THE UNIVERSITY OF ZAMBIA

THE EFFECT OF DIATOMACEOUS EARTH IN RABBIT RATIONS ON THEIR PERFORMANCE

BY

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A RESEARCH PROJECT REPORT SUBMITTED TO THE SCHOOL OF AGRICULTURAL SCIENCES IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF BACHELOR OF AGRICULTURAL SCIENCES

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UNZA, LUSAKA

SEPTEMBER, 2013.

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DECLARATION

This project report has been compiled by myself and has not been accepted in any previous application for a degree. The results shown herein are a true reflection of what was obtained from the study all sources of information have been acknowledged by means of references.

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NKOLE BWALYA

SEPTEMBER, 2013

DEDICATION

This report is dedicated to my mother, Miss Julia Shachakanza, my late dad, Mr. Navy Peter Nkole, my fiancé Mr. Charles Simusokwe, my family members and siblings who have all sacrificed their meager financial resources and rendered spiritual and moral support throughout my studies and to see me complete my degree programme.

ABSTRACT

The study to determine the effect of feeding rations containing different inclusion levels of the Diatomaceous Earth on the performance of rabbits. Each rabbit was assigned randomly to different cages and dietary treatments irrespective of their sex. The individual rabbits constituted the replicates in each of the treatments. The study was carried out at the University of Zambia, Department of Animal Science Field Station for seven weeks. This was done by determining the live weight gains of the rabbits, determining the feed conversion ratio and the average feed consumption for a period of seven weeks. The diatomaceous earth was added to the rabbit ration at 0%, 1%, 2%, 3% and 4% of the diet prepared for the rabbits. A total of 25 three month old rabbits were randomly assigned to different cages and different treatments. The rabbits were New Zealand White crossed with Chinchilla breed of rabbits. The experimental design used was the Randomized Complete Block Design and the analysis of variance (ANOVA) was used to test for the significant differences in live weight gain, average feed consumption and feed conversion ratio. The feeding rations based on these diets did not result in significant differences ($P > 0.05$) on feed consumption among the different treatments. The addition of DE did not have an effect significantly on feed consumption. However, less feed was consumed among the treatments as compared to the control. Addition of DE did not significantly have an effect on the weight gain of each of the rabbits among the different treatments. Generally, higher weight gains were reported among the treatments as compared to the control diet. There were no significant differences reported in the feed conversion ratio among the different treatments. Diatomaceous Earth was observed to improve the general appearance of rabbits as they had healthier coat appearance and their healthy status improved. No mortality was recorded during the period of the trial. The growth rate improved in rabbits fed DE among the different treatments. Droppings were observed to have a drier consistency in the rabbits fed diets containing DE than the control and round worms were passed out with feaces. The dry consistency of the droppings contributed to a cleaner environment and less flies and odors in the cages. I would therefore recommend that rabbit keepers and other farmers rearing poultry, cattle, and horses adopt the use of Diatomaceous Earth in order to reduce the number of flies, parasites and offensive odor in the housing pens and contribute to cleaner environments. I further recommend that this experiment be repeated and carried out for a longer period of time (i.e. for at least 3 months) so as to fully study the extent of the effects of adding DE and confirm these results. Further, studies should also be done to evaluate the meat quality tests of rabbits fed Diatomaceous Earth.

ACKNOWLEDGEMENTS

Special thanks to my supervisor Mr. K. Walubita for his effortless and enduring scholarly guidance and professional advice throughout my research period. This study would not have been possible without his support and help. I would also like to thank Miss Maliti, Mr. Mungili, and Mr. Lungu who made it possible for me to acquire the rabbits. Sincere thanks to my family and dear mother for her support, love encouragement and financial support throughout my study. I would not have reached this far if it wasn't for her sacrifice and support and made it possible for the success of my degree programme at The University of Zambia.

