European Journal of Agriculture and Food Sciences
www.ejfood.org

Effect of Diatomaceous Earth on Growth Rate, Egg Production, Feed Conversion Efficiency and Parasitic Load in Hens Raised on Deep Litter

Robert Alex Isabirye, Savino Biryomumaisho, Samuel Okello, James Okwee-Acai, and George William Nasinyama

ABSTRACT

The efficacy of diatomaceous earth (DE) on growth rate, egg production and on increasing feed conversion efficiency in deep litter raised layer hens was evaluated. The study was conducted at Mukono Zonal Agricultural Research and Development Institute (MUZARDI) in Uganda. Worms were collected from fresh intestines of indigenous chicken obtained from Kalerwe chicken market near Kampala. The DE was mined in Pakwach (formerly Nebbi) district in Northern Uganda. Chickens of the Lohmann Brown breed raised on deep litter were studied. At 7 weeks the birds were divided into 5 treatment groups, A, B, C, D and E each composed of 40 birds. Groups C, D and E were given an oral dose containing 250 embryonated eggs of A. galli while groups A and B were not infected. The chicks were weighed; and subjected to feeding trials as arranged below: A – Non-infected birds on DE (4%) supplemented diet; B –non-infected birds on neither piperazine (a conventional de-wormer) nor DE; C – infected birds on DE supplemented diet; D – infected birds on piperazine; and group E – infected birds on neither DE nor piperazine applied. Fecal samples were collected and analysed in the laboratory biweekly at week 16 till week 22 respectively for fecal egg counts. In a subsequent experiment, day-old layer chicks from Lohmann Brown strain but different from those used in earlier experiments, were used to assess the effect of DE on egg production. At 17 weeks of age the 420 were divided as follows: 6 treatment groups each having 7 replicates and each replicate having 10 birds. This study showed that DE can be used successfully in growing pullet diets to correct nutritional mineral imbalance since it supplies more than 14 trace elements and other elements. Diatomaceous earth also enables pullets to cope with *Ascaridia galli* load; and 2% DE supplementation did not have significant improvement on egg production as compared to no supplementation at all. However, reduction in egg production was experienced when supplementation with levels of DE higher that 2% was applied. Results from biweekly fecal analyses showed significant differences in fecal egg counts ($p<0.05$); and treatment by group ($p<0.05$).

Keywords: Diatomaceous earth, Ascaridia galli, feed conversion, laying hens, Uganda.

Submitted: December 17, 2020

Published: February 12, 2021

ISSN: 2684-1827

DOI: 10.24018/ejfood.2021.3.1.207

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I. Introduction

Poultry plays a vital role in alleviating poverty in Uganda despite its low contribution to GDP [1]. Promoting poultry production is, therefore, an appropriate avenue for improving peoples' livelihoods especially smallholder farmers in particular women, youth and children who are more often involved in poultry activities as compared to men [2]. Chicken is the commonest poultry species kept in Uganda *(ibid)*.

On the other hand, consumers are increasingly concerned with the safe and ethical production of their food. The demand for organically produced animal products including organic poultry eggs has been steadily increasing [3], [4]. This has led to production of organic poultry in many countries. In organic farming, use of synthetic medication is prohibited. It is hence a requirement for a country like Uganda to emulate other countries by practicing organic farming as much as possible so as to access prime international markets for its livestock products. This necessitates use of materials like diatomaceous earth, which are organic in nature and have been reported to improve livestock production and productivity [5]. On the other hand, feeds are expensive and account for 70% or more of the total cost of livestock production [6]. This is as a result of tight competition between humans and livestock for the conventional feed ingredients; there is also the need to ensure maximum utilization of the nutrients contained in the feed for growth of the birds.

