BIBLIOGRAPHY

LADU-AN, JERICHO L. APRIL 2013. Utilization of Activated Charcoal Containing Wood Vinegar as Feed Additive for Broilers.Benguet State University, La Trinidad, Benguet.

Adviser: Madeline S. Kingan, Msc.

ABSTRACT

The study was conducted to obtain scientific data indicating the effectiveness of using charcoal and mukusaku on broiler production. Specifically, the project aspired to determine the effect of charcoal and mokusaku mixture as part of the total diet on the growth of broilers in terms of body weight and gaining ability, to compare the feed consumption and feed :gain efficiency of the broilers, to compute the cost per kilogram gain of broiler produced as a result of the different feeding regimes, to observe differences in morbidity and mortality rates among the treatment groups, and to interpret and compare the harvest rate, broiler productivity index, and returns on investment derived from the different feeding programs.

Using Completely Randomized Design (CRD), 144 birds were distributed into three treatments. Each treatment had four replicates with 12 birds per replicate making a total of 44 birds per treatment. The three treatments were commercial feeds (T_0); 10g activated charcoal containing wood vinegar per kg of CF(T_1); and 20g activated charcoal containing wood vinegar/kg of CF (T_2)

The results of this study showed that there were no significant differences among the treatments in initial weight, feed consumption, feed conversion ratio, harvest rate, productivity index, and mortality rate. However, morbidity in the groups given 10g and 20g activated charcoal containing wood vinegar per kg of CF was significantly higher than the morbidity rate obtained on the birds given commercial feeds only.

Based onthe result of the study, supplementing either 10 or 20g activated charcoal containing wood vinegaron the broilers did not produced any positive effect on their overall performance.Although it was not found to have effectively enhanced the growth of broilers, its ability to adsorb harmful substances in the body can still be considered.Activated charcoal containing wood vinegar may be used as feed additive for broilers upon the discretion of the raisers.

INTRODUCTION

White meat such as chicken meat is considered superior in health aspects to red meat because of comparably low content of fat and cholesterol. Consumers also acknowledge the relatively low price, and the lack of religious restriction against its consumption.

Poultry meat ranks quite higher than beef and red meat in conversion efficiency, in spite of the use of forage crops by beef cattle and sheep, goat for meat production. Poultry produce, eggs and meat, are cheaper sources of high quality proteinous food and are very much useful to fight malnutrition (Jadhav and Siddiqui, 2007).

Globally changing consumer trends necessitate the need to look for alternative products to minimize the dependence on chemicals in livestock and poultry feeding. The need to minimize health risks resulting from the rampant use of growth enhancers, antibiotics and various synthetic feed additives to livestock and poultry bolsters the use of safer products. Furthermore, the growing awareness of consumers on better food choices make it worthwhile to adopt technologies that aim to reduce the use or even replace synthetic chemicals with plant-derived biocontrol agents and growth enhancers.

One such technology is the SAVERS technology in which farmers apparently have seen its beneficial effects on vegetable and flower cultivation. One product being advocated by this technology is Nekka-Rich, developed by Miyazaki-Midori Pharmaceuticals Inc. in Japan which consists of a mixture of charcoal and wood vinegar (wood vinegar). However, despite the fact that this product has been used for over a decade now in Japan, literature search on its use in animal production resulted to only a limited number of scientific publications.

To date, there is very little scientific data available to support that charcoal and wood vinegar are beneficial feed additives for swine and poultry. This study establishes scientific evidence that the marketed product is indeed effective in producing positive growth response in animals. It is imperative that its effect on animal growth was investigated if the product is to be used in any feeding program. Additionally, research results would help accelerate the dissemination of SAVERS technology in the locality.

On a general perspective, this proposed research aimed to obtain scientific data indicating the effectiveness of using charcoal and wood vinegar to animal production by enhancing healthy growth of animals and improving productivity and product quality.

Specifically, the project aspired to achieve the following:

1. determine the effect of charcoal and wood vinegar mixture as part of the total diet on the growth of broilers in terms of body weight and gaining ability.

2. compare the feed consumption and feed :gain efficiency of the broilers;

3. compute the cost per kilogram gain of broiler produced as a result of the different feeding regimes;

4. observe differences in morbidity and mortality rates among the treatment groups; and

5. interpret and compare the harvest rate, broiler productivity index, and returns on investment derived from the different feeding programs.

This study was conducted at the Poultry Project, BSU, La Trinidad, Benguet from October to December 2012.

REVIEW OF LITERATURE

Nekka-Rich

Nekka-Rich® (Miyazaki-Midori Pharmaceuticals Inc., Japan) is a product made by mixing activated charcoal and wood vinegar (wood vinegar) liquid that contains organic acids. The activated charcoal and wood vinegar liquid of Nekka-Rich are both obtained from the bark of evergreen oak (*Castanopsis cuspidate* and *Quercusacuta*) by carbonization.

