Feed utilization and growth performance of cockerels fed with soldier ants (*Dorylus* spp Fabricius) as protein source

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Abstract

The study was conducted to evaluate the effects of soldier ant as dietary supplements on the growth performance of cockerels. Two hundred cockerels of Nera white strain (aged 6 weeks) were randomly assigned into 5 dietary treatments in a completely randomized design. Each treatment was replicated 5 times with 8 cockerels per replicate. The cockerels were fed with diets containing 0% (T1, control), 1.49% (T2), 7.45% (T3), 14.89% (T4) and 29.78% (T5) inclusion of soldier ants meal at corresponding values of 0%, 5%, 25%, 50% and 100% dietary substitution of fishmeal respectively. The experimental diets and clean drinking water were supplied to the cockerels *ad libitum* for a period of four weeks. Weight measurements were taking weekly and the daily weight gain, feed conversion ratio, specific growth rate and survival rate were calculated. All levels of dietary supplements elicited growth performances with 100% survival rate among the treatments. Cockerels on T2 had a significant (p<0.05) higher weight gain (394.37±13.41) followed by those on T1 (379.25±13.19) and T3 (372.84±7.59) but significant (p<0.05) reduction in mean weight gain was observed in birds on T5 (220.77±24.32). Cockerels fed with T2 diet recorded the highest mean weight at the fourth week of the experiment. Least FCR was observed in cockerels on T2 (3.26±0.15) while those on T5 (7.70±0.96) recorded significant increase (p<0.05) in FCR. Cockerels on T5 recorded significant decrease (p<0.05) in SGR compared to other treatments. Soldier ant of 7.45% corresponded to 25% substitution of fishmeal inclusion level brought the better growth performance in cockerels.

Keywords: soldier ant meal, Nera white strain cockerel, growth performance, dietary supplements.

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Introduction

The productivity of Nigerian livestock is well below their genetic potential, mainly due to poor nutrition and inadequate quality feed. Poultry industry in Nigeria is on economic decline due to the high cost and poor quality of finished feed (Emenalom, 2004). However, harnessing the potentials of good quality and relatively inexpensive feed ingredients as replacement of the more expensive feed ingredients as suggested by Abulude (2005) can improve the situation. The cheaper the feed sources without sacrificing quality, the better the returns to the farmers. Hassan *et al* (2009) reported the need for farmers to learn how to compound feeds locally using the available feed ingredients as part of ways of reducing the high cost of feeds.

One of the important protein source of poultry feed is fishmeal. Soyabean meal and groundnut cake are also alternative sources of protein. However, the increasing demand for fishmeal in most developing countries has significantly increased over the years due to the growing number of poultry farms, which has consequently, led to scarcity and high cost. Hassan *et al* (2009) reported that the cost of feed ingredients has been on steady increase due to growing number of poultry farms and feed compounding mills. Adeniji (2007) reported that the high cost and scarcity of protein sources such as soyabean cake, groundnut cake and fishmeal are the major factors militating against commercial poultry production. It is therefore imperative to look for alternative source to fishmeal in poultry feed.

Insects have been regarded as a good source of protein by humans and animals alike. Melo *et al* (2011) reported that most species of order Orthoptera, especially grasshoppers, form part of the diet of some ethnic groups in all continents. Most edible insects are cheap, available and serve a good source of protein and minerals needed to complement cereal-based foods consumed in the developing countries (Ifie and Emeruwa, 2011). Studies have shown the importance of insects as a good source of protein. Banjo *et al (*2006) reported that the level of proteins in the insect species is far higher than those of traditional sources of protein such as meat, dairy products and some seeds. Nazneem *et al* (1995) reported that grasshopper meal could serve as a potential protein source for poultry feed, due to its high crude protein and ether extract. Ojewola *et al* (2005) stated that the search for alternative protein sources of feed ingredients as a partial or complete replacement to fish meal, a conventional costly ingredient in poultry diets seems difficult. At present, the demand for feed grade fish and fish meal far exceeds availability.

The proximate analysis of soldier ant shows that, it has a protein composition of 12.09%, fat 18.92%; fiber 20.13%, ash 8.54%, moisture 12.62% and carbohydrate 27.72% (Abulude *et al,* 2005); this invariably makes it a valuable constituent in the formulation of feed to livestock. Abulude *et al* (2005) also reported that soldier ants have potentials as good sources of protein, fat, carbohydrates and macro element. However, there has been a little report on the nutritional status of soldier ant meal on animals in Nigeria. Owagboriaye *et al* (2013) reported negative effects on some haematological, biochemical and enzymological parameters of albino rats fed different proportions of soldier ant as a protein source and recommended more studies on the nutritional status of soldier ant-meal.