Diatomaceous earth (DE) is the fossilized remains of diatom shells [7]. Some of the major merits in diatomaceous earth are that it acts as anti-caking agent to prevent the feed particles from forming clumps. This enhances the surface area of feed that comes into direct contact with the enzymatic and bacterial digestive processes [8]. This, therefore, leads to improvement in the feed digestibility and utilization, which consequently leads to improvement of the health and growth of the animals. On the other hand, DE is rich in minerals not available in many feed crops used in feed formulations and has the ability to bind toxic metals enabling removal of such metals from bodies of animals [9]. According to Hendel [10], DE contains silica, which is a very important trace element in improving animal health. The silica in DE is also important in eliminating toxic fats and assists in lowering cholesterol levels in animals which aspect is important for their health and well-being.

The action of DE on parasites is unclear but there are suggestions that the abrasive action of the powder pierces or scratches the outer protective layer of invertebrates, especially internal and external parasites, which later die as a result of dehydration. A similar principle probably explains the fact that birds frequently take dust baths, presumably to rid themselves of parasites. Some scientists believe that DE is a de-ionizer or de-energizer of worms and parasites [11]. DE therefore has a unique physical rather than chemical mode of action against parasites. This is a very important aspect as far as mammalian safety is concerned since it has negligible toxicity to mammals [12].

In Uganda however, the use of DE in livestock production is not common and not yet documented. This study, therefore, sought to assess the effect of DE on production and productivity of chicken raised on deep litter in Uganda.

II. Materials and Methods

A. Materials

1. Study site

The study was conducted at Mukono Zonal Agricultural Research and Development Institute (MUZARDI), which is one of the institutes under the National Agricultural Research Organization (NARO). This area is located in in Lake Victoria Crescent Agro-ecological Zone.

2. Source of DE for use in the study

The DE used in the study was obtained from Nebbi district in Northern Uganda. The mineral was mined by scooping the top soil for about 2–3 feet deep then exposing the DE which had a distinct colour as compared to the top soil. The DE formed a layer of about 2 to 4 feet in thickness. The mining was carried out by a group of young men resident in the mining area. After mining, the DE was ground on an electric powered grinding mill into small manageable pieces, which were then crushed to usable form (very fine particles comparable to talc powder) and packaged in packs of 200 g, 1 kg and 2 kg respectively. The material used to pack the DE was plastic paper, the sealing was done using a special electric heat sealing machine.

3. Source of birds used in the study

The birds were obtained from Ugachick Poultry Breeders, which is a renowned hatchery in Uganda. Ugachick Poultry Breeders is a private company.

4. Feeding trials to determine the effect of DE on Body weight

A total of two hundred day old Lohmann Brown layer chicks were obtained from a commercial hatchery for use in the experiment. At day one of age, the birds were fed on chick and duck mash till 8 weeks of age. However, at 7 weeks of age the birds were wing-banded and divided into 5 treatment groups, A, B, C, D and E each composed of 40 birds. Groups C, D and E were each given an oral dose containing 250 embryonated eggs of *A. galli* while groups A and B were not infected. [13], [14], the groups so formed are thus as described below:

Group A – Non-infected birds on 2% DE supplemented diet.

Group B – Non-infected birds neither piperazine nor DE applied.

Group C – Infected birds with worms and on 2% DE supplemented diet.

Group D – Infected birds with worms on piperazine (a conventional dewormer).

Group E – Infected birds on neither DE nor piperazine.

The birds were further divided into 4 replicates per group each replicate having 10 birds as illustrated in Fig. 1. This grouping was made according to the procedures of Adedeji *et al.* and Sadeghi *et al.* [13], [14]. however, with slight modifications hence 5 treatment groups x 4 replicates per group × 10 birds per replicate = 200 birds for the experiment. These modifications were made so as to maximize differences between the difference cages.

The 2% DE used in this experiment was in accordance with Bennett and other authors [15]. *Ascaridia galli* was used for this part of the study due to its importance in poultry production since its infestation can lead to impaired weight gain and growth, decreased egg production, increased mortality and possibly anemia in chicken [16]. Hence posing a big problem in poultry production requiring timely and effective interventions.