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ACRONYMS

ANOVA	Analysis of Variance
RCBD	Randomized Complete Block Design
FCR	Food Conversion Ratio
DE	Diatomaceous Earth
DF	Degree of freedom
DCP	Di-calcium Phosphate
ME	Metaboliseable Energy
KG	Kilograms
Kcal	kilo calories
CP	Crude Protein
FI	Feed Intake
LWG	Live Weight Gain

1.0 INTRODUCTION

Diatomaceous Earth is a naturally occurring siliceous sedimentary mineral compound composed of the miscroscopic skeletal remains of the unicellular algae like plants whose cell walls are impregnated with silica. These plants called diatoms have been part of the earth's ecology since prehistoric times. While alive, diatoms weave microscopic shells from silica extracted from the water. When they die, their silica shells accumulate on the floor of the body of the water in which they lived. Thick layers of these diatom shells have been preserved in the rock (Winter, 1982).

Diatomaceous earth is white, cream or ash colored. The material is mined and ground, then graded for countless uses. Its physical properties include high porosity due to its high negative charges and these attract and absorb positive things that are small enough to go through the holes. As a result of the strong charge, each shell can absorb a large number of positively charged substances whether they are chemical or in the form of bacteria or viruses, they pass, through the stomach and intestine, taking these harmful substances out of the body. Most food (animal or human), all water and air contains harmful substances which when taken internally causes stress on the immune system, using energy that could go for the production of milk, meat and eggs. Diatomaceous earth absorbs the bacteria causing scours, takes them out of the body and the animal is protected from unnecessary stress and possible death (Winter, 1982).

As Diatomaceous Earth passes through the digestive system, it rubs against parasites and being very abrasive, causes serious damage causing the parasite to die and pass out of the animal with no negative side effects making the effects on the animal nothing but beneficial. Benefits of using diatomaceous earth when used in feed additives include; natural, environmental friendly control of insects, internal parasites and worms, healthier appearance of the animals and better feed conversion ratio, a marked reduction of vet bills and losses, reduces odor and moisture in the barns and stalls, stops dirt licking and corral gnawing, reduced flies (fly larva are killed by the diatomite's left in the manure) and manure odor. It can also be used as a natural preservative by applying 3kg of the substance to each ton of maize, barley, wheat, oats, rice and mixtures of these grains directly after harvesting (Arey, 1963).

When used correctly, diatomite is effective against ants, aphids, bollworm, caterpillar, cockroach, maize worm, house flies, fruit flies, slugs termites weevils, leaf perforator and many other plant damaging insects. According to Watson (1983), DE works by scratching the waxy outer shell covering of insects and parasite bodies causing them to dehydrate, thus leading to their death (Arey, 1963).

1.1. FEED ADDITIVES

Feed additives are products used in animal nutrition for the purpose of improving the quality of feed and food from animal origin and so will improve the animal's growth rate and health. Feed additives maybe used to enhance the digestibility of the feed materials and also improve the nutritional status of the rabbits so as to improve the growth rate of the animals concerned and their health.

Very few people and farmers in Zambia are rabbit keepers and rare rabbits either for sale or for home consumption. This is due to the ignorance that people have on the benefits of rabbit keeping and mindset that rabbit keeping is restricted only to females keeping them. According to Winter (1982), High rabbit production can be attained by addition of DE as a feed additive as it contributes to the wellbeing of rabbits by reducing stress factors that affect their performance and ability to produce high meat production and thus more income due to high livestock production. This is particularly important because rabbits kept even on small scale rapidly increase in number due to their high prolificacy and large numbers of litters and short gestation periods, thus profits are realized faster as compared to other types of livestock production such as piggery and keeping cattle as the keeping of rabbits requires very minimal investment.

The keeping of rabbits not only leads to improved protein diets to people with a low minimum wage but also can be a source of employment and income. It is with this background that the study of the effects of diatomaceous earth as a feed additive on rabbit performance was undertaken.

