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Growth performance of broiler birds fed varying dietary levels of *artemisia annua* (sweet wormwood)

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Abstract

The study was conducted to investigate the growth performance of broiler birds fed varying dietary levels of Artemisia annua. A total of 90 broiler chickens (Arbor Acre strain) were used. The study lasted for eight weeks. At the starter phase, 90 fourteen-day old broiler chicks were randomly allocated to five groups and fed starter diets containing five levels of A. annua (0, 50, 100, 150 and 200 g per kg of diet, respectively). At the finisher phase, 90 forty-two-day old finisher broilers were randomly allocated to five groups and fed finisher diets containing five levels of A. annua (0, 50, 100, 150 and 200 g per kg of diet, respectively). Each group was replicated three times with six birds per replicate in a completely randomized design. Parameter measured includes body weight, average daily feed intake, feed conversion ratio and protein efficiency ratio. The result of the proximate composition showed that Artemisia annua leaf meal contained 10.50% moisture, 26.27% crude protein, 5.00% crude fibre, 9.60% ash, 2.00% ether extract and 46.63% nitrogen-free extract. The result showed that at the starter phase, the inclusion of varying levels of A. annua in the starter diets had significant ($p < 0.05$) effect on the final body weight (FBW) of birds. Birds fed diet 2 (diet containing 50g of A. annua per kg diet) had significantly ($p<0.05$) higher final body weight (FBW) value (1115.00g) than those fed diet 5 (diet containing 200g of A. annua per kg of diet) which had FBW value of 915.00g. Dietary treatments had no significant ($p > 0.05$) effect on average daily feed intake (ADFI), total weight gain (TWG), average daily weight gain (ADWG), feed conversion ratio (FCR) and protein efficient ratio(PER) of the birds. At the finisher phase, significant ($p < 0.05$) differences existed among treatments in ADWG, TWG, FBW and ADFI. Birds fed diet containing 50 g A. annua per kg diet had significantly ($p < 0.05$) higher ADWG, TWG and FWG values than those fed the control diet. However, no significant ($p > 0.05$) differences existed among treatments in FCR and PER. It is concluded that A. annua leaf meal can be included in the diet of starter and finisher broilers at 200g per kg of diet without any deleterious effect on the growth performance of birds.

Keywords: *Artemisia annua,* broilers, diets, growth performance

Introduction

Animal protein requirement in developing countries has become critical due to a disproportionate growth in human population relative to livestock production. Enhancing poultry production is recognized as one of the viable means of meeting the increasing demand for animal protein globally. Enzymes and antibiotics in feed, for example, which serve as aids to nutrition and are widely used in intensive livestock production systems in developed societies to improve the digestibility of feeds and utilisation of nutrients, are not available to many resource-poor farmers in developing countries. Besides, the fact that some serious disadvantages associated with synthetic drugs such as those used in the treatment of helminthosis and coccidiosis during poultry production have become evident, including resistance and the presence of traces of these drugs at later ends of the food chain due to their indiscriminate use has given farmers further encouragement to seek natural products such as *Artemisia annua*. *Artemisia annua*

(sweet wormwood) is a vigorous growing annual weedy herb, usually single-stemmed, reaching up to 2–3m in height (Ferreira and Janick, 2002). The plant produces a beautiful portfolio of bioactive compounds including flavonoids, coumarins, steroids, phenolics, purines, lipids, aliphatic compounds, monoterpenoids, triterpenoids and sesquiterpenoids (Bhakuni *et al*., 2001; Brisibe *et al*., 2009). *A. Annua* and its semi synthetically prepared derivatives such as dihydroartemisinin, artesunate, artemether, arteether, and artemisinin have also displayed unique pharmacological activities against a wide range of parasitic organisms including *Enterobacter and Klebsiella species, Streptococcus faecalis, Staphylococcus aureus, Shigella dysenteriae, Escherichia coli* and *Pneumocystis carinii* (Chen *et al*., 1994), an opportunistic pathogen which causes pneumonia in AIDS and other immune-compromised patients. Undoubtedly, there is growing interest in natural sources of nutrients and health-promoting compounds. Green plants generally are known as sources of bioactive compounds with potential use as antioxidants and immune system modulators. The present study was therefore, conducted to evaluate the growth performance of broilers fed varying dietary levels of *Artemisia annua* (sweet wormwood).