5. Management of experimental birds and litter material

The birds were raised on deep litter in twenty equidimensional pens and the 40 birds in each treatment group were further subdivided into four replicates with 10 pullets per replicate (5 treatment groups each having 4 replicates and each replicate having 10 pullets as illustrated in Fig. 1). Coffee husks were used as litter material. Feed ingredients were purchased and feeds formulated on-farm. The amount of feed the birds received was adjusted weekly during the growing period to maintain body weight as recommended by Lohmann Tierzucht GmbH (the commercial breeders of Lohmann Brown layer chicks). The basal composition of the diet used in this experiment is presented in Table 1. At 7 weeks, 10 birds were selected randomly from each group and their individual body weights taken weekly and feeding trials began immediately. This experiment lasted 17 weeks, from week 7 till week 24 of age. The birds were weighed on a digital weighing scale in the morning before being fed. All the birds were checked daily for the health status and husbandry conditions, and sanitary precautions for example proper cleaning and disinfection of utensils of utensils; ensuring drinking water hygiene; using foot baths at the entrance to poultry houses were strictly adhered to throughout the experimentation period.

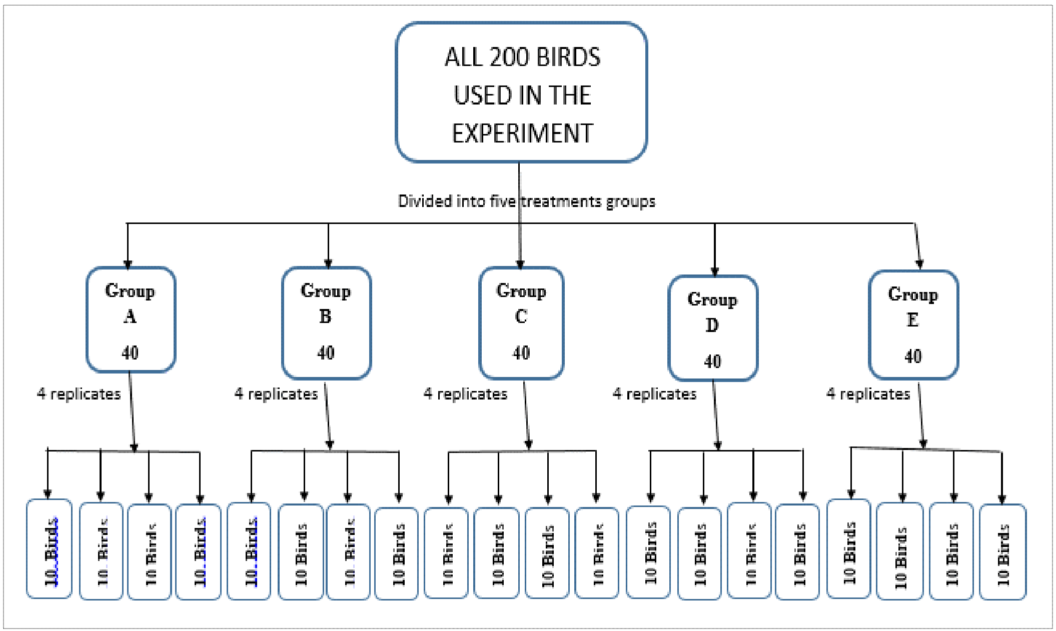

Fig. 1. Flow diagram illustrating grouping of birds on effect of diatomaceous earth on body weight and *Ascaridia galli* experiment.

B. Methods

1. Calculation of feed conversion ratio and feed efficiency

Feed consumption was recorded at weekly intervals beginning at week 7 till 24 weeks of age. Feed conversion ration refers to the ratio of feed (g) consumed per bird to average body weight of the bird during the week. Feed efficiency (FE) refers to the ratio of average body weight to feed (g) consumed. Hence, data were taken and feed conversion ratio (FCR) and feed efficiency were calculated using the following formulae:

$$\text{FCR} = \frac{\text{Average feed consumption/bird during the week (g)}}{\text{Average bodyweight (g)/bird during the week (g)}}$$

$$\text{Feed efficiency (FE)} = \frac{\text{Average bodyweight (g)/bird/week}}{\text{Feeds (g)/bird/week}}$$

A lower FCR means that there is better feed utilization and vice versa. Hence, the lower the FCR the better.

