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Performance of some broiler strains fed varrying energy levels in hot season of Sokoto, semi-arid Nigeria

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Abstract: *In study to determine the productive performance of broilers in hot season of semi-arid environment, three commercial broiler strains namely Arbor-acre, Marshall and Hubbard, were placed on three different dietary energy and crude protein levels of 2900Kcal/kg (ME) 22% CP, 3100Kcal/kg (ME) 23% CP, and 3300 Kcal/kg (ME) 24% CP representing low, medium and high energy levels at starter phase, respectively. At the finisher phase, they were fed 2800 Kcal/kg (ME) 19% CP, 3000 Kcal/kg (ME) 20% CP and 3200Kcal/kg (ME) 21% CP. A total of 675 birds were used in a completely randomized design (CRD) comprising 225 birds each of Arbor-acre, Hubbard and Marshall strains serving as treatments with each group replicated five times so that each replicate had 15 birds for 56 days. Feed and water intake, mortality, weight gain, feed conversion ratio and cost/kg gain was determined at the end of both starter and finisher phases. Data recorded at each phase were subjected to Analysis of variance (ANOVA) and least significant difference (LSD) was used for mean seperation. Results obtained indicated non-significant difference (P>0.05) in terms of feed and water intake, feed conversion ratio, average body weight gain and cost/kg gain at both starter and finisher phases among strains except for mortality, where Hubbard strain demonstrated a high level of survivability (P<0.05) than other strains at starter phase but Marshall strain had the lowest mortality (P<0.05) at finisher phase. It was equally observed to be more economical (P<0.05) to feed low energy diet to all the strains at both starter and finisher phases in hot season. It could therefore be concluded that Marshall strain should be raised in hot season of semi-arid Sokoto and should be fed low energy diet for optimum performance.*

Keywords: *broiler strains, energy levels, hot season, semi-arid*

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I. Introduction

Broiler birds among other species of poultry have the potential of providing quality protein to the populace owing to its short generation interval. However, seasonal challenges, nutrient content of the diet particularly energy and the strain of the birds have been some of the problems faced by broiler farmers in different parts of the world, particularly sub-African semi-arid environments, where the temperature of the environment can escalate without environmentally controlled housing facility.

The hot season of Sokoto semi-arid Nigeria extends between late February through May and is characterized by high ambient temperature of about 40ºC [1], this high ambient temperature is far above the recommended temperature of both brooding and finishing of broiler birds [2]. Similarly, broiler strains commonly supplied to the farmers in semi-arid Sokoto include *Arbor-acre*, *Hubbard* and *Marshall* which were developed in Asia and Europe, hatched and distributed by some companies in south western Nigeria, These differences in the environments and strains resulted in having inconsistent performance due to using a particular strain of broiler across different seasons of semi-arid Sokoto.

Furthermore, nutrient requirements of broiler birds depend on a number of factors, which include strain of the bird, age and environment in which the bird is reared. Therefore, knowing the strain that performs better in a hot season of semi-arid Sokoto when fed certain ditary energy level will remarkably improve broiler production and reduce the losses incurred by the farmers, resulting from placing wrong strain in the wrong environment and on the wrong diet.

II. Materials And Methods

2.1 Study area

The experiment was conducted at the Poultry Production and Research Unit of the Department of Animal Science, Usmanu Danfodiyo University, Sokoto, which is located at the Sokoto State Veterinary Centre. Sokoto state is located between latitudes 12^{o} and 13^{0} 05'N and between longitudes 4^{0}8 and 6^{0}4 E in the northern part of Nigeria and at an altitude of 350m above sea level [3]. The State falls within the Sudan savannah vegetation zone, with alternating wet and dry seasons. The hot dry spell extends from March to May and some time to June in most part of the state with temperature reaching 42°C.

2.2 Experimental design

A total of 675 broiler birds were used in each of the trials, two hundred and twenty five (225) birds each of *Hubbard*, *Arbor acre*, and *Marshall* Strains in a completely randomized design. Each of the strains was divided into three different energy groups of five replicates and each replicate contained fifteen birds. The three different energy groups for starter phase were 2900Kcal/kg (ME) 22% CP, 3100Kcal/kg (ME) 23% CP, and 3300 Kcal/kg (ME) 24% CP,respectively. For the finisher group energy and protein levels were 2800 Kcal/kg(ME) 19% CP, 3000 Kcal/kg(ME) 20% CP and 3200Kcal/kg(ME) 21% CP, respectively. as shown in Tables 1 and 2, respectively.