1.2 PROBLEM STATEMENT

The escalating prices of animal feeds, medicines, feed additives, replacement animals and the high mortality rates of animals have increased the cost of production, and thus lowering the profit margins of livestock farmers, including those involved in rabbit keeping.

Thus the inclusion of diatomaceous earth as a feed additive in the diets of cattle, poultry and rabbit rations can lead to the lowering of the cost of inputs, mortality rates, and veterinary bills as it is cheaper and will lead to lower costs of production to livestock farmers.

1.3 JUSTIFICATION.

Diatomaceous earth can be used for both internal and external parasite control and thus result in improved health, appearance and behavior, as well as assimilation of feed. This will lead to improved weight gain and lower feed costs.

Diatomaceous Earth is also used as an animal feed additive for cows, calves, horses, sheep, goats, pigs, rabbits, chickens, turkeys, ducks, dogs, cats, pigeons and other pet or farm animals. Diatomaceous earth can be applied to livestock's coats as an insect repellent/contact insecticide.

1.4 RESEARCH OBJECTIVES

1.4.1 MAIN OBJECTIVE

- To determine the performance of rabbits fed rations containing different inclusion levels of diatomaceous earth.

1.4.2 SPECIFIC OBJECTIVES

- To determine the live weight gain of rabbits fed on diets containing diatomaceous earth.
- To determine the feed conversion ratio of diets containing diatomaceous earth.
- To determine the average feed consumed at different inclusion levels.
- To determine the best inclusion rates of diatomaceous earth in the feed ration for rabbits.

1.5 RESEARCH HYPOTHESIS

- Null Hypothesis: There are no significant differences in the performance of rabbits fed rations containing different inclusion levels of diatomaceous earth.
- Alternative Hypothesis: There are significant differences in the performance of rabbits fed rations containing different inclusion levels of diatomaceous earth.

2.0 LITERATURE REVIEW

Diatomaceous Earth is a light coloured, light weighted, friable sedimentary rock composed of the siliceous shells of fossils of external skeleton of the microscopic aquatic plants called diatoms (Bates, 1969). The milling of Diatomaceous Earth produces different size and shaped particles and as a result, it is not advisable to use the filtering type of Diatomaceous Earth for agricultural purposes (Higgins, 1971). Diatomaceous earth has also been used in the control of insects, to dry environments and feeding of livestock.

2.1 DIATOMS

Diatomaceous Earth is composed of fossilized diatoms and readily crumbles to a fine powder. It is obtained from deposits of diatomites fossilized sedimentary layer of tiny phytoplankton called diatomite, many of them originating at least 20 million years ago in the lakes and seas. The developing North American continents were full of these organisms that ingested dissolved silica and converted it into a highly ordered shell. Therefore, diatoms that lived in the prehistoric seas are mined mostly in California USA. Sometimes DE is found on the surface in deserts. The world-wide association of diatomite deposits suggests that the availability of silica from volcanic ash maybe necessary for thick deposition of diatomites (Anonymous, 2007)

Diatoms belong to a division of algae but differ from algae because they are able to concentrate silica from the surrounding waters in their cell walls (Bates, 1969). These plants have been part of the earth's ecology since prehistoric times.

When diatoms die, their shells pile up at the bottom of the large water bodies to form a thick bed of sediments. Their cell walls are composed of soluble silica (sand). These beds called diatomite or diatomaceous earth are then mined from under the water source or from ancient dried lake bottom. According to Bates (1969) and Oriana (2006) commercial deposits of diatomite were deposited millions of years ago.

2.2 CHEMICAL COMPOSITION AND USES OF DIATOMACEOUS EARTH

Diatomaceous Earth is mined, ground and screened to various grades. The elements that make up the compound include silicon dioxide 83.7%, aluminum oxide 5.6%, iron oxide 2.3%, calcium oxide 0.4%, magnesium oxide 0.3%, alkalines 0.2-1.5%, organic matter 0-0.3%, and other oxides 1-1.9%.