2. Fecal egg counts

Fifty hens (10 hens per group) were randomly selected and fecal samples repeatedly sampled and examined at biweekly intervals between 16 and 22 wk of age. Approximately 4g of fecal matter were collected from the rectum of each selected hen into 50 ml centrifuge tubes. Fecal samples were transported to the Central Diagnostic Laboratory at the College of Veterinary Medicine, Animal Resources and Bio-security (COVAB), Makerere University. In the laboratory, fecal samples were weighed, preserved in 10% formalin using a 1:1 ratio of volume to fecal mass and refrigerated at 4 ºC till examination. Examination was always done every fortnight. Parasite eggs were quantified using a modified Wisconsin sugar flotation method [17], [18].

Briefly, the formalinized samples were diluted with distilled water to 35 ml, vortexed and centrifuged at 500 g for 7 min. The mixture was homogenized with a glass rod. The egg counts were conducted in duplicate. The contents were loaded into both chambers of a McMaster slide (Paracount kit, Chalex Corporation, Issaquah, WA) as per manufacturer's recommendations. The eggs were then counted under the light microscope using a magnification of 100x and the total eggs per gram (EPG) for each treatment was determined. Parasite eggs were then identified according to [19]–[21].

3. Feeding trials for effect of DE on egg production

In a subsequent experiment, day-old layer chicks from Lohmann Brown strain but different from those used in earlier experiments, were purchased from a reputable commercial hatchery. The chicks were brooded at 35 ºC at 1day old and fed on chick and duck mash. The temperatures were reduced gradually until the birds developed enough feathers to keep them warm. They were removed from the brooder to the main rearing house under deep litter system at 6 weeks of age. At 8 weeks of age their diet was changed to growers. The environmental conditions were maintained in accordance with the method described by Skrivan et al. [22]. They were randomly distributed under six treatment groups, every treatment having seven replications with 10 birds in each replication at 17 weeks of age therefore, 420 birds were used in the feeding trial. Thus, 6 treatment groups × 7 replicates each × 10 birds per replicate = 420 birds. All the feed ration formulations used in feeding the birds in this study were analyzed for proximate principles as per A.O.A.C and the results are shown in Table 1 below.

TABLE 1: NUTRIENT COMPOSITION OF DIETS (BEFORE DE SUPPLEMENTATION)[1]

Parameter	Chick and duck mash	Growers mash	Layers mash
Moisture	7.96±0.79	8.56±0.49	8.23±0.71
Total ash	6.75±0.86	5.68±0.54	5.79±0.70
Crude protein	16.46±0.77	15.23±1.01	21.25±0.91
Crude fibre	4.25±0.54	5.26±0.88	5.56±0.73
Crude fat	2.32±0.45	2.30±0.46	4.60±0.51
Carbohydrate	62.13±2.91	61.43±2.36	59.55±3.0
Energy (MJ/kg)	13.89±0.23	14.19±0.16	13.81±0.23

[1]Proximate analysis of diet determined according to AOAC [23]. All the diets were analyzed before addition of DE used in feeding trials. (Adopted from Isabirye et al., 2019[1]) [24].