Therefore, this study aims at assessing the nutritional value of soldier ant in partial replacement to fish meal for growing cockerels.

Materials and methods

Collection of soldier ants

Soldier ant collection was based on indigenous knowledge whereby pieces of foam were soaked with palm oil as bait and placed in their path. This greatly attracted the soldier ants and formed a large population around the baited foam which was immediately dropped in a bowl of hot water at 70°C for 10 minutes and then sieved. The dead soldier ants were sun dried for one week, and milled with moultinex electric blender (Figure 1). The soldier ant collection was carried out at different unfumigated area of Ago Iwoye (6° 57' 0" N, 3° 55' 0" E.) Ogun State, Nigeria.

Figure 1. Dried and blended soldier ant.

Experimental design

Two hundred healthy cockerels of Nera white strain, aged 6 weeks were used. They were acclimatized under the laboratory conditions of 25±5°C and 65±5% R.H for one week and given growers' mash before being subjected to the experimental diets. The cockerels were randomly assigned into five dietary treatments in a completely randomized design. Each treatment was replicated 5 times with 8 cockerels per replicate. The treatments; T1, T2, T3, T4 and T5 contained 0%, 1.49%, 7.45%, 14.89% and 29.78% inclusion of soldier ants respectively. These values correspond to 0%, 5%, 25%, 50% and 100% substitution for fishmeal respectively. Each cockerel was housed in wooden cage compartment measuring 47×34×44 cm. The experimental diets and clean drinking water were supplied to the cockerels *ad libitum* throughout the experimental period of four weeks. A detail of the dietary formulation is in Table 1. Cockerels were fed two times daily with their respective experimental diets for a period of 4 weeks. The feed intake of the cockerels were monitored and their drinking water were always changed daily to avoid fecal contamination.

Growth parameters

The cockerels were weighed weekly using a top loading electronic Mettler balance. The weight data were used to calculate other growth indices using the formulae below:

Specific Growth Rate (SGR, %/day) = 100 (Log Wt – Log Wo)/t.
Where Log Wo = Natural logarithm of initial weight.
Log Wt = Natural logarithm of final weight.
t = days of experiment.

Daily weight gain (DWG, g/day) = (Wt – Wo)/t.
Where Wo = initial weight (g).
Wt = Final weight (g).
t = days of experiment.

Percentage survival of the cockerel (X, %) = (*Nt*/*No*) $\times$ 100
Where: *No* = Initial number of cockerel.
Nt = Final number of cockerel.
Feed conversion ratio (FCR) was calculated by:
FCR = Weight of the feed consumed by the cockerel/ live weight gain.

Table 1. Composition (g/100g) of experimental diets fed to cockerels.

Ingredients	Weight (%)				
	T1 Diet	T2 Diet	T3 Diet	T4 Diet	T5 Diet
Corn	29.78	29.78	29.78	29.78	0.25
Fishmeal (65%)	29.78	28.29	22.33	14.89	0.00
Wheat offal	19.61	19.61	19.61	19.61	19.61
GNC	17.98	17.98	17.98	17.98	17.98
Soybeans meal	2.00	2.00	2.00	2.00	2.00
Soldier ant	0.00	1.49	7.45	14.89	29.78
Bone meal	0.50	0.50	0.50	0.50	0.50
Mineral premix	0.25	0.25	0.25	0.25	0.25
Dicalcium phosphate	0.10	0.10	0.10	0.10	0.10
Total	**100**	**100**	**100**	**100**	**100**

Where: T1 Diet is the control diet with 0% soldier ant and T2, T3, T4, T5 Diet have 1.49%, 7.45%, 14.89% and 29.78% soldier ant respectively. GNC – Groundnut cake.

Proximate composition and anti-nutritional content of the experimental diets

Crude fiber, moisture content, ash content, nitrogen free extracts, dry matter and ether extracts in the diet were analysed using AOAC Method (2002). Phytate and flavonoid contents of the diets were analyzed according to the method of Wheeler and Ferrel (1971). The procedure of Day and Underwood (1980) was adopted for the analysis of oxalate and protease inhibitor of the diets while saponin and tannin contents were determined according to the method of Makkar *et al* (1993).

Statistical analysis

Statistical analysis for all measurements was performed using Statistical Package for Social Sciences (SPSS) version 16.0. The mean, standard deviation of mean and Analysis of Variance were conducted. Post Hoc test was conducted using Duncan Multiple Range Test (DMRT). $p<0.05$ was considered to be statistically significant.