Wataraiet *al.* (2008) found that activated charcoal from bark containing wood vinegar liquid (Nekka-Rich) is an effective treatment for Cryptosporidiosis in calves by reducing the viability and inhibiting adsorption of the *C.parvum*ooctyes. Furthermore, the calves that were fed milk enriched with Nekka-Rich showed recovery from diarrhea one day after the start of treatment.

Mixture of charcoal and wood vinegar was proved to be useful as aqua feed(Yoo*et al.*,2007) while Samanya and Yamauchi (2001) found it a useful component in chicken feed.

Watarai and Tana (2005) studied the protective efficacy of activated carbon containing wood vinegar liquid (Nekka-Rich) against intestinal infection with *Salmonella Entericaserovarenteritidis* in chicken and showed that *S. enteritidis* was effectively adsorbed by activated charcoal. The wood vinegar included in Nekka-Rich inhibited the growth of S. Enteritidis whereas the growth of the normal bacterial flora in the intestine, *Enterococcus faecum* and *Bifidobacteriumthermophilu*, was enhanced. These results suggest that Nekka-Rich would be a good product for eliminating the carriage of *S. enteritidis* in domestic fowl.

Wood Vinegar (*Mokusaku*)

Wood vinegar is liquid obtained from oil, juices, sap and other liquid contents of organic materials such as wood, coconut shell, bamboo, grass and other plants after being heated in a chamber. It is composed of a lot of organic chemical substances. Studies in Japan have shown that there could be more than 300 chemical substances. However, these substances are dependent on the materials to be heated as well as the burning / carbonization process and the timing collecting cooled steam from the tube. Further researches are still needed to validate the chemical components since the data are based on few studies in Japan (Yokomori, 2011).

Wood vinegar is an all-natural deodorant derived from plant extracts. The skin friendly plant chemicals bind themselves to odor-causing agents on the animal's body and wastes, effectively breaking down, absorbing and transforming them into a natural acidic state and destroying suppressing bacteria, viruses, and other odor-causing pathogens (ACE Pte Ltd, Singapore, 2012).

Sjostrom (1993), Goldstein (1983) and Fengeland Wegener (1984) as cited by (Tiilikkala*et al.*, 2010) claimed that the main organic components of wood vinegar are methanol and acetic acid. Other components are acetone, methyl acetone, acetaldehyde, allyl alcohol, furan and formic, propionic and butyric acids.

Pyroligneous acid, also called wood vinegar, is a dark liquid produced through the natural act of cabonization, which occurs when wood is heated in an airless container during charcoal production. The principal components of pyroligneous acid are acetic acid, acetone and methanol. It was once used as a commercial source for acetic acid. In addition,

the vinegar often contains 80-90% water along with some 200 organic compounds (Anonymous, 2012).

Japanese farmers have been using wood vinegar to improve crop and livestock production. They use it as: (1) foliar spray, particularly for fungus (grey molds), (2) insecticide when mixed with pepper, (3) enhancer for compost-making, (4) soil conditioner to improve the soil when mixed with charcoal, and (5) feed supplement or additive for livestock feeds (Yokomori, 2009).

He cited that in chicken egg production, farmers claimed that their hens improved their egg-laying performance, had better rearing characteristics, and improved their hatching efficiency. It also improved the quality of eggs such as better taste, reduced cholesterol content and had harder egg shells.

Furthermore, studies on swine production showed that sows improved their performance. They became healthier, their fertility rate improved, and piglet size became uniform. The fatteners also improved their feeding efficiency and meat quality. The foul odor from the manure of the pigs was also reduced. Reports from farmers indicated that their sows increased their milk production and diarrhea among piglets were prevented or cured. In cattle, it said wood vinegar also improved meat quality, fertility rate, milk production and feed efficiency.

Choi*et al.* (2009), reported that apparent fecal digestibility of dry matter, gross energy and crude protein was significantly higher ($p<0.05$) in pigs fed the antibiotic diet when compared with pigs fed the control but comparable among pigs fed antibiotic, organic acid and wood vinegar diets. Higher populations of *Lactobacillus* ($p = 0.004$) were noted in the ileum of pigs fed the wood vinegar diet, while the population of coliforms in the

ileum and cecum was higher ($p<0.001$) in pigs fed the control diet when compared with pigs fed antibiotic, organic acid or wood vinegar diets. These results indicated that wood vinegar could improve the performance of weanling pigs by improving the nutrient digestibility and reducing harmful intestinal coliforms; moreover performance of pigs fed wood vinegar was superior to those fed organic acid.

In 2009, Rakmai evaluated the chemical components and bio-efficacies of four types of wood vinegar produced in Thailand. The results from her study indicated that all tested Thai wood vinegar showed antibacterial and antifungal activities against dermatitis bacteria and fungi and bacteria that cause gastrointestinal disorder. In addition the wood vinegars presented antioxidant activity.