The amount of feed the birds received was adjusted weekly during the growing period to maintain body weight as recommended by Lohmann Tierzucht GmbH. At 18 weeks of age, the feeding trial was run whereby the hens were fed the formulated diets beginning at 18 weeks of age. Data collection on effect of DE on egg production was done on weekly basis beginning with the period of week 20 to week 21, which period was denoted as week 21. Data on egg production was then collected during the consecutive weeks till the birds were 50 weeks of age. The six treatment groups formed were as follows: A_0 birds on a diet without any DE supplementation; and A_2, A_3, A_4, A_5, and A_6 were birds on diets supplemented with 2, 3, 4, 5, and 6% DE respectively. Egg production was recorded daily at 3.p.m. each day. Total number of eggs collected divided by total number of live hens per day in each group. Therefore, individual group egg production was worked using the following formula:

$$\text{Individual group egg production} = \frac{\text{Total number of eggs produced by the group}}{\text{Total number of hens housed in group}}$$

Percent lay on daily basis was calculated using the following formula given by [25]:

$$\text{Percent egg production on daily basis} = \frac{\text{Number of eggs produced on daily basis}}{\text{Number of birds available in the flock that day}} \times 100$$

4. *Statistical Analysis*

Data collected from experiments were analyzed using the General Linear models (GLM) procedure using Statistical Package for the Social Sciences software 16 (SPSS) of 2010 version. Statements of statistical significance were based on p<0.05.

III. Results

A. *Effect of DE on Chicken Body Weight*

The mean body weights of the experimental pullets during the experimental period are presented in Table 2. There was an increase in weight gain generally in all treatment groups throughout the eighteen weeks of experimentation. The average body weight of birds between week 8 and week 12 was not significantly (p>0.05) different among all the treatment groups. Although the average body weights for birds in Groups A, B, C & D were not significantly (p>0.05) different at 13-16 weeks, they were significantly (p<0.05) different from that of Group E. Similarly, at 17-20 weeks, there were no significant (p>0.05) differences in average body weights for birds in Groups A, B, C & D, however, Group E had the lowest average body weight. However, the average body weights between groups E, B, and D were not significantly different (p>0.05). Additionally, there were no significant differences (p>0.05) in average body weights at 21-24 weeks of age. On the other hand, findings of this study showed no significant (p>0.05) interactions between average daily weight gain (ADG) and the different treatments.

B. *Feed Efficiency and Feed Conversion Ratio*

Additionally, the results also showed a significant negative effect on feed conversion ratio (FCR) (p<0.05) due to infection of pullets with *Ascaridia galli* eggs whereby infected birds which were fed on a diet not supplemented with either DE or piperazine (manufactured by AGRAR Holland BV) (group E) a higher FCR was observed throughout the entire study period meaning that there was poor fed utilization. The birds in group E also showed a significantly lower average feed efficiency (p<0.05) between weeks 17 and week 20 of age. Between weeks 8 and 12 of age, there were no significant (p>0.05) differences between groups of birds in group C and their counterparts in group E.

Birds in groups A, B, C, and D had higher average feed efficiency as compared to those in group E. There were no significant (p>0.05) differences FCR between non-infected birds on DE supplemented diet and non-infected birds not supplemented with DE (groups A and B respectively) from week 8 till week 20 of age. In contrast significant (p<0.05) results in FCR were observed in groups A and B between week 20 and week 24 of age. There were also significant differences (p<0.05) in FCR between infected birds on DE supplemented diet (group C) as compared to infected birds on neither DE nor piperazine (group E) between week 8 and week 20 of age, birds in group C having a lower FCR.

TABLE 2: Average Values of Body Weight (G) ADG (G/Bird/Day), Feed Efficiency and FCR (G/G) During Progressive Weeks of Age under Different Treatments