Results

The response of the cockerels to the experimental diet was positive, irrespective of their composition as shown by the 100% survival. The data showing the proximate composition and anti-nutritional contents of the experimental diets are reported in Tables 2 and 3 respectively. There were significant ($p<0.05$) differences among values obtained for moisture content, dry matter, ether extract, crude fibre, crude protein and nitrogen free extract of the different experimental diets (Table 2). The moisture content, ash content, crude fibre and nitrogen free extract were significantly lower in diet T1 than other treatments (T2, T3, T4 and T5). Crude protein content was significantly higher in the TI and T5 as compared to other diets.

The phytate, protease, oxalate, saponin, tannin and flavonoids in the different diets were significantly different (Table 3). Flavonoids, saponin and phytate were significantly lower in T1 compared to experimental diets with different proportions of soldier ants with T5 recording the highest values. Levels of tannin and oxalate were also significantly higher in T4 and T5 than in the other experimental diets. There was no significant ($p>0.05$) difference in the levels of tannin and oxalate recorded in T1, T2 and T3 diets.

Weekly weights recorded for cockerels fed with different experimental diets were significantly different (Table 4). There was no significant difference in the mean initial weight recorded for the cockerels, but there was significant increase in weight of the cockerels fed with the experimental diets throughout the duration of experiment. The rate of weight gain was higher in the cockerels fed with the T1 and T2 diet. Cockerels fed with T2 diet recorded the highest mean weight at the fourth week of the experiment, and this followed the trend: T2 diet > T1 diet > T3 diet > T4 diet > T5 diet.

Growth parameters and nutrient utilization of the experimental cockerels is shown in Table 5. The weight gain, specific growth rate (SGR) and feed conversion ratio (FCR) were significantly different among the cockerels. Cockerels fed with T4 and T5 diets had significantly lower values of weight gain, daily percentage weight gain and specific growth rate than those fed with T3, T2 and T1 diets. The growth parameters and nutrient utilization showed no significant difference among the cockerels fed with T3, T2 and T1 diets. On the nutrient utilization tested, there was a significant increase in FCR for cockerels fed T5 (7.70±0.96) and T4 (6.25±0.36) when compared to other dietary treatments. Significant drop in FCR was recorded for cockerels fed T1, T2 and T3.

Table 2. Proximate composition (g/100gDM) of the experimental diets fed to cockerels.

Diet	Moisture	Dry matter	Ether extracts	Ash	Fibre	protein	NFE
TI Diet	$11.12{\pm}0.03^{e}$	$88.88{\pm}0.01^{a}$	$2.11{\pm}0.01^{b}$	$1.16{\pm}0.03^{d}$	$2.11{\pm}0.01^{d}$	$29.14{\pm}0.03^{a}$	$51.14{\pm}0.03^{d}$
T2 Diet	$11.98{\pm}0.01^{b}$	$88.02{\pm}0.03^{d}$	$1.79{\pm}0.03^{d}$	$1.84{\pm}0.03^{c}$	$2.15{\pm}0.03^{d}$	$27.08{\pm}0.01^{b}$	$54.46{\pm}0.03^{b}$
T3 Diet	$11.84{\pm}0.03^{c}$	$88.16{\pm}0.03^{c}$	$1.12{\pm}0.03^{e}$	$1.88{\pm}0.01b^{c}$	$3.11{\pm}0.01^{c}$	$27.60{\pm}0.28^{d}$	$55.20{\pm}0.28^{a}$
T4 Diet	$11.73{\pm}0.01^{d}$	$88.27{\pm}0.03^{d}$	$1.92{\pm}0.03^{c}$	$2.01{\pm}0.01^{a}$	$5.72{\pm}0.03^{b}$	$28.01{\pm}0.01^{c}$	$53.02{\pm}0.03^{c}$
T5 Diet	$13.63{\pm}0.03^{a}$	$86.37{\pm}0.03^{e}$	$2.41{\pm}0.01^{a}$	$1.92{\pm}0.03^{b}$	$6.52{\pm}0.03^{a}$	$28.98{\pm}0.01^{a}$	$55.04{\pm}0.03^{a}$
SA	11.66	88.34	2.34	2.67	8.12	28.12	47.08

Where T1 Diet is the control diet with 0% soldier ant and T2, T3, T4, T5 Diet have 1.49%, 7.45%, 14.89% and 29.78% soldier ant respectively). **Mean values (± Standard deviation) in the same column having the same superscript are not significantly different ($p>0.05$). NFE – Nitogen Free Extract, SA – Soldier Ant.