Table 1: Gross and calculated chemical composition of diets to be fed at the starter phase

Ingredients (%)	Diet1	Diet2	Diet3
Maize	50.00	54.50	50.00
Groundnut cake	14.50	32.00	30.00
Soya bean meal	20.00	4.50	7.50
Wheat Offal	4.00	2.00	-
Maize Bran	5.00	-	-
Blood Meal	1.50	2.00	3.50
Lime Stone	2.00	2.00	2.00
Bone Meal	1.80	1.80	1.80
Premix	0.25	0.25	0.25
Methionine	0.30	0.30	0.30
Lysine	0.30	0.30	0.30
Salt	0.30	0.30	0.30
Oil	-	-	4.00
Total	**100**	**100**	**100**
Calculated Analysis			
M.E.Kcal/kg	2,911	3,070	3,282
C.P.(%)	22.00	23.00	24.00
P(av)(%)	0.45	0.39	0.40
Ca(%)	1.27	1.27	1.28
EE	3.73	4.63	4.12
C.F	3.98	3.17	3.02
Methionine	0.60	0.60	0.60
Lysine	1.36	1.22	1.35

*****Vitamin A 30000000 i.u, Vitamin D3 6000000 i.u, Vitamin E 30000 i.u, Vitamin K 2000 mg, Vitamin B2 30000mg, Vitamin C 30 g, Niacin 40000 mg, Panthothenic acid 12000 mg, Vitamin B6 1500 mg, Vitamin B12 10000 mg, Folic acid 1000 mg, Bioton 400 mg, Choline chloride 300000 mg, Cobalt 200 mg, Copper 1200 mg, Iodine 20000 mg, Iron 40000 mg, Manganese 100000 mg, Selenium 150 mg, Zinc 30 mg, Antioxidant 1250 mg
**M.E= Metabolisable energy, C.P=Crude protein, P(av)=Available phosphorous, Ca=calcium, C.F= crude fiber, and EE = Ether extract

Table 2: Gross and calculated chemical composition of diets to be fed at the finisher phase

Ingredients (%)	Diet1	Diet2	Diet3
Maize	45.50	57.10	52.00
Groundnut cake	16.00	22.00	28.00
Soya bean meal	11.50	7.00	7.00
Wheat Offal	10.00	8.00	5.00
Maize Bran	12.00	-	-
Blood Meal	-	1.00	-
Lime Stone	2.00	2.00	2.00
Bone Meal	2.00	1.90	1.90
Premix	0.25	0.25	0.25
Methionine	0.21	0.20	0.25
Lysine	0.21	0.20	0.25
Salt	0.30	0.30	0.30
Oil	-	-	3.00
Total	**100**	**100**	**100**
Calculated Analysis			
M.E.Kcal/kg	2,827	2,977	3,178
C.P.(%)	19.00	20.00	21.00
P(av)(%)	0.44	0.41	0.41
Ca(%)	1.31	1.29	1.29
EE	3.53	4.15	4.18
C.F	4.75	3.39	3.32
Methionine	0.48	0.47	0.53
Lysine	1.02	1.03	1.06

*****Vitamin A 30000000 i.u, Vitamin D3 6000000 i.u, Vitamin E 30000 i.u, Vitamin K 2000 mg, Vitamin B2 30000mg, Vitamin C 30 g, Niacin 40000 mg, Panthothenic acid 12000 mg, Vitamin B6 1500 mg, Vitamin B12 10000 mg, Folic acid 1000 mg, Bioton 400 mg, Choline chloride 300000 mg, Cobalt 200 mg, Copper 1200 mg, Iodine 20000 mg, Iron 40000 mg, Manganese 100000 mg, Selenium 150 mg, Zinc 30 mg, Antioxidant 1250 mg
**M.E= Metabolisable energy, C.P=Crude protein, P(av)=Available phosphorous, Ca=calcium,
C.F= crude fiber, and EE = Ether extract

2.3 Sources of experimental birds

The birds used for this experiment were sourced from three commercial hatcheries all of which are from Oyo State in Nigeria. The strains used were *Hubbard, Marshall* and *Arbo acre*. The birds were purchased from these hatcheries at the same time so that each strain was obtained in the same day.

2.4 Birds and their management

Experimental birds were kept for three days after transport to take care of stress due to transportation. During the three days, they were administered anti stress drugs, later weighed and alloted to their replicate groups. Each strain group (treatment) were replicated five times. Routine vaccinations were administered; antibiotics and coccidiostats were also administered according to the recommendations of [2]. The birds were housed in deep litter with open sided walls. The house and pens were cleaned, washed Fumigated and disinfected prior to the arrival of the birds. Wood shavings were used as litter material.