Parameter	A	B	C	D	E	SEM
			Average body weight (g)			
8 - 12	856±13.9^{a}	836.08±13.9^{a}	828±13.9^{a}	851.16±13.9^{a}	824±13.9^{a}	0.24
13-16	1208±15.5^{c}	1178±15.5^{c}	1179±15.5^{c}	1185±15.5^{c}	1092±15.5^{b}	0.43
17-20	1504±15^{e}	1475±15.5^{de}	1495±15.5^{e}	1475±15.5^{de}	1412±15.5^{d}	0.39
21-24	1780±10.02^{f}	1746±9.54^{f}	1764±9.36^{f}	1749±8.57^{f}	1712±8.38^{f}	0.25
			Average daily weight gain (ADG) (g/bird/day)			
8 - 12	12.87±0.55^{cdefg}	12.74±0.55^{cdefg}	13.96±0.55^{g}	13.39±0.56^{efg}	12.39±0.56^{bcdefg}	0.24
13-16	10.17±0.62^{abcd}	12.52±0.67^{bcdefg}	10.02±0.63^{abc}	10.88±0.65^{abcdef}	9.4±0.74^{ab}	0.43
17-20	11.83±0.62^{abcdefg}	11.24±0.65^{abcdefg}	14.01±0.68^{fg}	11.83±0.66^{abcdefg}	13.39±0.68^{defg}	0.39
21-24	8.95±0.70^{a}	8.84±0.67^{a}	8.75±0.69^{a}	8.62±0.71^{a}	10.2±0.71^{abcde}	0.25
			Average feed efficiency			
8 - 12	14.8±0.13^{abcd}	14.4±0.13^{abc}	14.3±0.13^{ab}	14.7±0.13^{abcd}	14.2±0.13^{a}	0.074
13-16	17.6±0.14^{g}	17.4±0.16^{g}	17.2±0.15^{g}	17.3±0.52^{g}	15.93±0.17^{g}	0.07
17-20	18.8±0.14^{h}	18.5±0.15^{h}	18.7±0.16^{h}	18.4±0.15^{h}	17.6±0.17^{g}	0.062
21-24	15.5±0.16^{ef}	15.1±0.16^{cdef}	15.3±0.16^{def}	15.2±0.17^{def}	15±0.17^{bcde}	0.055
			Feed conversion ratio (FCR) (g/g			
8-12	0.068^{a}	0.070^{a}	0.071^{a}	0.069^{a}	0.071^{a}	0.00082
13-16	0.057^{a}	0.058^{a}	0.058^{a}	0.58^{a}	0.063^{b}	0.00045
17-20	0.053a	0.054^{a}	0.054^{a}	0.054^{a}	0.057b	0.00038
21-24	0.065^{a}	0.067^{ab}	0.066^{ab}	0.067^{ab}	0.068^{b}	0.00054

$^{a-h}$ The means in values in same row with different superscripts differ significantly (p<0.05).

C. Efficacy of DE on Ascaridia galli Fecal Egg Counts

The results on efficacy of DE on *Ascaridia galli* are presented in Fig. 2 and 3. Error bars represent the mean±standard error (n=10). Biweekly fecal analyses showed significant differences in FEC p<0.05; and treatment by group p<0.05. The lower diagram represents birds infected with *Ascaridia galli* eggs. These are comprised of birds on DE supplemented diet (Group C); on piperazine supplementation (D); and on neither DE nor piperazine added to their diets (Group E). Meanwhile, the upper diagram represents results on birds that were not infected with *Ascaridia galli* eggs. Error bars represent the mean±standard error (n=10) Biweekly fecal analyses showed significant differences in FEC (p<0.05); and treatment by group (p<0.05).

The results of this study, therefore, indicate that dietary supplementation with DE had significant effect on *A. galli* counts. These results contradict findings of [15], [26] who both concluded that the effect of DE on internal parasites in chicken was not significant (p>0.05). However, whereas the former used 2% DE in the experimental diet (the same concentration as in the current study), the latter used 1.35% DE which factor might have caused variation in the latter case. However, the DE application intervals in all the three studies did not vary. Results of the present study therefore depict that inclusion of 2% DE in diets of layer chickens can help reduce on their intestinal parasitic load.