DE has been used for various purposes in the past 50 years. One of the major uses of DE includes being used as an animal feed additive in both ruminant and non-ruminant rations. DE has been reported to improve the production levels of animals (Arey, 1963). According to Braz (2005), DE is a source of 15 trace elements which are good for animals, humans, plants and the soil; these include Copper, Zinc, Selenium, Manganese, Phosphorus, Cobalt, Rubidium, as well

as major nutrients like Calcium, Iron, Magnesium, Aluminum and Sodium. In addition, DE reduces scours, results in better feed conversion, promotes shiner coats, better overall health, eliminates pests in stored grain, controls flies, kills fleas and tick reduces manure odour.

The animal health benefits means reduction in veterinary bills and diseases. DE is also used as an anti-caking agent, absorbent and insecticide. DE is also used as filler in paints, a mild abrasive in products including tooth paste, mechanical insecticide, absorbent for liquids, matting agents for coatings, reinforcing filler in plastics and rubber, cat litter, activator in blood clotting studies, a stabilizing component of dynamite and a thermal insulator, cosmetics and drugs. DE has been reported to increase the milk production and combat mastitis in dairy cattle (Oriana and Fox, 2005).

According to Arey (1963), the main uses of diatomaceous earth based products when fed to domestic animals and poultry gives digestive aid and acts as colon cleanser, and as source of valuable trace minerals. It is also a valuable inert carrier for nutrients and medicaments for release through the gut. The structural features of the diatoms (sharp abrasive particles) that make it effective as a natural insecticide are the main reason research and field studies have shown reductions in the presence of internal parasites. This abrasive action has not been shown to cause any insult to the mucous or barrier wall. Diatomaceous Earth can also act as a rumen buffer, or alkalizing agent when added to the feed by regulating the acid-base balance in the gut and decrease problems of acidosis.

2.3 SAFETY CONSIDERATIONS

According to Bates (1969) DE is a non-toxic, safe substance made of crushed fossils of fresh water organisms and marine life crushed to fine powder. DE is deadly to insects and completely harmless to animals, fish, fowl or food. Most insects have a waxy outer shell covering their bodies, but the compound causes dehydration in insects leading to eventual death.

Today's formulations are safe to use as they are predominantly made up of amorphous silica and contain little or no crystalline silica. There are guidelines to follow for the maximum amounts allowable in the products and in the air near the breathing zone of workers.

DE used as a feed additive for animal feeds is not calcined or altered in any chemical way. It is classified as amorphous silica and containing less than 1% crystalline silica. It has no toxins and can be used in food storage (Braz, 2005). Table 1 below shows the recommended rates of DE use as a feed additive.

TABLE 1: Showing the recommended rates of the use of Diatomaceous Earth as a feed additive

ANIMAL	**Typical Application Rate**
humans	1 heaped teaspoon daily
poultry	2% by weight of feed
cattle	1-2% application by weight of dry ration and 5% by weight of grain feed.
horses	150grams. (1 cup in daily feed ration)
pigs	2% of total feed ration
sheep	1% in ground grain
goats	1% weight of grain feed
Cats	1 teaspoon in daily ration
dogs	2 tablespoon in daily ration for dogs over 45kg, 1 tablespoon in daily ration for dogs weighing 25-45kg, 2 tablespoon in daily ration for small dogs and puppies.

R. Kayumu (2008).

3.0 MATERIALS AND METHODS

Materials used in the study included on station compounded feed, Diatomaceous Earth, feeding trays, drinking trays, weighing balance and cages. 25 three month old rabbits were used during the study.

The study was done between 20th January 2013 to 18th March 2013 for a period of seven weeks at the University of Zambia, Department of Animal Science Field Station. The rabbits were randomly housed and assigned to treatments. Rabbits were provided with fresh feed once a day and water was available at all times. Before the start of the study, each rabbit was weighed and their weights were recorded. All rabbits were fed the standard feed during the first week of the study so as to acclimatise them with the feed and gradually, the diatomaceous earth was introduced in the diets at the start of the second week. The quantities of feeds given were recorded weekly and the change in weight of the rabbits was recorded at the end of every two weeks.

