EFFCETS OF VARYING LEVELS OF DIATOMACEOUS EARTH ON PERFORMANCE AND SERUM CHOLESTEROL LEVELS IN BROILER CHICKENS

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ABSTRACT

The effect of inclusion of different levels of diatomaceous earth on performance of broiler chickens was investigated. The variables being investigated on were weight gains, feed conversion ratio, feed intake and cholesterol levels. The experiment comprised of 99 day old broiler chicks which were randomly allotted to three different dietary treatments containing diatomaceous earth. The control had 0% DE (T1), and two different levels of inclusion of DE 2% (T2) and 3% (T3). The control birds were fed a diet without diatomaceous earth. The feed given was weighed on a daily basis and feed intake was recorded daily. The chickens were weighed every week and weights were recorded, cholesterol levels were analysed at the end of the experiment (day 42). There were significant differences in weight gains among treatments, with those fed on 3% recording higher weight gains. There were no significant differences in feed intake between 0% and 2%, but a significant difference was observed between 3% and the other two treatments (0% and 2%). There were no significant differences in FCR between the control and 2%. Significant differences were observed between the control and 3%. There were no significant differences in cholesterol levels between 0% and 3%, significant differences were observed between the control and 2%. The birds fed on 3% DE recorded the highest mean value (103.28 mg/dl) and those fed on 2% recorded a lower mean value (77.48 mg/ dl). Diatomaceous earth increases weight gains, improves feed efficiency and feed conversion in broiler chickens.

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LIST OF ABBREVIATIONS

DE.....Diatomaceous Earth

FCR.....Feed Conversion Ratio

ANOVA.....Analysis of Variance

CRD.....completely Randomised Design

CHAPTER 1

INTRODUCTION

Broiler chickens have been developed with genetic potentials for a faster growth rate to attain market weight in the shortest time possible. These genetic potential cannot be fully utilized or expressed if the right or optimal environment is not provided, it therefore means that animals should be adequately provided with the right kind of nutrients for the maximum expression of their genetic endowment (Adeyemo, 2012). However, most small scale farmers experience slow growth rates of their broiler chickens hence attaining market weights later than the expected six weeks.

Sub therapeutic use of antibiotics in poultry feeds has become undesirable because of the residuals meat products and development of antibiotic-resistant bacterial populations in humans (Adebiyi, 2009). In Europe, use of antibiotics as growth-promoting agents for poultry has been banned. Diatomaceous Earth or Fossil Shell Flour (FSF) is so pure that the Food and Drug Administration has given it a "food-grade" designation. The health improvements observed in animals appear to be a result of three primary actions: Eliminating parasites, reduces physiological stress and increases assimilation of nutrients from food. It also increases appetite and production, stimulates basic metabolism, increases protein digestion and absorbs destructive and poisonous sediments in animals.

Diatomaceous earth is a promising feed additive and minerals supplement for livestock as it contains about 14-15 trace minerals which are all important to animal diets (John, 2006). Some of the minerals are calcium, magnesium, sodium, potassium, copper, zinc, iron, phosphorus and selenium. Some of the potentials of Diatomaceous earth were discovered to act as anti-caking agent to prevent "clumping" of feed particles, thereby enhancing the surface area of feed to be exposed to and increase both bacterial and enzymatic digestive processes (Adebiyi 2009). Through this, more feed is actually digested, utilized and health of the animals improved, hence causing a faster growth rate and early attainment of market weight. If fully utilized and good management observed, chickens can reach market weight as early as five weeks.

The mechanism by which DE works to improve animal's health can be attributed to the outcome of its primary actions such as reduction in physiological stress and increases nutrient utilization because of its potency to eliminate parasites from the host animals. The DE is a rich source of minerals not available in today's feed crops used for ration formulation; and its

binding ability to toxic metal build-up and subsequent removal of such from the body (John, 2006).

Philip (2003) reported that addition of DE to dairy cows' feed prevented insect damage, keeps virus epidemics and worms from incubating. Besides, it also enhance better digestion, improves health and growth of young animals.