Activated Charcoal

In 2002, Organic Materials Review Institute (OMRI) updated a previous evaluation of activated charcoal as an animal feed supplement for the USDA. The panel is in complete agreement as to the unmatched efficacy of activated charcoal for the treatment of animal poisoning. However, it should be clear that charcoal is inert and thus it is neither digested nor assimilated by any animal.

The Food and Fertilizer Technology Center of the Asia Pacific Region in cooperation with KwangHwa Jung National Livestock Research Institute in Korea (2012) recommends that bamboo charcoal may be fed at a rate of 1-2% by volume of the feed mix to cattle, 1-1.5% to fattening cattle, 1-5% for pigs, 1-1.5% for laying hens and 1% for broilers.

They noted increase in milk production for cattle, decrease in mastitis and reduction in mortality for pigs and laying hens as benefits when feeding charcoal powder to

domesticated animal. In addition, overall disease reduction, improve feed: weight ratio of pigs and 50% reduction in the offensive smell of manure of manure were observed.

The same source cited in Europe, many small and large farmers widely follow the age-old practice of mixing charcoal specifically designed to be added to cattle or poultry feed or to the drinking water because animals are increasingly subjected to contaminated water and feed. The activated charcoal supplement is able to adsorb many toxins from water-borne organisms or toxins from decomposing feeds. An added benefit is the marked reduction in waste odor.

MATERIALS AND METHODS

Materials

The study used a total of 144 straight-run day old chicks which was obtained from a reliable supplier. Other materials required for the experiment includes brooding-rearing cages partitioned into 12 pens, electric bulbs, commercial feed and biologics, newspapers for bedding, watering facilities, weighing scale, and record book.

Methodology

House preparation. General cleaning of the house was done two weeks before the chicks arrived. All adhering dirt and fecal droppings in the cages wasscrapped and brushed off. After dry cleaning, thorough wetting was done to loosen up whatever residue left. This was followed by scrubbing with a detergent sanitizer solution (detergent powder diluted in water). Feeders, watering devices and sacks for curtains and dividers were likewise washed in detergent solution.

Rinsing with water under high pressure was done to ensure that all facilities are thoroughly clean. The cages were then divided using feed sacks into 12 pens following recommended space requirements. The heating lamps were also installed in the pens.

Disinfection followed after the house and equipment were dry. The ceiling, walls and floors including the feeders and drinkers was sprayed with disinfectant then allowed to dry. A second disinfection was done after two days using an organic disinfectant. The disinfected poultry house was closed and all unnecessary entry was prevented until the chicks arrived.

Brooding and rearing management. Pre-heating of the brooders was done by turning on the bulbs one hour prior to expected placement of the chicks. Feeds and water mixed with dextrose was readily available. Newspapers laid on top of each other to about ten layers was used as bedding material and feed receptacles during the first seven days to allow the chicks to familiarize themselves with the feeds before feeders were introduced on the second week.

The optimum brooding temperature requirements was followed throughout the brooding stage. The brooding pens was also later served as rearing pens to minimize unwanted stress which can be incurred when the chicks are transferred from a brooding to a rearing area.

Experimental design and treatment. The experiment was laid out in a Completely Randomized Design. There were three treatments replicated four times with 12 birds per replicate. Therefore, there were 48 birds in each treatment comprising a total of 144 birds for the whole study. Following manufacturer recommendations, the feeding regimes are as follows:

T_0 - commercial feeds (CF) + antibiotic premix (control)

T_1- 10g activated charcoal containing wood vinegar/kg CF (Figure 1a)

T_2- 20gactivated charcoal containing wood vinegar/kg CF (Figure 1b)

Procurement of the activated charcoal and wood vinegar mixture.Activated charcoal containing wood vinegar (Figure 1c and d) was provided by the Japanese Agricultural Exchange Cooperation (JAEC). The additive was added to the ration of the designated experimental birds at 1% and 2% by weight of the commercial feeds per manufacturer recommendation.