Materials and methods

The study was conducted at the Department of Animal Science Teaching and Research Farm, University of Nigeria, Nsukka. At the starter phase, a total of 90 fourteen-day old broiler chicks (Arbor Acre strain) were randomly divided into five treatment groups of 18 birds each. The groups were randomly assigned to five experimental diets containing 0g, 50g, 100g, 150g and 200g, respectively of *A. annua* per kg diet in a completely randomized design (CRD). At the end of the starter period, the 90 birds (forty-two-day old finisher broilers) were assigned to five experimental diets containing 0g, 50g, 100g, 150g and 200g, respectively of *A. annua* per kg diet. The percentage compositions of the starter and finisher diets are shown in Tables 1 and 2.

Each treatment group was replicated three times with six birds per replicate and housed in 2.6m x 3m deep litter pens of fresh wood shavings. The birds were properly vaccinated as and when due. Feed and water were offered *ad libitum* every morning, from7.00am to 8.00am during the eight weeks experimental period. The weight of the feed offered minus the weight of the left over feed was recorded as the daily feed intake. The birds were weighed at the beginning of the experiment to determine their initial body weights, and subsequently on weekly basis to determine their live body weights. The birds were also weighed at the end of the experiment to determine their final body weights.

Proximate analysis

Experimental diets and the test ingredient (*A. annua*) were subjected to proximate analysis according to AOAC (2006).

Statistical analysis

Data collected were subjected to analysis of variance for completely randomized design as described by Steel and Torrie (1980) and according to the procedure for a one-way analysis in a completely randomized design using a Stat Graphic Computer Package (SPSS, 2007) Model. Significantly different means were separated using Duncan's New Multiple Range Test (Duncan, 1955).

Results and discussion

Proximate composition of Artemisia annua leaf meal and experimental diets

The proximate compositions of the starter and finisher broiler diets are presented in

Table 1: Percentage composition of starter diets

	Dietary levels of *Artemisia annua* leaf meal(g /kg diet)				
	0	**50**	**100**	**150**	**200**
Ingredients/Diets	**1**	**2**	**3**	**4**	**5**
Maize	29.60	29.60	29.60	29.60	29.60
Wheat offal	14.00	13.95	13.90	13.85	13.80
Soya bean meal	16.60	16.60	16.60	16.60	16.60
Groundnut cake	16.80	16.80	16.80	16.80	16.80
P.K. Cake	15.00	15.00	15.00	15.00	15.00
Fish meal	3.0	3.0	3.0	3.0	3.0
Artemisia annua	0.00	0.05	0.10	0.15	0.20
Bone meal	4.00	4.00	4.00	4.00	4.00
Salt	0.25	0.25	0.25	0.25	0.25
Methiomine	0.25	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25	0.25
Vit. Min. Premix*	0.25	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00	100.00
Calculated Analysis:					
Crude Protein (%)	24.02	24.02	24.03	24.04	24.04
Crude fibre (%)	6.00	6.04	6.04	6.04	6.03
Energy (Kcal of ME/kg)	2,859	2,862	2,956	3,004	3,053

Vit A –*10,000.00 iu., D_3-2,000 iu., B_1-0.75g., B_2-5g., Nicotinic acid – 25g., Calcium pantothanate 12.5g., $B_1$2-0.015g., K_3-2.5g., E-25g., Biotin – 0.050g., Folic acid –1g., Manganese 64g., Choline chloride 250g., Cobalt-0.8g., Copper 8g., Manganese 64g., Iron –32G., Zn-40g., Iodine-0.8g., Flavomycin-100g., Spiramycin 5g., Dl-methionine-50g, Selenium 0.6g., Lysine 120g., BA

Table 2: Percentage composition of finisher diets

	Dietary levels of *Artemisia annua* leaf meal(g /kg diet)				
	0	**50**	**100**	**150**	**200**
Ingredients/Diets	**1**	**2**	**3**	**4**	**5**
Maize	38.00	38.00	38.00	38.00	38.00
Wheat offal	16.00	15.95	15.90	15.85	15.80
Soya bean meal	10.00	10.00	10.00	10.00	10.00
Groundnut cake	12.00	12.00	12.00	12.00	12.00
Palm kernel cake	17.00	17.00	17.00	17.00	17.00
Fish meal	2.00	2.00	2.00	2.00	2.00
Artemisia annua	0.00	0.05	0.10	0.15	0.20
Bone meal	4.00	4.00	4.00	4.00	4.00
Salt	0.25	0.25	0.25	0.25	0.25
Methionie	0.25	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25	0.25
Vit. M. P.	0.25	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00	100.00
Calculated Analysis:					
Crude Protein (%)	20.02	20.02	20.03	20.04	20.04
Crude fibre (%)	5.90	5.90	5.89	5.89	5.89
Energy (Kcal of ME/kg)	2,900	2,900	2,982	3,031	3,079