Hendel (2009) stated that silica contained in diatomaceous earth is the most important trace mineral for animal health. Diatomaceous earth also contains 5 percent sodium, 3 percent magnesium and 2 percent iron. The silica in diatomaceous earth also helps to eliminate toxic fats and assists in lowering cholesterol levels in animals.

Broiler welfare is commonly addressed through addition of feed additives, generally referred to as "growth promoters" into the formulated diets (Adebiyi, 2012). Diatomaceous earth is a natural organic feed promoter used to enhance growth in broiler chickens. Growth promoters, coupled with properly maintained broiler house conditions protect chickens against pathogenic organisms through enhanced immunity status.

The World Health Organisation (WHO) in 1997 published a report on the medical impact of the use of antimicrobials in food animals suggesting a link between the two on an epidemiological basis. This report recommends on precautionally grounds that governments adopt a proactive approach to reduce the need for antimicrobial use in animals and establish surveillance of antimicrobial growth promoters. Thus, Cervantes (2004) reported the plans of EU commission to withdraw approval for the antibiotic growth promoter in European Union member nations in 2006. This created a significant need for alternatives to antibiotic growth promoters such as diatomaceous earth.

The governments of the United States and Canada recognise that diatomaceous earth is safe to use in animal foods. When added to the feed as mentioned earlier, it prevents clumping of feed particles by keeping them separate, so there is improved flowability, mixability and handling of the animal feed. This in turn, creates a big advantage to animals which consume the feed because when acting as an anticaking agent to prevent clumping of feed particles, the surface area of feed exposed to the digestive processes is increased and therefore more feed is actually digested and utilized (Adebiyi, 2009).

As an anti – caking agent diatomaceous earth prevents grain and feed from clumping together, as well as helping to lubricate feed materials being compressed into pellets.

Hence the aim of this study was to investigate the effects of varying levels of diatomaceous earth on performance and serum cholesterol levels in broiler chickens.

1.1 **PROBLEM STATEMENT**

Sub therapeutic use of antibiotics in poultry feeds has become undesirable because of the residuals in meat products and development of antibiotic-resistant bacterial populations in humans. In Europe and most other countries, use of antibiotics as growth-promoting agents for poultry has been banned.

Antibiotic growth promoters are not readily available and most small scale farmers cannot manage to buy them due higher prices. Hence, their broiler chickens die in numbers due to infectious bacterial diseases.

1.2. JUSTIFICATION/ RATIONALE

DE does not cause bacterial resistance and has no known side effects.DE earth is cheaper and can be used even by small scale farmers.

Diatomaceous earth is also believed to increase weight gains of broiler chickens when added to broiler feeds. It cleanses and polishes the colon and internal passages at the same time, removing excess mucus and bad bacterial build – ups which may have occurred overtime. This provides a greater ability to digest and absorb the feed nutrients provided.

DE also stimulates basic metabolism, converts feed better, reduces odour and moisture in poultry houses which can lead to ammonia toxicity and reduces overall animal stress.

It also reduces death rate in chickens, hence increasing productivity and profitability.

On the health of broiler chickens diatomaceous earth has been reported in scientific literature to absorb bacteria, endotoxins and viruses. Diatomaceous earth has a negative charge and bacteria has a positive charge, wherein it is believed that it sweeps bacteria out of the body by trapping it in its honey comb shaped skeletal form. There is no withdraw period when used in broilers.

1.3 RESEARCH OBJECTIVES.

1.3.1 GENERAL OBJECTIVES

To determine the effects of diatomaceous earth on growth performance and blood lipid profile of broiler chickens.

1.3.2 SPECIFIC OBJECTIVES.

To compare body weight gain, FCR and feed intake in broiler chickens fed on diets containing 0% (control), 2% and 3% diatomaceous earth.

To compare serum cholesterol levels in broiler chickens fed on treatment diets containing 0% (control), 2% and 3% diatomaceous earth

STATISTICAL HYPOTHESIS

1.4. RESEARCH HYPOTHESES

Added to broiler feed, diatomaceous earth increases the growth rate of broiler chickens.