Twenty five (25) rabbits were used in the study. The rabbits were three months old each of varying weights and cross breeds of the New Zealand white and Chinchilla breeds. The rabbits were housed according to the five treatments with five replicates per treatment. Each replicate was assigned a separate cage. The experimental design used was the Randomized Complete Block Design. The analysis of variance (ANOVA) was used to test for the significant differences in live weight gain, average feed consumption and feed conversion ratio.

3.1 RATION FORMULATION

The ingredients used in the experiment for the feed formulation included maize meal, soya bean meal, DCP and salt to add taste to the feed. All the ingredients were purchased from the Livestock Services Cooperative Society.

The proximate analysis of Maize Meal and Soya Bean meal to ascertain their nutritional values and determine their nutrient compositions was done (Table 2 refers) . Five diets were formulated with varying amounts of diatomaceous earth that were added to the ration at 0%, 1%, 2%, 3% and 4% of the diet, respectively. The diets contained 14% crude protein and about 3300kal/kg metaboliseable energy (ME).

TABLE 2: Showing the Ingredients and Nutrient Composition of the Experimental Diets.

Nutrient amount	**Maize Meal**	**Soya Bean Meal**
ME., (kcal/kg)	3438kcal/kg	2977kacl/kg
Crude Protein	11.43%	46.05%
Total Phosphorus	0.28%	0.29%
Total Calcium	0.02%	0.84%

4.0 RESULTS AND DISCUSSION

4.1. TABLE 3: Showing Calculated Nutrient Composition of Feed Ingredients

Ingredient	**Amt. mixture (%)**	**CP (%)**	**Ca (%)**	**P (%)**
Soya bean meal	13.33	5.07	0.84	0.29
Maize meal	86.0	9.83	0.02	0.28
DCP	0.17	-	0.06	0.03
Salt	0.5	-	-	-
TOTAL	100	15	0.92	0.60

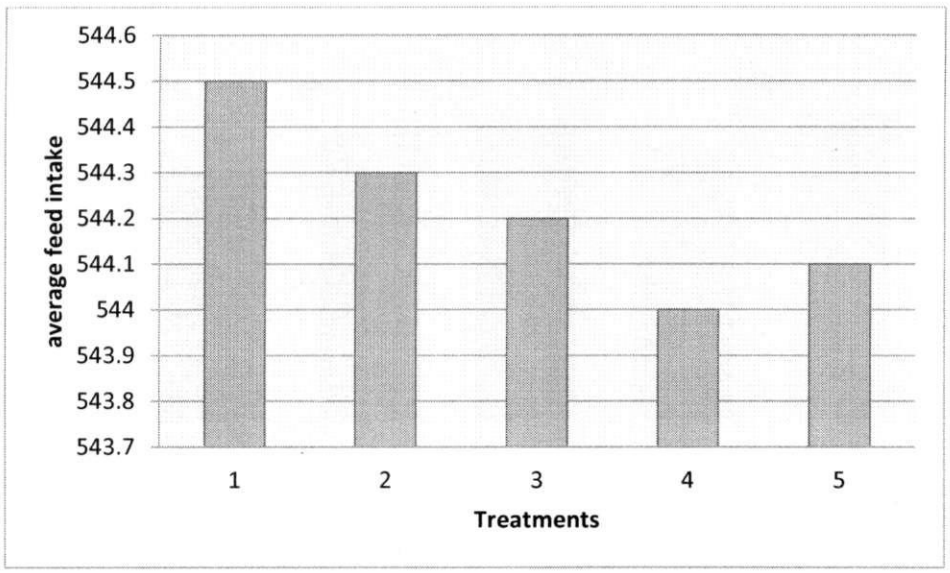
Data on feed consumption was collected on a weekly basis. The average weekly consumption for each rabbit and the average feed consumption per rabbit for the seven week experimental period were calculated. The live weight gain and feed conversion ratio were also calculated at the end of the seven experimental period.