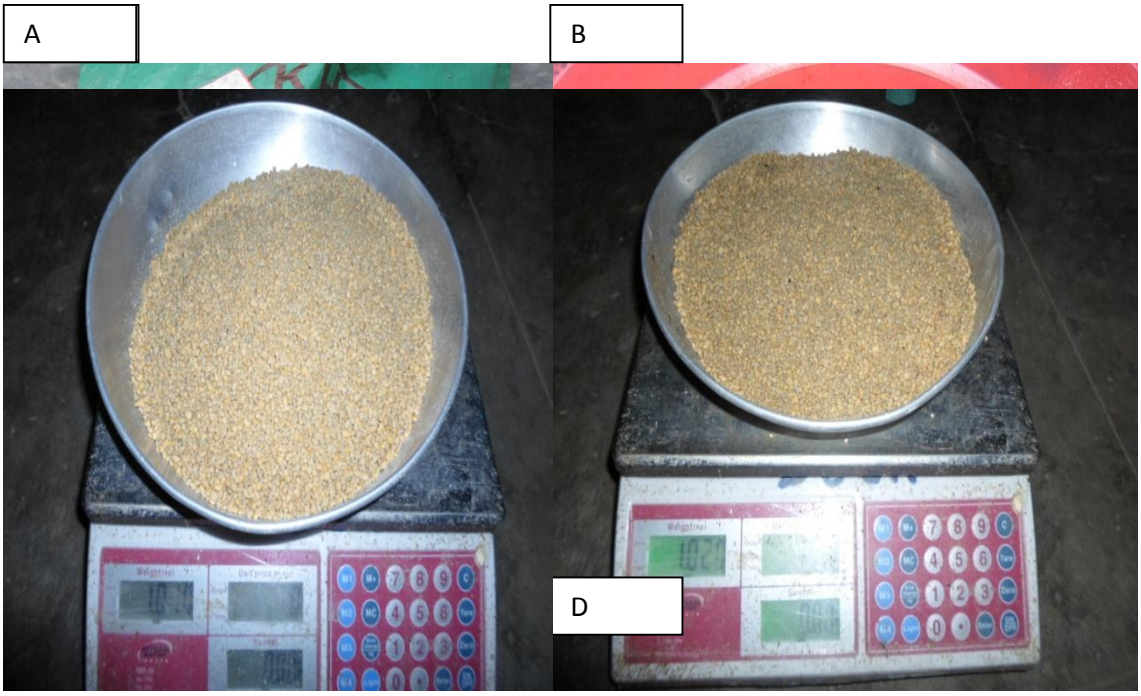

Figure 1.The treatments : (a) 10 g activated charcoal containing wood vinegar in 1 kg commercial feed; (b) 20 g activated charcoal containing wood vinegar in 1 kg commercial feed; (c) and (d) the activated charcoal containing wood vinegar in 1 kg commercial feed

Lighting Management.Sufficient light was provided to the birds to maximize their growth potential. The intermittent lighting program was adopted by giving continuous light for the first two weeks of brooding then shifted to 16 hrs light and 8 dark period starting on the first day of the 3rd week. The dark period was from 10 o'clock in the morning to 5 o'clock in the afternoon. The lights were turned on only at 5:00 PM.

Water management. Water wasprovided *ad libitum* to all birds from the start (day 1) to the end of the study (day 42). On the first day (day 1) to the last day of the third week (day 21), antibiotic premix was added to the drinking water of all the birds. On the first day of the fourth week (day 22), plain water was given to all birds until the end of the study.

Feed management. Feeds were given evenly on the newspaper matting during the first week. Feeding troughs were introduced on the second week. The feeders were checked

every 6 hours to ensure that feeds were always available. All the chicks were fed a crumble booster diet from 1 to 13 days of age, starter ration from 13 to 25 days then finisher ration from 26 to 42 days which is the culmination of the study.

Activated charcoal containing wood vinegar was incorporated in the ration of the designated birds (T_1 and T_2) from the first day until the end of the study (42^{nd} day).

Data Gathered

1. Initial weight (kg). This is the weight of the chicks at day-old.

2. Weekly body weight (kg). This refers to the weekly weight increment of the broilers while feeding on the experimental diets.

3. Final weight (kg). This was taken by weighing the birds individually at the end of the study when they are 6 weeks old or 42 days of age.

4. Feed offered (kg). This is the amount of feed offered to the birds and weighed daily for the 42 days of feeding experiment.

5. Feed left-over (kg). This is the amount of feed left in the feeders and collected daily for the 42 days of experimental feeding.

6. Feed cost (Php). This refers to the prevailing cost of commercial ration at the time of the study.

7. Morbidity. This refers to the number of birds that succumbed to disease from the start to the end of the study.

8. Mortality. This refers to the number of birds that died during the conduct of the experiment.

Data Computed

1. Total gain in weight (kg). This was computed by subtracting the initial weight from the final weight.

2. Average daily gain in weight (kg). This reflects the daily weight increment of the birds which was taken by dividing the total gain by the total number of feeding days.

3. Total feed intake (kg). This is the amount of feed left-over subtracted from the amount of feed offered.

4. Average daily feed intake (kg). This is the amount of feeds consumed by each bird daily which was computed by dividing the total feed intake by the total number of feeding days.

5. Feed conversion ratio. This parameter measures the amount of feed consumed to produce a kg gain. It was computed by dividing the total feed intake by the total gain in weight.

6. Feed cost to produce a kg of broiler (Php). This was obtained by multiplying the feed conversion ratio by the cost per kg of feed.