Diatomaceous earth improves feed efficiency in broiler chickens.

DE earth improves the growth performance and lowers blood cholesterol levels in broiler chickens.

NULL HYPOTHESIS (H_0)

There are no significant differences in body weight, FCR, cholesterol levels and feed intake between broiler chickens fed on diets containing diatomaceous earth and those fed on diets without diatomaceous earth (control).

ALTERNATIVE HYPOTHESIS (H_1)

There are significant differences in body weight, FCR, cholesterol levels and feed intake between broiler chickens fed on diets containing diatomaceous earth and those fed on diets without diatomaceous earth (control).

CHAPTER 2

LITERATURE REVIEW.

Broilers are chickens reared for their meat to slaughter weight in six weeks (Smith 2010).

Broiler birds have been developed with genetic potentials for a faster growth rate to attain market weight in the shortest time possible. These genetic potential cannot be fully utilized or expressed if the right or optimal environment is not provided, it therefore means that animals should be adequately provided with the right kind of nutrients for the maximum expression of their genetic endowment. However, a lot of factors militate against meeting these requirements for nutrient to ensure maximum productivity (Adeyemo, 2012).

Diatomaceous earth is a naturally occurring, silicon rich sedimentary rock made up of fossilized remains of millions of diatoms, a type of hard-shelled plant algae originally deposited millions of years ago in the earth from dried up seas and lakes.(Hinner 2011).

Sub - therapeutic use of antibiotics in poultry feeds has become undesirable because of the residuals meat products and development of antibiotic-resistant bacterial populations in humans. In Europe, use of antibiotics as growth-promoting agents for poultry has been banned (Janet, 2009)

Diatomaceous earth also known as diatomite has been recognised as an organic product for animal health and nutrition, and serve as food for aquatic life. This substance, otherwise called fossil shell flour, is a promising feed additive and minerals supplement for livestock as it contains about 14-15 trace minerals which are all important to animal diets (Pym, 2009). It is made up of approximately 33 percent silicon, 19 percent calcium, 5 percent sodium, 3 percent magnesium 2 percent iron and many other trace minerals such as titanium, boron, manganese, copper and zirconium.

Some of the potentials of Diatomaceous earth were discovered to act as anti-caking agent to prevent "clumping" of feed particles, thereby enhancing the surface area of feed to be exposed to and increase both bacterial and enzymatic digestive processes. As an anti – caking agent it also helps to keep feed from clumping when stored in bins and silos.

Through this, more feed is actually digested, utilized and health of the animals improved. The mechanism by which DE works to improve animal's health can be attributed to the outcome of its primary actions such as reduction in physiological stress and increases nutrient utilization because of its potency to eliminate parasites from the host animals.

The DE is a rich source of minerals not available in today's feed crops used for ration formulation; and its binding ability to toxic metal build-up and subsequent removal of such from the body (John, 2006).

Philip (2003) reported that addition of DE to dairy cows' feed prevented insect damage, keeps virus epidemics and worms from incubating. Besides, it also enhance better digestion, improves health and growth of young animals.

Animals that are subject to chemical control of parasites must go through a withholding period before the sale and/ or transportation of the animals can take place. Animals that are fed diatomaceous earth (natural silica) will have no withholding period as parasite control is accomplished chemically free (Korunic 2011)

Diatomaceous earth also contains silica which helps to destroy bad fats in the body (Dee 2015). Used as a daily treatment, diatomaceous earth can alleviate the potentially deadly risk of cholesterol. Additionally, due to its physical structure diatomaceous earth is a highly effective anti – inflammatory and internal cleansing agent for the body of an animal.

Fossil shell powder inclusion in diets daily tends to keep the animals free of parasites and toxic chemicals so it can get maximum benefits from the feed and water it consumes (Janet, 2009).