Table 3. Secondary metabolites content (mg/g) of experimental diets fed to cockerels.

	Phytate	Protease inhibitor	Oxalate	Saponin	Tannin	Flavonoid
TI Diet	1.24 ± 0.01^{d}	1.18 ± 0.01^{d}	1.19 ± 0.03^{c}	2.74 ± 0.03^{e}	1.98 ± 0.01^{c}	1.21 ± 0.01^{e}
T2 Diet	1.33 ± 0.03^{c}	1.22 ± 0.03^{d}	1.16 ± 0.01^{c}	3.06 ± 0.03^{d}	1.92 ± 0.03^{c}	1.92 ± 0.03^{d}
T3 Diet	1.25 ± 0.03^{d}	1.95 ± 0.03^{a}	1.19 ± 0.03^{c}	3.95 ± 0.01^{c}	1.91 ± 0.01^{c}	2.51 ± 0.01^{c}
T4 Diet	2.31 ± 0.01^{b}	1.62 ± 0.03^{c}	2.21 ± 0.01^{b}	6.02 ± 0.01^{b}	3.80 ± 0.14^{b}	2.98 ± 0.01^{b}
T5 Diet	2.76 ± 0.01^{a}	1.81 ± 0.01^{b}	2.71 ± 0.01^{a}	6.88 ± 0.01^{a}	4.79 ± 0.03^{a}	$3.61 \pm 0.01^{`a}$
SA	2.81	2.37	2.69	7.04	3.89	3.01

**Mean values (± Standard deviation) in the same column having the same superscript are not significantly different (p>0.05). SA – Soldier Ant.

Table 4. Weekly growth performance of cockerels fed with different proportions of soldier ant as protein source.

	T1	T2	T3	T4	T5
Initials	326.52 ± 0.59^{e}	325.99 ± 0.48^{e}	326.02 ± 0.29^{e}	325.88 ± 0.51^{e}	326.48 ± 0.75^{e}
Week 1	401.01 ± 5.26^{d}	386.21 ± 10.85^{d}	392.19 ± 15.29^{d}	381.39 ± 16.86^{d}	374.26 ± 14.27^{d}
Week 2	458.95 ± 10.89^{c}	454.00 ± 9.16^{c}	448.22 ± 15.03^{c}	424.12 ± 23.83^{c}	408.64 ± 11.47^{c}
Week 3	602.36 ± 22.59^{b}	598.66 ± 11.81^{b}	591.59 ± 29.43^{b}	507.95 ± 20.11^{b}	479.70 ± 14.37^{b}
Week 4	705.90 ± 12.76^{a}	720.36 ± 13.45^{a}	698.86 ± 7.56^{a}	596.94 ± 15.62^{a}	547.25 ± 24.34^{a}

**Mean values (± Standard deviation) in the same column having the same superscript are not significantly different (p>0.05).

Table 5. Growth parameters of cockerels fed with soldier ant inclusion diets as protein source.

Treatment	Initial weight (g)	Final weight (g)	Weight gain (g)	Daily weight gain (g)	% weight gain	Specific growth rate	Feed conversion ratio	% Survival
T1	326.52 ± 0.59^{a}	$705.77 \pm 13.0\ 2a^{b}$	379.25 ± 13.19^{ab}	13.55 ± 0.47^{ab}	116.15 ± 4.11^{ab}	1.19 ± 0.03^{ab}	3.44 ± 0.16^{c}	100.00±0.00
T2	325.99 ± 0.48^{a}	720.36 ± 13.45^{a}	394.37 ± 13.41^{a}	14.08 ± 0.48^{a}	120.99 ± 4.11^{a}	1.23 ± 0.03^{a}	3.26 ± 0.15^{c}	100.00±0.00
T3	326.02 ± 0.29^{a}	698.86 ± 7.56^{b}	372.84 ± 7.59^{b}	13.32 ± 0.27^{b}	114.36 ± 2.34^{b}	1.18 ± 0.02^{b}	3.50 ± 0.09^{c}	100.00±0.00
T4	325.89 ± 0.48^{a}	596.94 ± 15.62^{c}	271.05 ± 15.75^{c}	9.62 ± 0.56^{c}	83.17 ± 4.87^{c}	0.94 ± 0.04^{c}	6.25 ± 0.36^{b}	100.00±0.00
T5	326.48 ± 0.75^{a}	547.25 ± 24.34^{d}	220.77 ± 24.32^{d}	7.88 ± 0.86^{d}	67.62 ± 7.46^{d}	0.80 ± 0.07^{d}	7.70 ± 0.96^{a}	100.00±0.00

**Mean values (± Standard deviation) in the same column having the same superscript are not significantly different (p>0.05).