The data collected was analyzed using the Genstat Software from which the ANOVA was computed. The treatment means were compared using the analysis of variance for the Randomized Complete Block Design.

4.2 FEED INTAKE

There were no significant differences in the average feed consumption in each treatment at 95% confidence level (Figure 1 refers).

FIGURE 1: Showing the Feed Intake in Treatment levels

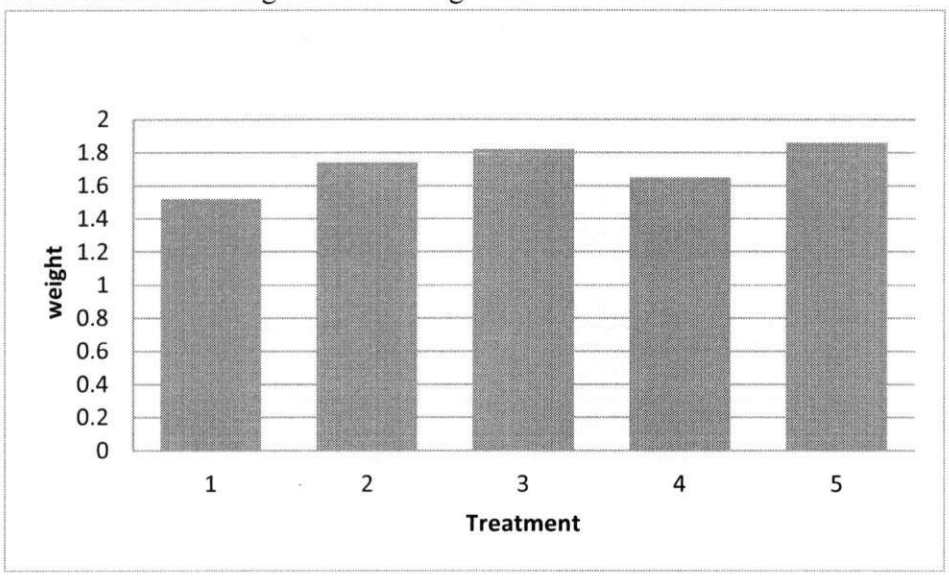


Leonard et al (1971) reported that including DE to rations slowed down the passage of feed in the intestines hence feed intake decreased. This is in partial agreement with the findings in this study as the rabbits consumed less with addition of DE, yet there were no significant differences in the average feed consumed per rabbit in each of the treatments when the feed intake data was analysed. The minimal deviations recorded were by a difference of 0.1grams and these differences was attributed to the physical dusty nature of the ration. This is in agreement with the findings of Leonard et al (1971).

4.3 LIVE WEIGHT GAIN

There were no significant differences in the live weight gain of the rabbits at 95% confidence level amongst the treatments given to rabbits (Figure 2 refers).

FIGURE 2: Showing the Live Weight Gain in treatments.