Broiler welfare is commonly addressed through addition of feed additives, generally referred to as "growth promoters" into the formulated diets (Adebiyi et al, 2012). Diatomaceous earth is a natural organic feed promoter used to enhance growth in broiler chickens. Growth promoters, coupled with properly maintained broiler house conditions protect chickens against pathogenic organisms through enhanced immunity status.

The World Health Organisation (WHO) in 2002 published a report on the medical impact of the use of antimicrobials in food animals suggesting a link between the two on an epidemiological basis. This report recommends on precautionally grounds that governments adopt a proactive approach to reduce the need for antimicrobial use in animals and establish surveillance of antimicrobial growth promoters. Thus, Cervantes (2004) reported the plans of EU commission to withdraw approval for the antibiotic growth promoter in European Union member nations in 2006. This created a significant need for alternatives to antibiotic growth promoters such as diatomaceous earth.

The governments of the United States and Canada recognise that diatomaceous earth is safe to use in animal foods in an amount not to exceed 2 percent by weight of the total feed ration.

When added at this percentage as mentioned earlier, it prevents clumping of feed particles by keeping them separate, so there is improved flowability, mixability and handling of the animal feed. This in turn, creates a big advantage to animals which consume the feed because when acting as an anticaking agent to prevent clumping of feed particles, the surface area of feed exposed to the digestive processes is increased and therefore more feed is actually digested and utilized (Adebiyi et al 2010). Thousands of animal owners and livestock breeders have discovered that adding diatomaceous earth to their animals' rations has produced a number of incredible benefits.

Diatomite shell has a strong negative charge and it is very fortunate that many harmful things entering the body have a positive charge. Acting as a magnet, the negatively charged shell attracts and absorbs positive things that are small enough to go through the holes.
Because of the strong charge, each shell can absorb a large number of positively charged substances, irrespective of whether they may be chemical or in the form of bacteria or viruses. They pass on through the stomach and intestine, taking these harmful substances out of the body. Gram positive bacteria that are usually targeted in ruminant animals by the use of antimicrobial feed additives may also bind to the negatively charged shells if diatomite would be added into the feed of such animals.
Diatomite may perhaps be an effective replacer for antibiotic and antimicrobial products commonly used to perform these functions (Hinner, 2011).

CHAPTER 3

MATERIALS AND METHODS

Experimental chicks

The study was carried out at the university of Zambia field station, Lusaka Zambia.

The broiler house was cleaned and disinfected a week before the arrival of the chicks. The windows were covered with black polythene plastics to regulate ventilation and heat distribution a day before the arrival of the chicks. Litter, feed, heaters and water were put in the poultry house and left overnight.

A total of ninety nine day old broiler chicks were bought from a commercial hatchery for the experiment. The birds were raised on deep litter in the pens.

The birds were randomly divided into three equal treatment groups of 33 birds each on day four of the experiment. The control had 0% DE and the other two had 2% and 3% DE respectively.

The feed consumed by the birds was weighed every day and the feed intake was recorded on a daily basis. The DE was mixed with the feed using a mixer which is at the field station. Feed mixed with DE was fed throughout the research period (2% and 3% DE)

The chickens were weighed on weekly basis. The weights were recorded every week.

The feed and water were given ad - libitum. Water was replaced every day to ensure the litter is kept dry all the time.

Gumboro and New castle vaccines were given on day ten (10) and day fourteen (14) and repeated on day eighteen (18) and day twenty one (21) respectively

Blood samples were analysed to check for serum cholesterol levels on day 42 of the experiment.

Experimental design

The design of the experiment was completely randomized design (CRD).

The data was be analysed by using the SAS package (2002) Software and means were separated using student test.

The analysis was done by one way ANOVA.

The model used was;

$Y_{ij} = \mu + \alpha_i + e_{ij}$

Where;

Y_{ij} is the observation

α_i is the effect of the levels of diatomaceous earth.

μ is the overall mean

e_{ij} is the residual error.

CHAPTER 4

RESULTS

The results significant differences are tabulated in table 3.

Initial body weight

There were no significant differences ($P > 0.05$) in body weight among all the birds. All birds were the same.