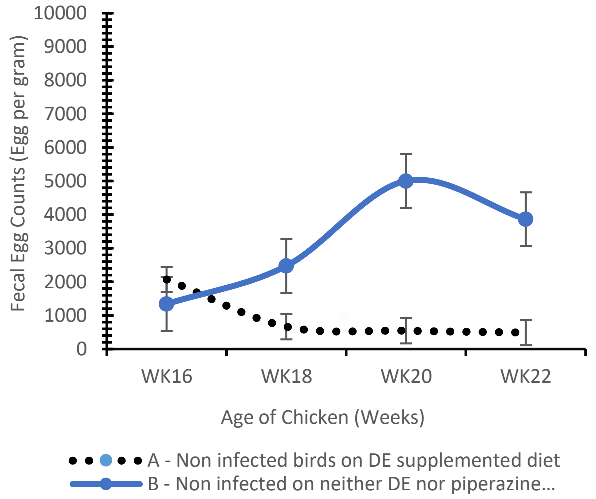

Fig. 2. Fecal egg counts (eggs per gram) of non-infected chicken.

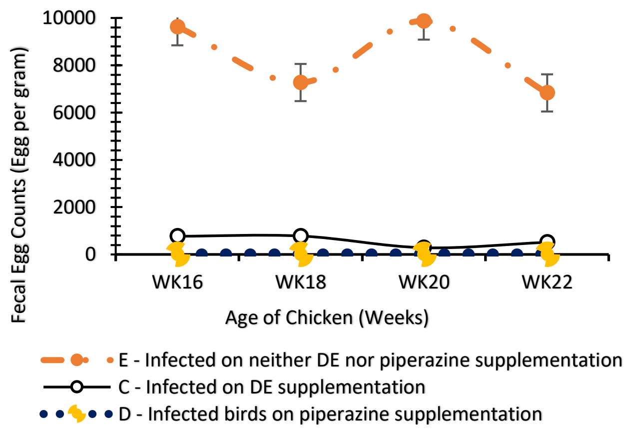

Fig. 3. Fecal egg counts (eggs per gram) of infected chicken.

D. Effect of Dietary DE on Egg Production

The results of the effect of DE on egg production are presented in Table 3. The supplementation of DE did not have significant (p>0.05) effects on egg production at 0% and 2% DE supplementation. There was, however, significant (p<0.05) reduction in egg production in birds fed on diets with higher DE supplementation levels of 3-6% egg production being lowest at 6% DE supplementation.

IV. Discussion

The reduction in average body weight in birds of group E during the experimental period depicts that *Ascaridia galli* infection leads to weight loss in the host which normally has a correlation with worm burden [27]. Since group E comprised of birds which were infected with *Ascaridia galli* and were given neither piperazine (the conventional remedy for *Ascaridia galli* in Uganda) nor DE, the results on average body weight in this study are an indication that 2% DE supplementation can enable pullets cope with parasitic load as evidenced by the difference in body weight of birds in group C and those in group E.

This coping mechanism might be attributed to the presence of a number of important minerals and trace elements in DE [28]. which may have improved absorption of nutrients by slowing gastric passage leading to better feed utilization and hence higher average body weight in group C as compared to group E [29], [30]. On the other hand, findings of this study showed no significant (p>0.05) interactions between average daily weight gain and the different treatments.

Basing on the results on average FCR in this study, it is suggestive that DE enabled birds in group C to cope with parasitic load leading to better feed utilization compared to their control counterparts in group E from week 17 to week 20 of age. The findings therefore indicate that daily supplementation of DE in diets of chicken tends to keep animals free from intestinal parasites or helps them have a coping mechanism to parasites (Janet., 2009 and Isabirye et al., 2019[2]) [31], [28]. which allows them get maximum benefits from the water and feed they consume.

These results of week 17 to week 20 of age are consistent with findings of Bennett et al., 2011 [15]. who reported that hens fed DE supplemented diets laid more eggs than hens fed the control diet. The way how DE helps hens to increase their egg production might not be so clear. It can however be suggested that the trace elements present in DE [28]. may improve absorption of nutrients leading to better feed utilization and hence improved egg production. It is also assumed that the compounds present in DE increase the absorption of nutrients by slowing gastric passage leading to better feed utilization and hence improved egg production [29], [30]. Additionally, the efficacy with which pullets convert nutrients from feed into tissue during their growth is important in determining the egg production that follows [32].