2.5 Period and duration of experiment

The experiment was carried out in the months of March and April because they are characterized by high ambient temperature and low humidity for the period of 56days (8weeks) for both starter and finisher phases from 9th March to 8th May, 2015.At the end of starter phase the replicates were combined together and then re allocated for finisher phase depending on the number of birds that survived to the finisher phase after which the experiment was terminated.

2.6 Data collection

Feed intake was recorded on daily basis by subtracting remnants from quantity offered the previous day. Body weight gain was recorded weekly by weighing the birds and determining increase or loss of weight from which the average daily gain was determined. Record of feed intake and weight gain were used to compute the feed conversion ratio for each replicate. This was done for both starter and finisher phases of the study.

2.7 Data analysis

Data obtained from feed intake, water intake, weight gain, feed conversion ratio, efficiency, and carcass evaluation was subjected to Analysis of Variance (ANOVA) using Stat View Analytical computer package version 5 [4]. Regression model was used to determine the relationship between the variables, which are Temperature and relative humidity with feed intake, water intake and mortality. Least significant difference (LSD) was used for means comparison while mortality was calculated in percentage

III. Results And Discussion

Result on the effects of strain, dietary energy levels and their interactions on the performance of different broiler strains at the starter phase in the hot season of semi-arid Sokoto is shown in Table 3. There were no significant differences (P>0.05) in final weight, weight gain, FCR, mortality and cost/kg gain across all the strains (*Arbor-acre*, *Hubbard*, and *Marshall*) tested. However, significant differences (P<0.05) in mortality were observed with *Marshall* strain having the highest mortality of 24% followed by *Arbor-acre* and *Hubbard* which had 19.5 and 16.5% mortality, respectively.

Similarly, there were significant differences (P<0.05) in final weight, weight gain, feed intake, water intake, and cost/kg gain across three different energy levels (2900, 3100 and 3300ME/Kcal), but, there were no significant differences (P>0.05) in feed conversion ratio and mortality. The birds that consumed low energy diet were observed to have high average daily gain of 13.698g/b followed by those that consumed medium and high energy diets which had 10.02 and 8.93g/b, respectively. However, birds on low energy diet had the highest feed intake of 32.680g/b/d while there were no significant differences (P>0.05) between broilers that consumed medium and high energy diets which ha 25.68, and 23.27g/b/d respectively. Furthermore, similar pattern of feed intake was observed for water intake. Broiler starters on low energy diet had significantly (P<0.05) higher water intake of 93.32mls/b/day than those fed medium and high energy diets which observed to have 72.84 and 70.67mls/b/day, respectively. Significant difference (P<0.05) also existed in cost per kg gain, as birds on high energy diet were observed to have significantly (P<0.05) higher cost/kg gain of N303, followed by those on medium and low energy diets which had N247 and N240 cost/kg gain, respectively. But, there was no significant difference (P>0.05) between birds on medium and high energy diets in terms of cost/kg gain.
There was significant interaction (P<0.05) between strains and energy levels among all the growth and performance parameters with the exception of initial weight, water intake and feed conversion ratio at starter phase of hot season.

Table 3: Main effects of strains, energy and interactions on growth and performance parameters of different broiler strains at starter phase in hot season of semi-arid Sokoto

Factor	ADG (g/b)	Feed intake (g/b/day)	FCR	Water intake (mls/b/day)	Mortality (%)	Cost/kg gain(~~N~~)
Arbor-acre	11.02	27.91	2.63	80.08	19.57[ab]	271.98
Hubbard	10.47	26.64	2.58	77.23	16.44[b]	265.17
Marshall	11.15	27.08	2.45	79.51	24.00[a]	254.42
SEM	0.64	1.40	0.12	3.28	2.25	13.51
Energy						
Low energy	13.70[a]	32.68[a]	2.40	93.32[a]	20.89	240.14[b]
Medium energy	10.02[b]	25.69[b]	2.61	72.84[b]	20.44	247.47[b]
High energy	8.93[c]	23.27[b]	2.64	70.67[b]	18.67	303.97[a]
SEM	0.34	0.89	0.11	1.77	2.38	11.61
Strain X Energy	**	*	NS	NS	*	*

Means with different superscript across the column are statistically significant at (P<0.05)
ADG= Average daily gain
FCR= Feed conversion ratio

'Table 4 shows main effects of strains, dietary energy levels and their interactions on the performance parameters of different broiler strains at finisher phase in the hot season of semiarid Sokoto. There was no significant difference (P>0.05) in terms of average daily gain, feed intake, feed conversion ratio, and cost/kg gain between the different strains (*Arbor-acre*, *Hubbard* and *Marshall*).Howeversignificant difference (P<0.05) was observed in water intake and mortality among the tested strains where *Arbor-acre* and *Marshall*strains were observed to have significantly (P<0.05) higher water intake of 315.78 and 305.98mls/b/day respectively than the*Hubbard* strains which had 279.24mls/b/day. Percent mortality was significantly higher (P<0.05) for*Hubbard* and *Arbor-acre* strains which had 5.57 and 3.90% respectively, while *Marshall* had the least percentage mortality of 0.56%.