Final body weights.

There were significant differences ($P < 0.05$) among all the treatments. Birds fed on 3% diatomaceous earth had the highest weight, followed by those fed on 2% and the control recorded the lowest weights respectively.

Total feed intake

There were no significant differences ($P > 0.05$) between the birds fed on 0% and those fed on 2%, but there were significant differences between the control (0%) and 3%.

Total weight gain

There were significant differences ($P < 0.05$) between the control and 3%, but no significant differences between the control and 2% statistically, but 2% recorded a higher weight (2540.84g) than the control (0%) which recorded (2413.31g).

Daily weight gain

Statistically there were significant differences ($P < 0.05$) between birds fed on 3% and the control, no significant differences between 2% and 3%.

Feed conversion ratio (FCR)

There were no significant differences in feed conversion ratio between birds fed on 2% DE and the control but there were significant differences between the control and 3%.

Cholesterol levels

There were no significant differences between the control and 3%. Significant differences were observed between the control and 2%. Birds fed with 3% recorded a high mean value (103.28 mg/dL) and those fed with 2% recorded a lower mean value 77.48 mg/ dL.

DISCUSSION

There was an increase in weight gain generally throughout the six weeks of the experiment especially on the birds fed 3% diatomaceous earth. Although Adeyemo (2012) indicated that there were no significant differences in feed intake among birds fed with DE, this study however shows that the average feed intake was declining as the inclusion level of DE increases with diets 0% and 3% having the highest and least feed intake respectively. This trend in the feed intake could be attributed to the dusty nature of the Diatomaceous earth as reported by Adebiyi (2010), which may cause off – feed by nasal irritation. Significant differences were not observed in total feed intake of birds fed with the experimental diet (2%DE) and the control. There were significant differences between the control and 3%.

Birds fed on diatomaceous earth generally recorded higher weights as also reported by Hinner (2011). This is due to the fact that DE cleanses and almost polishes the colon and internal passages at the same time. It also removes excess mucus and bad bacterial build ups internally which may have occurred over time. This provides a greater ability to digest and absorb the feed nutrients being provided (Pym, 2009).

DE also prevents clumping of feed particles by keeping them separate, so there is improved flow ability, mixability and handling of the animal feed. DE acts as an anti – caking agent to prevent clumping of feed particles, hence increasing the surface area feed is exposed to the digestive processes, both bacterial and enzymatic is increased and therefore more feed is digested and utilized as reported by Adeyemo (2012)

There were no significant differences in feed conversion ratio between birds fed on 2% DE and the control but there were significant differences between the control and 3%. This is because diatomaceous earth reduces stress, increases assimilation of nutrients from feed and increases appetite.

The differences observed which were not significant might be due to factors such as, the rate of utilization of available energy by animals, reduced competition amongst the birds for feed because of adequate amount of feed and water spaces.

There were no significant differences in cholesterol levels between the control and 3%. Significant differences were observed between the control and 2%. Birds fed with 3% recorded a high mean value (103.28 mg/dL) and those fed with 2% recorded a lower mean value 77.48 mg/ dL. However these figures are still within the normal accepted levels of cholesterol in broiler chickens which are between 53 – 563 mg/ dL.

CONCLUSION/ RECOMMENDATION

The present study demonstrated that diatomaceous earth increases weight gains in broiler chickens. There was also an improvement in feed conversion and less feed intake was also observed in birds fed on diatomaceous earth. There was a reduction in cholesterol levels in birds fed on 2% diatomaceous earth.

However, a study should be carried out to check on bone characteristics and egg quality of layers fed on DE. The cholesterol levels should also be checked by analysing blood samples from a large sample of birds.

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Table 1: Composition of fossil shell flour (Diatomaceous earth) in percentages.