*Vit A – 10,000.00 iu., D_3-2,000 iu., B_1-0.75g., B_2-5g., Nicotinic acid – 25g., Calcium pantothenate 12.5g., $B_1$2-0.015g., K_3-2.5g., E-25g., Biotin – 0.050g., Folic acid –1g., Manganese 64g., Choline chloride 250g., Cobalt-0.8g., Copper 8g., Manganese 64g., Iron –32G., Zn-40g., Iodine-0.8g., Flavomycin-100g., Spiramycin 5g., Dl-methionie-50g, Selenium 0.6g., Lysine 120g., BA

Tables 3 and 4, respectively. The result of the proximate composition showed that *Artemisia annua* leaf meal contained 10.50% moisture, 26.27% crude protein, 5.00% crude fibre, 9.60% ash, 2.00% ether extract and 46.63% nitrogen-free extract. The CP value (26.27%) obtained in the present study is slightly lower than the value (27.1%) reported by Brisibe *et al*. (2009) and greater than the value (20.3%) reported by Esmaeili *et al*. (2009). The value for ash content (9.60%) agrees with that (9.6%) reported by Brisibe *et al.* (2009) but disagrees with the values (7.5% and 10.26%) reported by Iqbal *et al*. (2012) and Brisibe *et al.* (2008), respectively. The variation in proximate values may be attributed to environmental conditions and stages of plant growth (Khudsar *et al*., 2004; Zhang *et al*. (2004; Aftab *et al*., 2010; Yekuan *et al*., 2010).

Table 3: Proximate composition of the starter diets

	Dietary levels of *Artemisia annua* leaf meal(g /kg diet)				
Proximate components (%)	0	50	100	150	200
Dry matter	91.50	90.50	91.50	89.00	91.00
Crude protein	24.01	24.08	24.04	24.03	24.09
Crude fibre	4.50	5.00	5.50	6.00	6.50
Ash	5.50	7.80	6.00	6.80	7.50
Ether extract	2.50	1.50	3.00	2.50	3.00
Nitrogen-free extract	54.99	52.12	52.96	49.67	58.91

Table 4: Proximate composition of the finisher diets

	Dietary levels of *Artemisia annua* leaf meal(g /kg diet)				
Proximate components (%)	0	50	100	150	200
Dry matter	90.00	91.50	90.5	91.50	90.00
Crude protein	20.08	20.02	20.05	20.03	20.05
Crude fibre	5.50	6.00	6.50	6.80	6.90
Ash	7.80	8.30	8.30	8.30	7.30
Ether extract	3.50	2.50	3.50	3.50	3.50
Nitrogen-free extract	53.12	63.18	61.65	61.37	62.25

Performance of starter broilers fed diets containing varying levels of *A. annua*

Table 5 shows the performance characteristics of starter broilers fed diets containing varying levels of A. Annua. The effects of treatments on final body weight were significant ($p < 0.05$).

Table 5: Growth performance of starter broilers fed diets containing varying levels of *Artemisia annua* leaf meal

	Dietary levels of *Artemisia annua* leaf meal(g /kg diet)					
	0	**50**	**100**	**150**	**200**	
Parameters/Diets	**1**	**2**	**3**	**4**	**5**	**SEM**
Initial body weight(g)	544.17	522.50	485.00	515.00	521.67	13.48
Final body weight(g)	1046.70^{ab}	1115.00^{a}	1023.30^{ab}	950.00^{ab}	915.00^{b}	28.16
Total weight gain (g)	502.50	592.50	538.33	435.00	393.33	31.93
Average daily weight gain (g)	27.69	29.33	27.62	27.44	26.52	0.43
Average daily feed intake (g)	77.62	79.46	79.44	76.33	70.71	1.35
Feed conversion ratio	2.81	2.71	2.88	2.79	5.39	0.52
Protein efficiency ratio	1.49	1.55	1.45	1.50	1.57	0.03

^{ab}Means on the same row with different superscripts are significantly($p<0.05$) different. SEM = Standard error of mean.