7. Percent mortality. This refers to the quotient of the number of dead birds by their initial number multiplied by 100.

8. Percent morbidity. This was the quotient of the number of sick birds by their initial number multiplied by 100.

9. Harvest rate (%). This was computed using the following formula:

[HR= (# of harvested birds ÷ initial number of birds) x 100]

10. Productivity index (%). This was computed using the following formula

[PI = (live body weight, kg × 100) ÷ feed conversion ratio]

11. Cost: benefit analysis. This was measured in terms of return on investment (ROI) which was computed by dividing the net profit by the total cost of production then multiplying the quotient by 100.

Statistical Design and Analysis

Significant differences in all response variables were determined through Analysis of Variance (ANOVA). Significant differences were compared using the Duncan's Multiple Range Test.

RESULTS AND DISCUSSION

Initial Weight

The initial weights of the birds in the different treatments are shown in Table 1. Statistical analysis revealed that there were no significant differences on the average initial weight of the birds at day old on the start of the study. This implies that the body weight of the experimental unit were more or less identical. The average initial weight of the birds was 0.047 kg.

Weekly Weight Increment of Birds

Figure2shows the average weekly weight increment of the birds from day old up to the 42nd days of age. Statistical analysis showed that there was no significant difference in the weight increment of the birds in the three treatments. The birds fed with 20 g activated charcoal per kilogram commercial feed had a higher growth pattern followed by the birds fed 10 g activated charcoal per kilogram feed and then the birds fed with commercial feeds only. All the birds followed an ascending growth trend showing

Table 1.Initial weight of the birds at day old

TREATMENT	INITIAL WEIGHT(kg)
Commercial feeds	0.048^{a}
10g activated charcoal containing wood vinegar/kg CF	0.047^{a}
20g activated charcoal containing wood vinegar/kg CF	0.048^{a}

Means with the same superscripts are not significantly different (P ≥ 0.05) DMRT

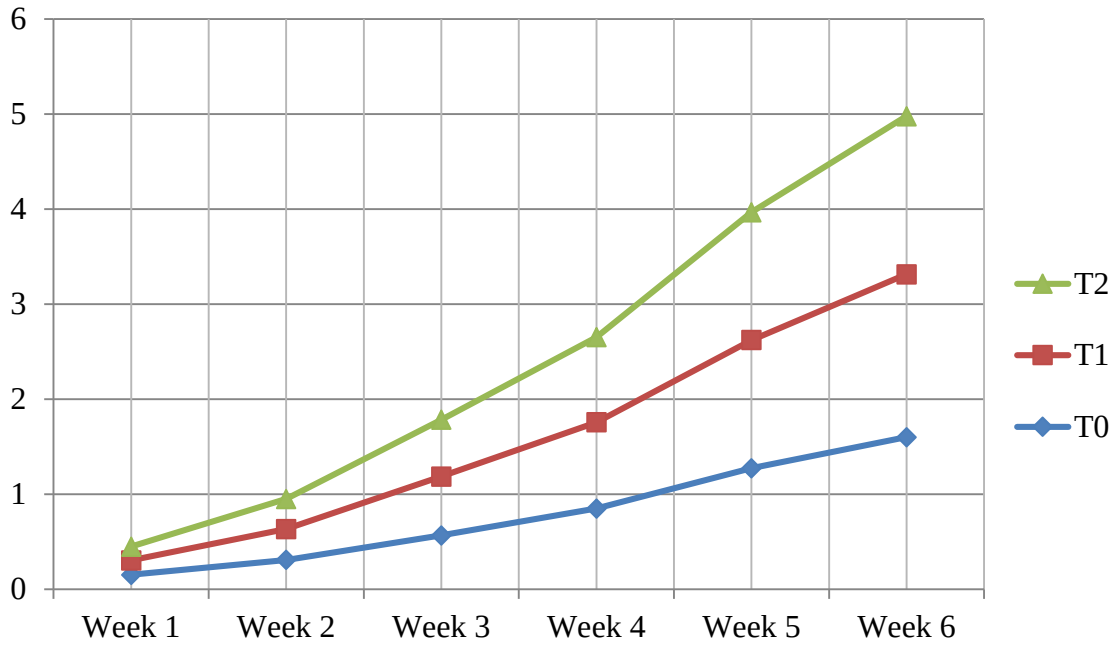

Figure 2. Weekly weight increment of birds

that the feed additive given did not produce any adverse effect on a 42- days feeding period.

Final Weight

Table 2 presents the final weight of the experimental birds in the different treatments. The average final weight was taken at the end of the study when the birds are 42 days old. Statistical analysis revealed no significant differences on the final weight of the birds. The average final weight of the birds given pure commercial feeds (1.601 kg)was not far from the average final weight of the birds supplemented with 10g and 20g activated charcoal containing wood vinegarhaving an average final weight of 1.713 kg and 1.664 kg, respectively.