Discussion

Insects are natural food source for most poultry. The highest growth and weight gain observed in cockerels fed T2 diet and T1 diet showed that the treatments were able to utilize the diet better than the other treatments. The major protein content of insect is chitin which could have enhanced the bird's growth-performance (Ojewola *et al*, 2005). However, according to Ramachandran *et al* (1987), chitin is known to have a growth-promoting effect at low levels by producing glucosamine during its digestion. Furthermore, Spreen *et al* (1984) reported that chitinous materials at lower levels support the growth of bifidobacterium, thus stimulating improved gains. The observed growth and weight gain in birds fed T2 could also be as a result of low level of anti-nutrient content (such as tannin, phytate, oxalate) in their diet which could interfere with the nutritional value and the digestive processes of the diet. However, the significant reduction in mean weight gain of cockerels fed with T5 diet may be attributed to the high anti-nutritional contents of the experimental diet.

Tannin has been reported to interfere with digestion by displaying anti-trypsin, anti-prolin and anti-amylase activity in animal (Helsper *et al*, 1993). Tannin can also form insoluble complexes with proteins thereby reducing the absorption as protein in the system due to phenolic hydroxyl groups which produces unstable radicals (Feeney, 1969). However, high level of tannin in the experimental diet of birds on T5 might have formed insoluble complexes with the proteins required for growth and well being of animal, thereby reducing its absorption and making protein unavailable for use. This finding agrees with Abbey *et al* (1979) that tannin causes severe growth depressions in rats.

Phytates and oxalates form insoluble salts with essential minerals like calcium, iron, magnesium and zinc in food, rendering them unavailable for absorption into the blood as reported by (Young and Greeves, 1940). The same mechanism might be taking place in the cockerels fed T5. More so, the reduction could also be due to the high fibre levels present in their diet as reported by Brooker *et al* (2008) that monogasrics cannot utilize high crude fibre diets efficiently. This finding confirms the work of Ijaiya and Eko (2009) that 100% replacement of silk worm caterpillar meal for fishmeal in broiler starter led to lower feed intake in broiler chicks due to its high fibre content.

The SGR measures the rate of body weight change within a specific time frame and a high positive SGR indicates consumed dietary feed nutrients are partitioned towards optimum growth. In contrast, FCR, expressed as the amount of feed consumed per unit of body weight gained, is an important indicator of feed utilization efficiency, balance of bioavailable nutrients, and partitioning dietary nutrients towards growth (Luzzana *et al,* 2003; Angelidis *et al,* 2005). Thus, SGR and FCR can both be used to assess the palatability, acceptability and dietary constituents of a feed as reported by Ayoola *et al* (2010).

Apart from favorable economic attributes, minimizing FCR has significant environmental benefits, as a greater proportion of feed nutrients are converted to animal biomass and fewer nutrients are emitted into the environment where it may have adverse ecological consequences. Moreover, energy costs and environmental emissions associated with the manufacture and transport of feed decrease as FCR decrease for animal production (Ayoola *et al,* 2010). The higher the FCR, the worse it is while the lower the FCR the better it is. The low FCR observed in cockerels fed T1, T2 and T3 could be attributed to the low level of anti-nutrient contents in the diets which led to improvement in the availability and utilization of nutrients in soldier ants. The results of SGR observed in the cockerels on T1, T2 and T3 showed that, the cockerels were able to efficiently utilize the carbohydrate contents in the experimental diets as reported by Lin *et al* (1997).

Considering the economic viability of feeding the cockerels with soldier ant meal, soldier ants (*Doryllus spp*) have the ability to make reasonable contributions to growth of cockerel. It also has the potential to partially replace fish meal in a feeding regime and, thereby, reduce feed cost to the poultry farmer, whose most important production cost comes from feed.

This study has demonstrated that soldier ant meal could be included up to 7.45% level in cockerel's diets without any negative effects on the growth. This study revealed that the best inclusion level was found in the diet containing the 1.49% soldier ant meal. Soldier ants are available in the Nigeria environments throughout the year. It is, therefore, more economical to partly replace fishmeal with soldier ant at the range of 1.49-7.45% inclusion level without reduction in growth. However, more research is needed on the area of how to make soldier ants readily available

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