TABLE 3: EFFECT OF VARYING DIETARY DIATOMACEOUS EARTH CONCENTRATIONS ON EGG PRODUCTION IN DEEP LITTER RAISED LAYING HENS

Age (weeks)	Treatment (dietary diatomaceous earth inclusion %) and egg production (%)						SEM	*P*-Value
	0	2	3	4	5	6		
21-25	79.8±1.38[ab]	81.4±1.28[ab]	83.9±1.20[a]	76.8±1.80[b]	76.6±1.80[b]	75.7±1.81[b]	0.664	<0.001
26-30	79.5±0.92[a]	81.7±1.22[a]	78.8±0.98[a]	73.4±0.82[b]	73.8±0.76[b]	73.2±0.94[b]	0.450	<0.001
31-35	80.2±1.41[ab]	83.1±1.30[a]	75.2±1.078[b]	69.8±1.50[c]	68.9±1.48[c]	67.1±1.65[c]	0.704	<0.001
36-40	77.6±0.99[a]	79.0±0.95[a]	66.4±1.76[b]	64.99±1.36[b]	65.2±1.27[b]	63.1±1.43[b]	0.694	<0.001
41-45	78.8±1.58[ab]	82.4±1.29[a]	73.4±1.26[bc]	72.1±1.87[c]	68.9±1.65[c]	69.3±1.44[c]	0.704	<0.001
46-50	78.4±1.21[ab]	80±1.326[a]	79.6±1.46[a]	76.79±1.16[ab]	74.1±0.96[b]	73.8±0.92[b]	0.509	<0.001

[a-c]Means within rows with different superscripts are significantly different (P<0.05).

These results depict that the efficiency of feed utilization was adversely affected by infection of birds with *Ascaridia galli* as evidenced in group E, and also that DE supplementation enhanced the efficiency of feed utilization in group C between week 17 and week 20. The results of the present study are at variance with those of Bernard and others [33] who observed no difference (p>0.05) whatsoever in growth parameters of goats supplemented with diatomaceous earth. These results contradict Kiaei and co-workers [34]. who observed that 2% DE supplementation in broiler diets had no significant effect on FCR of the birds but are in agreement with [8]. who reported that dietary DE supplementation improved FCR of broilers. Similarly, Tran and others [35] also reported that DE supplementation in turkey diets lead to improvement in FCR. However, the differences in the results of this study with other studies could be ascribed to differences in the genotype and species of the animals.

V. CONCLUSION

This study showed that DE can be used successfully in growing pullet diets to correct nutritional mineral imbalance since it supplies more than 14 trace elements including silica which are essential for animal well-being. Although some observations in some parameters were not significantly different during at during some time in the study period, DE supplementation somehow enabled pullets cope with *Ascaridia galli* load; and improves the efficiency of feed utilization especially during weeks 17 to week 20 of age. Additionally, supplementing with 2% DE did not show significant improvement in egg production in deep litter raised chicken compared to where no supplementation was applied. However, reduction in egg production can be got when supplementation with levels of DE higher that 2% are applied. Further research is required to investigate the effect of DE supplementation on feed efficiency in deep litter laying hens. Biweekly fecal analyses showed significant differences in FEC (p<0.05); and treatment by group (p<0.05) in birds infected with *A. galli* and treated with DE as compared to those infected and not supplemented with DE in their diet. This therefore gives evidence that dietary supplementation with DE had significant effect on *A. galli* counts. The results of the present study therefore depict that inclusion of 2% DE in diets of layer chickens can help reduce on their intestinal parasitic load.

ACKNOWLEDGMENTS

The authors are grateful to The World Bank who through the National Agricultural Research Organization Competitive Grant Scheme (NARO-CGS Cohort III) (Grant Number CGS/2/12/14) funded the study.

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