It can be observed that the body weights of the birds relatively low for their age and expected genetic potential. This could possibly be attributed to the effect of activated

Table 2. Final weight of the birds at 42 days of age

TREATMENT	FINAL WEIGHT(kg)

Commercial feeds	1.601[a]
10g activated charcoal containing wood vinegar/kg CF	1.713[a]
20g activated charcoal containing wood vinegar/kg CF	1.664[a]

Means with the same superscripts are not significantly different ($P \geq 0.05$) DMRT

charcoal. As stated by Cunha (2011), though the toxicity of charcoal is reduces up to 60% and can absorb chemicals, it can also decrease the body's absorption of certain nutrients such as vitamins or minerals and also interfere with medications. Since the activated charcoal is mixed with the feed, it could have interfered with the absorption of essential nutrients, thereby slowing the growth of the chicken, which resulted to lower body weights.

Total and Average Daily Gain in Weight

Table 3 presents the total and average daily gain in weight of the birds in the different treatments. In terms of average daily gain, analysis of variance revealed that there were no significant differences of the birds in the different treatments. This implies that the gain in weight of the birds from the different treatments were more or less similar.

Following the trend in the average daily gain in weight, there were no significant differences in the total gain in weight of the birds in the different treatments. This portrays that the birds given 10g activated charcoal containing wood vinegar had gained as much as the birds fed commercial feeds only and also those birds given 20g activated

Table 3. Total gain in 42 feeding days and average daily gain in weight

TREATMENT	GAIN IN WEIGHT (kg)	
	TOTAL	DAILY
Commercial feeds	1.553[a]	0.037[a]
10g activated charcoal containing wood vinegar/kg CF	1.666[a]	0.040[a]
20g activated charcoal containing wood vinegar/kg CF	1.616[a]	0.038[a]

Means with the same superscripts are not significantly different (P ≥ 0.05) DMRT

charcoal containing wood vinegar. The total gain in weight of the birds in 42 daysranges from 1.553 kg to 1.666 kg.

Total and Daily Feed Consumption

Table 4 presents the average total and daily feed consumption of birds within the experimental period of 42 days. Average total and daily feed consumption of the birds on the different treatments of 3.910 kg and 0.093 kg, 4.070 kg and 0.097 kg, 4.078 kg and 0.097 kg ,respectively. These did not differ from each other statistically. This could mean that feed consumptions of the birds werenot affected whether the ration was incorporated with activated charcoal containing wood vinegar or not.

Feed Conversion Ratio

Feed conversion ratio of the birds per treatment is presented on Table 5. The birds fed with 10g activated charcoal containing wood vinegar per kilogram feed incurred an FCR mean of 2.429 followed by the control birds with an average FCR of 2.524 and then the birds fed 20g activated charcoal per kilogram feed (2.529). Statistical revealed insignificant differences among treatments. This may imply that the addition of 10g or 20g

activated charcoal containing woodvinegar to the diet of broilers neither enhanced nor decreased the ability of the birds to convert feed into meat.

Compared to the expected FCR of broilers at present, the FCR numerical values derived from this study are quite high which indicates lesser efficiency relative to the industry FCR standard according to BAS (2003) of 2.13 at 36-42 days of age. This may be attributed the genetic make-up of the birds, having gained low despite *ad libitum* feeding and provision of optimum growing environment. It may also be attributed to the fact that the feed efficiency of broilers gets lower as they grow older.

Table 4. Feed consumption of thebirds from 1-42 days of age

TREATMENT	TOTAL FEED CONSUMPTION(kg)	DAILY FEED CONSUMPTION(kg)
Commercial feeds	3.910[a]	0.093[a]
10g activated charcoal containing wood vinegar/kg CF	4.070[a]	0.097[a]
20g activated charcoal containing wood vinegar/kg CF	4.078[a]	0.097[a]

Means with the same superscripts are not significantly different (P ≥ 0.05) DMRT

Table 5. Feeds conversion ratio of the birds at 42 days of age

TREATMENT	FEED CONVERSION RATIO
Commercial feeds	2.524[a]
10g activated charcoal containing wood vinegar/kg CF	2.429[a]
20g activated charcoal containing wood vinegar/kg CF	2.526[a]

Means with the same superscripts are not significantly different (P ≥ 0.05) DMRT

Feed Cost to Produce a Kilogram of Broiler

Feed cost to produce a kilogram of the broilers is shown on Table 6. Birds supplemented with 10gactivated charcoal containing wood vinegar had the lowest cost of P65.583 and followed by the birds given pure commercial ration and those that was given 20g activated charcoal containing wood vinegar supplementation of P68.141 and P68.195, respectively. Statistical analysis revealed no significant differences on the feed cost to produce a kilogram gain. This means that there was neither a significant increase nor a significant decrease in the cost per kilogram gain with the addition of activated charcoal containing wood vinegar.