Furthermore, Significant differences (P<0.05) were observed in the main effects of dietary energy levels on weight gain, feed intake, water intake and cost/kg gain while there was no significant difference (P>0.05) observed. Significant differences (P<0.05) also existed in terms of weight gain of the birds across dietary energy levels, the birds that consumed lower energy diets were observed to have significantly(P<0.05) higher average daily gain of 32.96g/b than those that consumed medium energy diet which had an average daily gain of 29.69g/b which was also significantly higher (P<0.05) than 23.56g/b for those that consumed high energy diet. Similarly, the birds that consumed low dietary energy were reported to have significantly higher (P<0.05) water intake of 334.99mls/b/day than those that consumed medium dietary energy diet which had an average daily water intake of 295.423mls/b/day which was also significantly higher (P<0.05) than for those that consumed low energy diet which had 270.57mls/b/day as their water intakes. Significant difference (p<0.05) equally existed in terms of cost/kg gain across the three different dietary energy levels. The cost/kg gain of those birds that consumed high dietary energy irrespective of strain was significantly higher (P<0.05) (N279.20/kg gain) than those that consumed medium dietary energy (N236.81/kg gain) which was equally higher (p<0.05) than for broilers that consumed low dietary energy which had N223.43/kg gain.

Significant interaction (P<0.05) between strains and dietary energy levels in terms of average daily gain, feed and water intakes were observed at the finisher phase of hot season but there was no significant interaction (P>0.05) in terms of feed conversion ratio, mortality, and cost/kg gain in this phase of the experiment.

Table 4: Main effects of strains, energy and their interactions on growth and performance parameters of different broiler strains at finisher phase in hot season of semi-arid Sokoto

Factor	ADG (g/b)	Feed intake (g/b/day)	FCR	Water intake (mls/b/day)	Mortality (%)	Cost/kg gain(~~N~~)
Arbor-acre	28.62	78.60	2.77	315.78[a]	3.89[a]	247.89
Hubbard	28.60	74.74	2.64	279.24[b]	5.56[a]	241.03
Marshall	29.01	79.37	2.78	305.98[ab]	0.56[b]	250.52
SEM	1.37	2.77	0.07	10.172	1.30	9.640
Energy						
Low energy	32.96[a]	87.14[a]	2.66	335.00[a]	3.89	223.43[b]
Medium energy	29.69[b]	79.23[b]	2.70	295.42[b]	3.33	236.81[b]
High energy	23.57[c]	66.33[c]	2.83	270.57[c]	2.78	279.20[a]
SEM	0.88	1.73	0.07	8.06	1.50	7.18
Strain X Energy	*	*	NS	**	NS	NS

Means with different superscript across the column are statistically significant at (P<0.05)

ADG=Average daily gain

FCR=Feed conversion ratio

3.1 Main effects of strain, dietary energy and their interactions on performance parameters of different broiler strains at starter phase in hot season of semi-arid Sokoto

The *Hubbard* strain of broilers at starter phase irrespective of the dietary energy level survived better than both *Marshall* and *Arbor-acre* in hot season of semi-arid Sokoto. This could be the effect of parental or vertical immunity that they might have acquired from the grandparents which is purely genetic. This is in line with the finding of [5] which suggested that different broiler strains have different survivability in different environments. Similarly, [6] reported *Arbor-acre* strain to have survive better than *Anak* strain in humid tropical environment which also agrees with the findings of this research. Zahid and Hussain (2002) reported significant difference in the mortality rates of different broiler strains in Pakistan, which contradicts the findings of this study, The findings of this research is in line with that of Chew *et al.* (1978) that compared 10 strains of broilers and reported non-significant difference in weight gain at the end of the fourth week of the experiment, even though [7] reported significant difference in weight gain of different broiler strains which disagrees with the findings of this research. Results obtained from this study disagrees with the results of [8] that reported significant differences in body weight, FCR and feed intake of three commercial broiler strains namely *Ross*, *Anak*, and *Marshall*. [9] reported non-significant difference in cost/kg gain of *Arbor-acre*, *Hubbard* and *Marshall*strains which is in line with the findings of the present study.