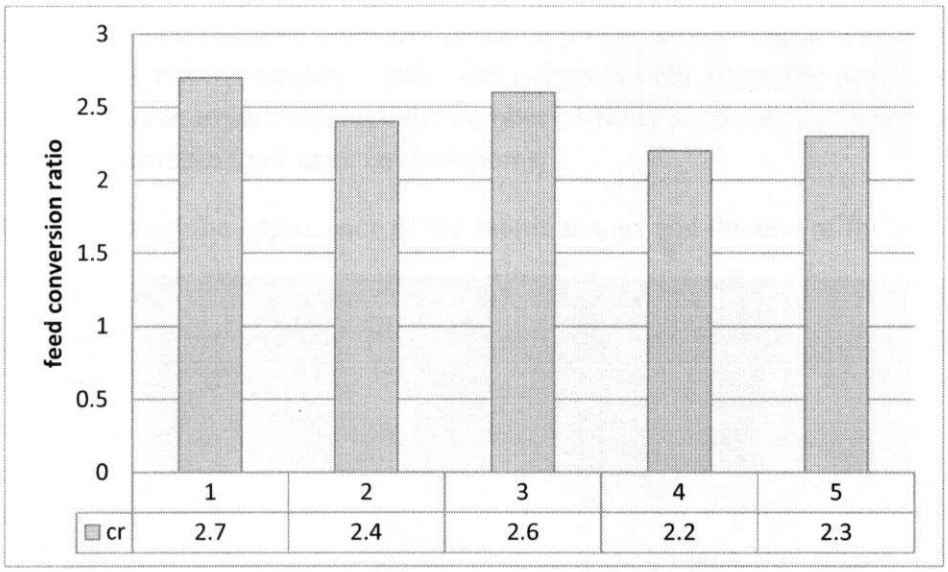


The study showed that there was an improvement in the weight gain of the rabbits as the DE was included in the diets as compared to the control. This is in agreement with Arey (1963) who reported that adding DE to diets contributes to better healthy status of animals. He also reported that adding DE enhances digestion, thus allowing for maximum nutrient and essential mineral absorption for body development. However, there were no significant differences in the live weight gain of the rabbits in the study. This indicates that the feed that the rabbits were given contained adequate minerals required for maximum growths hence the weights increased despite the different inclusion levels. According to Braz (2005), where there is inadequate supply of minerals in the feed, DE would supply some of them.

4.4 FEED CONVERSION RATIO

There were no significant differences in the feed conversion ratio at 95% confidence level among the different treatments given to the rabbits after an analysis of variance for feed conversion ratio (Figure 3 refers).

FIGURE 3: Showing the Feed Conversion Ration.



Ensiminger (1978) reported that addition of DE to diets led to healthier appearance of the rabbits as well as better and improved feed conversion ratios. This is in agreement with the findings of the study as the treatments had lower feed conversion ratios than the control. However, there were no significant differences in the feed conversion ratio among the treatments and the control. Rabbits have an efficient FCR of 2.0 - 3.0 (GART, 1999). Similarly, the same were found during the study. These shows that the diets fed to the rabbits had adequate amounts of minerals at different inclusion levels of DE added, hence no significant differences were observed as a high growth rate was still reported.

4.5 OTHER OBSERVATIONS

The addition of Diatomaceous Earth to feeds at the various inclusion levels did not affect the performance of the rabbits significantly in all the performance characteristics measured when compared among the four test groups and control. However, Diatomaceous Earth improved the general appearance of rabbits (Plate 1 refers) and improved their healthy status as no mortality was recorded during the period of the study. The growth rate increased in rabbits fed DE among the different treatments. Droppings were observed to have a drier consistency in the rabbits fed diets containing DE than the control and round worms were passed out (Plate 2 refers). The dry consistency of the droppings contributed to a cleaner environment and less flies and odors in the cages. This was in agreement with Braz (2005) who said that DE reduces the odor of droppings, reduces the occurrence of flies and parasites in the environment. Therefore, rabbit keepers and other farmers rearing poultry, cattle, and horses should adopt the use of Diatomaceous Earth as the use results in order to reduce the number of flies, parasites and offensive odor in the housing pens and contribute to cleaner environments.

Plate 1: showing the appearance of the rabbit at start and the end of the experiment.