Morbidity and Mortality

Table 7 presents the morbidity and mortality percentage of the birds in the different treatments.Out of 144 birds, 20 birds got sick during the conduct of the studyand out of the 20 heads morbidity, 10 birds died. Morbidity from the birds supplemented with 10g and 20g activated charcoal containing wood vinegarof 18.750% is significantly higher than those birds given commercial ration only of 4.167%. Lameness was observed

Table 6. Feed cost to produce a kilogram of broiler in 42 days

TREATMENT	FEED COST TO PRODUCE A KILOGRAM OF BROILER (Php)
Commercial feeds	68.141[a]
10g activated charcoal containing wood vinegar/kg CF	65.583[a]
20g activated charcoal containing wood vinegar/kg CF	68.195[a]

Means with the same superscripts are not significantly different ($P \geq 0.05$) DMRT

on the sick birds in T_1 and T_2 which has lead to reduced feed intake, emaciation and eventually death.Medina (2010) found that while not fully proven, there is evidence that long term use of vinegar could cause potassium loss and vinegar ingestion has one recorded case of possibly causing hypocalcemia, hyperreninemia and osteoporosis. This may help explain why the birds given activated charcoal containing wood vinegar eventually became lame.

Two birds died from the birds given pure commercial ration. Bulging of the head and hardened abdomen for anunknown cause was observed on these birds that died. Five from the birds supplemented with 10g activated charcoal containing wood vinegar and the other three were from the birds with supplementation of 20g activated charcoal containing wood vinegar. Although statistical analysis revealed that there were no significant differences on the mortality rate of the birds on the different treatments, the mortality head count was higher on the birds given 10g activated charcoal containing wood vinegar of five heads, followed by the birdssupplemented with 20g activated charcoal containing wood vinegar of three heads andthose with no supplementation of two heads.

Table 7. Morbidity and mortality of broilers in 42 experimental days

TREATMENT	MORBIDITY(%)	MORTALITY(%)
Commercial feeds	4.167[a]	4.167[a]
10g activated charcoal containing wood vinegar/kg CF	18.750[b]	10.416[a]
20g activated charcoal containing wood vinegar/kg CF	18.750[b]	6.250[a]

Means with the same superscripts are not significantly different ($P \geq 0.05$) DMRT

Productivity Index and Harvest Rate

Productivity index and the harvest rate of the birds were presented on Table 8. Statistical analysis revealed no significant differences among treatments. This implies that activated charcoal containing wood vinegar as feed supplement did not improve the performance of broilers. The productivity index of the birds fed commercial feeds only was 63.632, 70.604 for the birds given 10g activated charcoal containing wood vinegar and 65.944 for those that were given 20g activated charcoal containing wood vinegar.

Meanwhile, the harvest rate of 95.833% of the birds fed commercial feeds onlywas not significantly different to the 89.583% harvest rate of the birds supplemented with 10g or the that of the birds given 20g activated charcoal containing wood vinegar which is 93.750%.Despite setbacks brought about by morbidity and mortality, the productivity index and harvest rate were relatively not affected.

Table 8. Productivity index and harvest rate of broilers at 42 days of age

TREATMENT	PRODUCTIVITY INDEX	HARVEST RATE(%)
Commercial feeds	63.632[a]	95.833[a]
10g activated charcoal containing wood vinegar/kg CF	70.604[a]	89.583[a]
20g activated charcoal containing wood vinegar/kg CF	65.944[a]	93.750[a]

Means with the same superscripts are not significantly different ($P \geq 0.05$) DMR

Return on Investment

The returns on investment on the different treatments are shown in Table 9. Data shows that negative ROI was obtained in all treatments. This was primarily caused by the higher production cost due to the *ad libitum* feeding system, high cost of feeds and lower sales due to lower live weights at market. Lower sales were also due tosignificant morbidity and mortality losses.

Other Observations

Throughout the study, the manure of the broilers supplemented with activated charcoal containing wood vinegar was found less odorous than the birds given pure commercial feeds. This observation goes with the study of ACE Pte Ltd (2012) that wood vinegar is an all-natural deodorant that could also reduced the foul odor of pigs manure.

Table 9. Return on investment

PARTICULARS	**TREATMENTS**		
	100% CF	10G ACTIVATED CHARCOAL CONTAININGWOOD VINEGAR/KG CF	20G ACTIVATED CHARCOAL CONTAINING WOOD VINEGAR/KG CF
Total Sales	9588.15	9585.55	9740.25
TotalCost of Production	10621.00	10971.00	11021.00
Net Income	-1032.85	-1385.45	-1280.45
ROI(%)	-9.72	-12.63	-11.62

SUMMARY,CONCLUSION AND RECOMMENDATION

Summary

Using Completely Randomized Design (CRD), a total of 144 birds were distributed into three treatments replicated four times with 12 birds per replicate, making a total of 48 birds per treatment. Following the manufacturer's recommendations, the feeding regimes as follows: commercial feeds (CF) + antibiotic premix (T_0); 10g activated charcoal containing wood vinegar/kg CF (T_1); 20g activated charcoal containing wood vinegar/kg CF (T_2).