Birds fed diet 2 (diet containing 50g of *A. annua* per kg diet) had significantly ($p<0.05$) higher final body weight (FBW) value (1115.00g) than those fed diet 5 (diet containing 200g of *A. annua* per kg of diet) which had FBW value of 915.00g. Birds fed diets 1, 3,4 and 5 (Diets containing 0g, 100g,150g and 200g, respectively of *A. annua* per kg of diet) had comparable FBW values (1046.70g, 1023.30g, 950.00g and 915g, respectively). Birds fed diets 1, 2, 3 and 4(Diets containing 0g, 50g, 100g and 150g, respectively of *A. annua* per kg diet) also had comparable FBW values (1046.70g, 1115.00g, 1023.30g, and 950.00g , respectively). There were non-significant ($p > 0.05$) differences between the treatments in average daily feed intake, total weight gain, average daily weight gain, feed conversion ratio and protein efficiency ratio. As shown in Table 5, the inclusion of varying levels of *A. annua* (50g, 100, 150g and 200g/kg, respectively) in the broiler starter diets had no significant ($p>0.05$) effect on daily feed intake, total weight gain, average daily weight gain, feed conversion ratio and protein efficient ratio of the birds. This tends to suggest that *A. Annua* leaf meal can be included in broiler starter diet at 200g per kg of diet without adverse effects on broiler performance. This agrees with the report of Allen *et al*. (1997). It is likely that Artemisinin, the main bioactive compound in the herb, *A. annua* enhanced the performance of the birds. Artemisinin, the bioactive compound in *A. Annua* leaf meal has a beneficial effect on the gut microbiota. It has immunomodulatory and antioxidant properties and these can result in improvement of production and growth performances (Sugiharto, 2014).

Performance of finisher broilers fed diets containing varying levels of A. Annua

Table 6 shows *the data on the performance of finisher broilers fed diets containing varying levels of A. Annua.*

Table 6: Growth performance of finisher broilers fed diets containing varying levels of *Artemisia annua* leaf meal

	Dietary levels of *Artemisia annua* leaf meal(g /kg diet)					
	0	**50**	**100**	**150**	**200**	
Parameters/Diets	**1**	**2**	**3**	**4**	**5**	**SEM**
Final body weight(g)	2103.30^{b}	2738.30^{a}	2295.80^{ab}	2291.50^{ab}	1868.80^{b}	93.91
Total weight gain (g)	1056.70^{b}	1623.30^{a}	1272.50^{ab}	1336.50^{ab}	966.42^{b}	79.62
Average daily weight gain (g)	37.93^{b}	57.97^{a}	45.47^{ab}	47.70^{ab}	34.51^{b}	2.31
Average daily feed intake (g)	145.43^{a}	160.32^{a}	161.15^{a}	144.95^{a}	128.54^{b}	3.69
Feed conversion ratio	4.13	2.77	3.60	3.10	3.76	0.21
Protein efficiency ratio	1.13	1.47	1.17	1.37	1.14	0.06

^{ab}Means on the same row with different superscripts are significantly($p<0.05$) different. SEM = Standard error of mean.

Significant ($p < 0.05$) differences existed among treatments in final body weight (FBW), total weight gain (TWG), average daily weight gain (ADWG) and average daily feed intake (ADFI). Birds fed diet containing 50 g of *A. annua* per kg diet (treatment2) had significantly ($p < 0.05$) higher FBW, TWG and ADWG and ADFI values (2738.30, 1623.30 and 57.97 g, respectively) than the FBW, TWG and ADWG values (2103.30, 1056.70 and 37.93 g, respectively) of birds fed the control diet. Birds fed diets 1, 3, 4 and 5 had similar ($p>0.05$) FBW, TWG and ADWG values. Birds fed diets containing 50, 100 and 150 g of *A. annua* per kg diet

had similar ADFI values with those fed the control diet and these were significantly ($p < 0.05$) higher than the ADFI value (128.54 g) of birds fed diet containing 200g of *A. annua* per kg diet (treatment 5). There were no significant ($p > 0.05$) differences among treatments in feed conversion ratio and protein efficiency ratio. As shown in Table 6, the growth rate of birds fed diets containing varying levels of *A.annua* improved significantly compared to those fed the control diet. The significant improvement could be attributed to the essential minerals and vitamins in the test ingredient. It is interesting to note that *Artemisinin,* the main bioactive compound of the herb *A.annua* has been extensively studied for its effects on performance of broiler chickens and it has been shown that the active compound enhances the growth of broilers (Brisibe *et al*., 2009). As shown in Table 6, the mean ADFI value of birds fed diet containing (200g of *A.annua* per kg diet) was 128.54g and this was lower than that of birds fed the control diet. This could be attributed to the high inclusion of *A.annua* in the diet. This probably might have imparted a bitter taste on the feed and consequently reduced feed intake (Yeka and Harris, 2010). Considering the observed improvement in growth performance of birds at all the inclusion levels of dried *A. annua* leaves in the broiler diets, it could be inferred that the diets were acceptable to the birds and that *A. annua* leaves can be used in compounding feed rations for broiler birds (Mojarad *et al.,* 2005).

Conclusion

The study showed that A. *annua* leaf meal can be included in the diet of starter broilers at 200g per kg of diet without any deleterious effect on the growth performance of birds.

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