The birds that consumed low energy diet were observed to have higher average daily gain followed by those that consumed medium and high energy diets, respectively. However, those on low energy diet had the highest feed intake while there were no significant differences between birds on medium and high energy diets,similar pattern was observed for feed intake and water intake. Birds on low energy diet had significantly higher water intake than those fed both medium and high energy diets respectively, which is in line with the recommendations of [2] which stated that there is significant correlation between feed intake and water intake of broiler birds. The feed intake pattern follows the standard set by [10], [2] that stated that the lower the energy content of the diet the higher the intake of that diet, it also tallies with the findings of [11] that reported decrease in the feed intake of birds as energy/protein of the diets are increased. It also agrees with findings of [12] that there was significant increase in water intake as feed intake increased.

Significant difference also existed in cost per kg gain, birds on high energy diet was observed to have significantly higher cost/kg gain followed by those on medium and low energy diets respectively, but there was no significant difference between birds fed medium and high energy diets in terms of cost/kg gain. These findings tally with that of [5], [9] that showed increase in the cost per kg gain of birds as the protein content of the diet increased. Similarly [13] reported significant difference in the weight gain, feed intake, feed conversion ratio and cost/kg gain of broiler chicks fed different energy sources which is in agreement with the findings of this study. This is very obvious due to the fact that energy and protein ingredients are the most costly among other feed ingredients due to their competitive nature due to human's demand and they make the bulk of poultry diets. Therefore as these ingredients proportion in the diets increases, the cost of the diet per kg also increases and so the cost per gain.

3.2 Main Effects of strains, energy levels and their interactions on the performance and growth parameters of different broiler strains at finisher phase in hot season of semi-arid Sokoto

The non-significant difference that was revealed by statistical analysis in terms of average daily gain, feed intake, feed conversion ratio, and cost/kg gain of different strains (*Arbor-acre, Hubbard* and *Marshall*) signified that all the tested strains performed equally in terms of these parameters. This is in line with the findings of [14], [15] and [16] that showed non-significant difference in the same parameters of various broiler strains in their respective researches. But the finding contradicts those of [17] that shows significant difference in terms of feed efficiency of the same strains, however these differences could be due to the fact that the two separate researches were carried out in two different environments. [17] further reported significant differences in the weight gain, feed conversion ratio and feed intake of these strains with their sex interaction which equally disagrees with the findings of this research. The higher percentage mortality observed in the two strains (*Arbor-acre* and *Hubbard)* could be an indication that it may not be economically feasible to raise the two strains in hot season of semi-arid environment, taking into consideration the similarities in other production parameters with *Marshall* Strain [14]. This feed intake pattern followed the standard set by [10], [2] that reported that the lower the energy content of the diet the higher the intake of that diet, it also tallies with the findings of [11] that reported decrease in the feed intake of the birds as energy/protein of the diets are increased. It was equally clear from this result that; the birds that consumed more feed appeared to gain more weight, similar patter observed in the feed intake and weight gain was also observed in water intake. Similarly, the Significant difference that was equally observed in terms of cost/kg across three different energy levels, the cost/kg gain of those birds that consumed high energy diet irrespective of their strains was significantly higher than those that consumedmedium and low diets. The findings of this study tallies with that of [8] that compared the economics of the same strains in derived savanna environment of Nigeria. [9]. Similarly, the non-significant difference that was observed in terms of feed conversion ratio and mortality across all the energy levels signified that energy content of the diet irrespective of the strain of the birds has no impact on mortality and feed conversion ratio of these tested strains at finisher phase in hot season of semi-arid environment, even though the difference was not exist statistically significant in terms of feed conversion ratio yet those birds that consumed low energy diet appeared to have a numerically better feed conversion ratio than those that consumed medium energy diet which also had a better feed conversion ratio compared to those that consumed high energy diet but reverse is the case in terms of percentage mortalities where those on high energy diet appeared to have lower mortality than those on medium energy diet which was equally lower than those on low energy diet. It could be established from this result that those birds that consumed more feeds are likely to deposit more abdominal fat which in turn make them more susceptible to heat stress which may finally results in high mortality when the environmental temperature exceeds their comfort zone [14].

The significant interaction that was revealed by statistics at this phase of the experiment, tallies with the findings of [18] that compared performance and economic suitability of some fast growing broiler strains under farming condition in Bangladesh where they found out that some strains performed better under certain nutrient and environment than others. But it disagrees with their findings in terms of feed conversion ratio, where they reported it to have been influenced by strains and nutrients which is not the case in this experiment.

IV. Conclusion

It could therefore be concluded from the study that Marshall strain having shown better performance among others, should be raised in hot season of semi-arid Sokoto and should be fed with low energy diet for optimum performance.

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