Based on results, activated charcoal containing wood vinegar, added as part of the diet of broilers at a rate of 10g and 20g per kilogram feed did not enhance their growth performance in terms of body weight and ability to gain weight. The feed consumption and feed: gain efficiency was likewise not improved. In terms of the cost of feed required to produce a kilogram gain, it was found to be similar across treatments. The harvest rate and productivity index were also comparable. However, a significantly higher morbidity rate was observed in the group given 10g activated charcoal containing wood vinegar due to lameness and some unknown causes, not the diet. A similarly negative ROI was realized from all three treatments as a result of high cost of production and low revenue.

The average initial weight of the birds was 0.047kg while the average final weight was 1.659kg. The average daily gain observed was 0.038kg. At 42 days of age, the birds had an FCR 2.493 at an average daily feed intake of 0.096kg. The cost per kilogram gain was of Php67.307. A harvest rate of 93.055% and a productivity index of 66.726 was realized.

Conclusion

Activated charcoal containing wood vinegaradded to broiler rations at a rate of either 10g or 20g per kilogram have no effect on the overall performance of broilers.The

numerical differences on all growth parameters were found to be insignificant. This reflects that the product is safe for animal consumption despite having produced no economic advantage.

Recommendation

Activated charcoal containing wood vinegar may be used as feed additive for broilers upon the discretion of the raisers. Although it was not found to have effectively enhanced the growth of broilers, its ability to absorb harmful substances in the body can still be considered using a different feeding regime designed in such a way that activated charcoal will be fed separately after feeding the basal ration.

LITERATURE CITED

ACE Pte Ltd. 2012.Wood Vinegar.Retrieved on June 11, 2012 from http://www.ace-agro.com/wood-vinegar.html.

BUREAU OF AGRICULTURAL STATISTICS, STATISTICAL RESEARCH AND TRAINING CENTER and LIVESTOCK DEVELOPMENT COUNCIL. 2003. Livestock and Poultry Statistics Handbook on Definitions, Concepts, Parameters and Assumptions. BAS: Los Baňos. P 121

ANONYMOUS. 2012. Pyroligneous acid. Retrieved on June 11, 2102 from http://en. Wikipedia.org/wiki/Pyroligneous_acid.

CHOI, J.H., P. L. SHINDE, I. K. KWON, Y. H. SONG, and B. J. CHAE. 2009. Effect of wood vinegar on the performance, nutrient digestibility and intestinal microflora in weanling pigs. Asian Aust Journal of Animal Science; 22(2):267-274.

CUNHA, J.P. 2011.Emedicine Health.Retrieved on 11 March 2013 from http://www.emedicinehealth.com/activated_charcoal/article_em.htm.

MEDINA, V. 2010.Side Effect of Vinegar.Retrieved on 11 March 2013 from http://www.ehow.com/facts_5507551_side-effects-vinegar.html.

JADHAV, N. V. and M. F. SIDDIQUI. 2007. Handbook of Poultry Production and Management. Jaypee Brothers Medical Publisher (P) Ltd. P. 3.

RAKMAI, J. 2009. Chemical determinations, antimicrobial and antioxidant activities of Thai wood vinegars.Master in Pharmacy degree in Pharmaceutical Sciences Thesis.GS Prince of Songkla University, Thailand.

SAMANYA,M. and YAMAUCHI, K. 2001. Morphological changes of the intestinal villi of chickens fed the dietary charcoal powder including wood vinegar compounds. Journal of Poultry Science; 38:289-301.

THE FOOD and FERTILIZER TECHNOLOGY CENTER (Asia Pacific Rigion). 2012. Activated Charcoal as Animal Feed Supplement. Retrieved on November 7, 2012 from http://www.buyActivatedcharcoal.com/animal feed.

TIILIKKALA,K., FAGERNAS, L., and TIILIKKALA, J. 2010. History and use of wood pyrolysis liquid as biocide and plant protection product. The Open Agriculture Journal; 4:111-118.

WATARAI,S., TANA, and M. KOIWA. 2008. Feeding activated charcoal from bark containing wood vinegar liquid (Nekka-Rich) is effective as treatment for cryptosporidiosis in calves. Journal of Dairy Science. 91:1458-1463.

WATARAI, S. and TANA. 2005. Eliminating the carriage of Salmonella entericaserovarenteritidis in domestic fowls by feeding activated charcoal from bark containing wood vinegar liquid (Nekka-Rich). Graduate School of Agriculture and Biological Sciences. Osaka Prefecture University, Japan. Pp.515-521.

YOKOMORI, W. 2011. Manual: Organic Farming Technology in Japan. Koibuchi College of Agriculture and Nutrition.Pp.3-31.

YOO,J. H, JI, S.C, and JEONG,G.S. 2007.Effect of dietary charcoal and wood vinegar mixture (CV82) on body composition of Olive Flounder Paralichthysalivaceus. Journal of World Aquaculture Society.36(2):203-208.