Aluminium (Al)	0.65
Boron (B)	0.0023
Calcium (Ca)	0.40
CaO	0.55
Copper(Cu)	0.0019
Iron(Fe)	0.72
Magnesium(Mg)	0.21
MgO	0.34
Manganese(Mn)	0.0052
Phosphorus(As P2O5)	0.037
Potassium(K)	0.16
Sodium(Na)	0.26
Strontium(Sr)	0.0599
Sulphate sulphur(S)	0.062
Titanium(Ti)	0.42
Vinadium(V)	0.0438
Zinc(Zn)	0.0022
Chlorides(Cl)	0.74

Source: www.freshwaterorganics.com

Table2: feed composition of dietary treatment (finisher phase) /100Kg

Ingredient	**Quantity (kg)**
Maize	77.03
Soya bean meal (full fat)	19.51
DCP	1.85
Lime	0.75
Methionine	0.2
Lysine	*0.15*
Broiler premix	0.2
Salt	0.1

Table 3: Performance characteristics of broilers fed diets with 0% (control), 2% and 3% Diatomaceous Earth.

	CONTROL	DIATOMACEOUS EARTH	
VARIABLE	**0%**	**2%**	**3%**
Initial body weight (g/b)	161.69 ±7.2[a]	150 ± 10.57[a]	148 ± 9.13[a]
Final body weight (g/b)	2575.09 ± 293.12[a]	2690.84 ± 248.98[b]	2784.56 ± 375[c]
Total weight gain (g/b)	2413.39 ± 293.64[a]	2540.84 ± 248.51[ab]	2636.56 ± 375[b]
Total feed intake for 42 days (g/b)	4491.44 ± 41.91[a]	4454 ± 44.02[a]	4273 ± 44.61[b]
Daily weight gain (g/b/d)	57.46 ± 6.99[a]	60.84 ± 6.07[ab]	62.78 ± 8.93[ab]
Daily feed intake (g/b/d)	106.94 ± 0.22[a]	106.05 ± 0.14[a]	101.74 ± 0.26[b]
Feed conversion ratio (FCR) (g:g)	1.9 ± 0.47[a]	1.8 ± 0.32[ab]	1.6 ± 0.26[b]
Cholesterol levels (mg/dL)	92 ± 12.16[a]	77.48 ± 11.29[b]	103.28 ± 2.37[a]

Values are means ± SD (n = 33). Levels not connected by the same letter within the same row are significantly different.

Table 4: Economic evaluation of performance of broiler chickens fed diets with 0% (control), 2% and 3% diatomaceous earth.

VARIABLE	CONTROL	2% DE	3% DE
Feed cost per kg (ZMW)	2.66	2.66	2.66
Feed cost per bird 4-42 days	12.92	11.85	11.37
Feed cost per kg gain (ZMW)	5.35	4.78	4.50
Cost of day old chick (ZMW)	4.75	4.75	4.75
Total cost of feed per bird + day old chick/ bird	17.67	16.6	16.12
Selling price (ZMW) live bird	10.48	10.28	10.24
Gross profit per bird	9.33	10.4	10.88

APPENDICES

Analysis of variance (ANOVA) for total feed intake, total weight gain, FCR and Serum cholesterol levels of broiler chickens fed on different levels of Diatomaceous Earth.

TABLE 5: Total feed intake

Source	**df**	**ss**	**ms**	**F ratio**
Model	17	218105.55	12829.7	72.27
Error	108	19171.08	177.5	
Total	125	237276.63		

TABLE 6: Total weight gain

Source	df	ss	ms	F ratio
Model	3	771608.0	257203	2.6
Error	92	8919109.8	96947	
Total	95	9690717.7		

TABLE 7: Feed conversion ratio (FCR)

Source	df	ss	ms	F ratio
Model	17	10.74	0.63	7.72
Error	107	8.75	0.08	
Total	124	19.50		

TABLE 8: Serum Cholesterol Estimations

Source	df	ss	ms	F ratio
Model	2	1676.39	838.194	
Error	12	1124.08	93.67	
Total	14	2800.46		

TABLE 8: Serum Cholesterol Estimations

Source	df	ss	ms	F ratio
Model	2	1676.39	838.194	
Error	12	1124.08	93.67	
Total	14	2800.46		