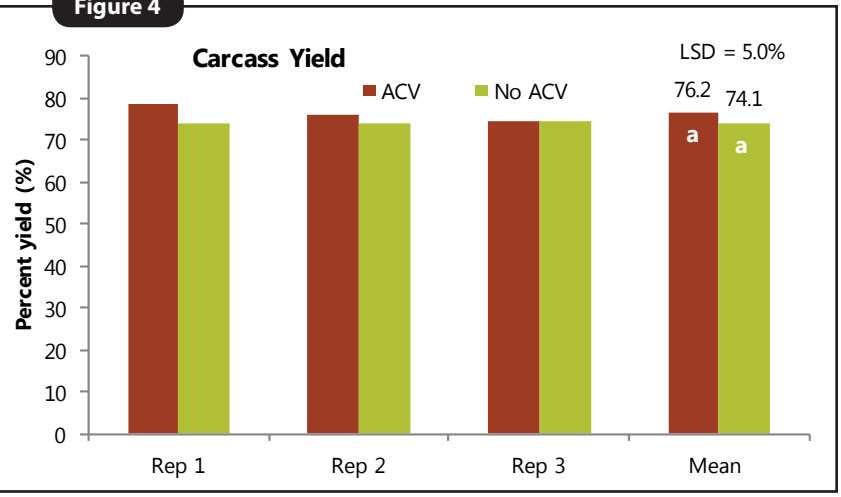

Figure 4. Carcass yields for each rep as well as for pigs fed apple cider vinegar (ACV) and those not (No ACV). For the mean, columns with same letters are not significantly different at $P \leq 0.05$. The least significant difference (LSD) is indicated above the mean column.

From the data that was collected, "It looks like there is a tendency to get a better carcass yield from vinegar fed pigs, but we need more trials to prove this," stated Tom.

Parasites

At the end of replications one and two, one pig from each treatment group was harvested at a local locker so the Frantzens and their veterinarian could make visual comparisons of the carcasses. Their vet, Dr. Ashlie Kolbet from the Osage Veterinary Clinic observed liver lesions in the No ACV pigs and no liver lesions in the ACV pigs. She attributed the lesions to roundworms (*Ascarid suum*), which is the most prevalent internal parasite of swine (Vet Med, 2015).

Tom heard that ACV acts as a natural dewormer, so he wanted to see for himself if it made a difference. During the third replication of the feed trial, Tom took fecal samples near the beginning and end of the trial to test for internal parasites. Fecal samples were collected from pigs in both treatment groups on July 16, 2015 and November 12, 2015 and sent to the Veterinary Diagnostic

Laboratory at Iowa State.

Fecal sample results from July showed a few number of Ascaris eggs in the ACV pigs and a few number of *Ascaris* and *Trichuris* (whipworm) eggs in the No ACV pigs. Although a few eggs were present, this quantity did not warrant treatment. Fecal samples from November showed no parasite eggs present in either sample. Tom wonders if the acid in the vinegar could be creating an environment non-conducive to parasites.

Table 3

Costs and profits incurred from pigs supplemented with apple cider vinegar (ACV) and those that were not supplemented with apple cider vinegar (no ACV).

	Rep 1		Rep 2		Rep 3		Mean	
Treatment	ACV	No ACV	ACV	No ACV	ACV	No ACV	ACV	No ACV
Carcass price ($/lb)	$2.00	$2.00	$2.00	$2.00	$2.00	$2.00	$2.00	$2.00
Carcass weight (lb/hd)	173.00	177.40	179.07	155.99	187.69	165.42	179.92	166.27
Carcass value ($/hd)	$346.00	$354.80	$358.14	$311.98	$375.38	$330.84	$359.84	$332.57
Total feed intake (lb/hd)	637	741	679	607	671	585	662	644
Total feed costs ($/hd)	$168.17	$184.51	$179.26	$151.14	$177.14	$145.67	$174.76	$160.36
Net returns ($/hd)	$177.83	$170.29	$178.88	$160.84	$198.24	$185.17	$185.08	$172.21

During a farm visit, Dr. Kolbet observed the live pigs involved in the feed trial. She noted, "The ACV pigs have better and brighter eye appearance and seem more vigorous."

Costs and Returns

Carcass price, carcass value, total feed costs and net returns are presented in **Table 3**. The cost of the ACV is included in total feed costs for each replication. ACV cost $6/gal and on average, 5 gallons was added per ton of feed, so ACV treatment cost $30/ton of feed. Tom fed a total of 50 gallons of vinegar over the three replications, spending $300 on ACV. The cost of feed used in the study amounted to $0.249/lb for feed without ACV and $0.264/lb for feed with ACV; it cost 1.5¢ more per pound of feed to add the ACV.

Though not statistically significant, ACV pigs had, on average, better feed efficiency and higher carcass yields. As carcass weights per head were greater for the ACV pigs, the carcass value of the ACV pigs averaged $359.84 compared to $332.57 for the No ACV pigs. This $27.27 increase in carcass value covered the $14.40/head in extra expenses to feed the ACV. This translated to ACV pigs netting $12.87 more per head than No ACV pigs.

Conclusions and Next Steps

Tom came to two conclusions at the end of the trial. All three replications showed the ACV pigs had better feed efficiency and greater than or equal to carcass yields to the No ACV pigs.

Though this trial bore no statistically significant effects of ACV, this was likely due to the results of replication one which served as a learning experience for implementing the trial. Differences between treatments were much starker in replications two and three which more resembled the means. On average, however, the ACV pigs did turn out to be more profitable than the No ACV pigs as Tom was able to cover the increase in feed costs associated with ACV with an increase in carcass weight and value.

Tom and Irene were convinced by the observed trends that show apple cider vinegar certainly has benefits that have yet to be scientifically proven. Each round of ACV fed pigs visibly stood out - they looked sleeker and were bigger. "Every time we sorted pigs, I could see a difference in size and could pull out vinegar pigs right away from their looks", expressed Irene. "After feeding ACV in three repetitions, I saw improved pig vitality. Vinegar pigs were more vigorous," declared Tom.

Tom and Irene will continue to feed ACV to both their grow-finish pigs and cattle, and may start feeding it to sows. Tom wants to develop a feeding chart that determines how many gallons of ACV should be added to a ton of feed, based on a pig's increasing feed consumption - so he is able to consistently deliver 2 oz. per head per day.

Tom stressed that this trial was a learning lesson, and that he learned quite a lot in a year's time. "The results indicate that ACV improves pig performance and this is something that merits further investigation, by other farmers and by industry," said Tom. He hopes future research will continue and would like to see similar on-farm trails replicated by other PFI farmers.

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