Start  End

Plate 2: Showing Round Worms passed out

5.0 CONCLUSIONS AND RECOMMENDATIONS

There were no significant differences ($P>0.05$) in the feed consumption, live weight gain and feed conversion ratio in all the five treatments after analysis was done. There were no significant differences in the overall performance of rabbits because the feed provided to the rabbits had adequate minerals necessary for optimum growth. Where there is inadequate supply of minerals in feed, DE would supply some of them. Diatomaceous Earth should therefore, be recommended for use as an additive in rations for poultry, cattle, rabbits and other ruminant farmers because of the many uses it has, as can be observed from this report. I would also recommend that this experiment be repeated and conducted for a longer time than seven weeks so that the efficiency of DE on the performance of rabbits be observed. Also, studies should be done on the effect of Diatomaceous Earth on the meat quality of the rabbits.

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APPENDICES

Appendix 1a: Showing the Analysis of Variance of Live Weight Gain

ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.044	4	.011	.434	.783
Within Groups	.512	20	.026		
Total	.557	24			

Appendix 1b: Showing the Analysis of Variance of Average Feed Intake

ANOVA

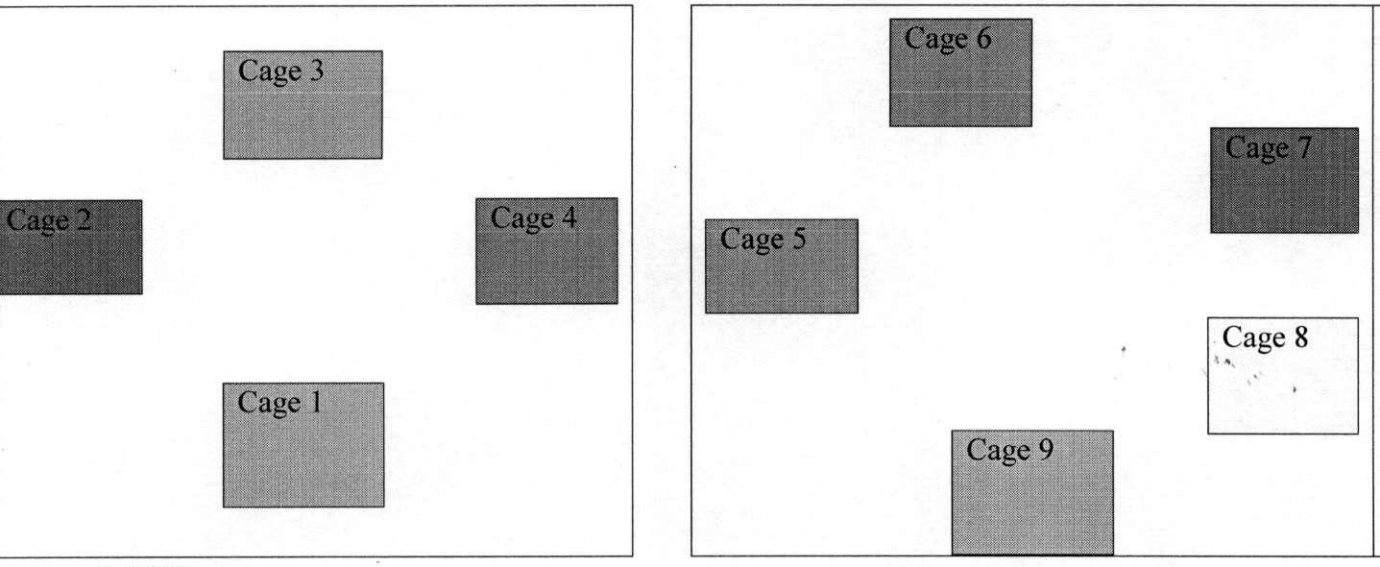
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	819.760	4	204.940	2.617	.066
Within Groups	1566.000	20	78.300		
Total	2385.760	24			

Appendix 1c: Showing the Analysis of Variance of Feed Conversion Ratio

ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.106	4	.026	.268	.895
Within Groups	1.968	20	.098		
Total	2.074	24			

Appendix 2:Showing the Schematic Diagram of Replications and Orientation of Treatments.



EAST

Each cage contains 3 replicates of different treatments completely randomised