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ENERGY UTILIZATION BY BROILERS FED DIFFERENT MICRO-NUTRIENT MIXTURES

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ABSTRACT

Three commercial micro-nutrient mixtures, designated A, B and C were evaluated in terms of broiler performance characteristics, energy efficiency and blood metabolites. The study was conducted using Randomized Complete Block (RCB) design. The results obtained were confirmed by measuring the specific enzymes involved in the oxidation of carbohydrates and energy utilization. Micro-nutrient mixture C was found to result in lower growth rate, smaller live weight gain, higher blood glucose and lower serum Glutamic Oxaloacetate Transaminase (SGOT) activities. Feeding micro-nutrient mixture B improved energy efficiency. It was concluded that the poor performance and the poor energy efficiency of C-fed broilers was as a result of the micro-nutrient imbalance of the mixture since the mixture is deficient in Zinc and four B-vitamins that affect energy utilization. It also contains unbalanced over dosing of vitamin K. The better performance and better energy efficiency of B-fed broilers compared to A-fed broilers was due to the inclusion of adequate amounts of vitamin K, Zinc and the four B-vitamins that affect utilization of energy. The poor performance of A-fed broilers was attributed to deficiency of thiamine and vitamin K. B was recommended followed by A. It was suggested that the value of thiamine in B be increased to meet the NRC recommendation and further enhance efficiency of energy utilization.

Key Words: Energy, Broilers, Micro-nutrient mixtures

INTRODUCTION

The production of animal protein in the developing countries to meet the demands of the teeming populating is insufficient. Feed cost is estimated to account for over 70% of the total cost of producing livestock intensively (Oluyemi 1964; Ogunfowora, 1984). The cost of the conventional energy-giving ingredients is increasing daily. Yet the diets are not often properly utilized due to imbalance of the micro-nutrients in relation to the energy levels of the diets.

The interdependence of utilization of micro-nutrients and energy has been established (Lockhavt, Bryan and Bolin, 1966a,b), although when basic principles of nutrition were being established, nutrients were considered independently in order to identify their significance and to determine their quantitative needs. This approach has long been overshadowing the obvious fact that nutrient are not required in isolation. The complex interrelationships between nutrients point to the fact that for proper characterization of diet actions, the interaction between the nutrients must be considered. Certain micro-nutrients are needed in adequate quantities for proper energy utilization. The interdependence of certain micro-nutrients and energy becomes more apparent when intakes of one or another is below or is in excess of requirements.

In Nigeria, as in many developing countries, the import restriction, necessitates the use of various forms of vitamin and mineral combinations and therefore creates the obvious need for testing the relative usefulness of these micro-nutrient combinations in relation to energy efficiency. Consequently, this study was embarked upon to evaluate the performance and energy efficiency of broilers fed on three commercial micro-nutrient mixtures in isocaloric and isonitrogenous diets.

MATERIALS AND METHODS

Three isocaloric and isonitrogenous diets were formulated for the starter and finisher phase of the trial. Each of the diets contained one of the three commercial micro-nutrient mixtures. The composition of the experimental diets is shown in Table 1 while the micro-nutrient mixtures are presented in Table 2. A total of 180 day-old brown hyperco broilers were randomly allotted to three treatment groups in three replicates.

The micro-nutrients being supplied by each of the mixtures were carefully compared with the recommendations of national Research Council (1977). The micro- nutrients mixtures selected for use are chosen in such a way that one of them contained the micro-elements that affect energy utilization far above NRC (1977) recommendations (mixture A). The other contained these micro-elements far below the recommendations (mixture C) while the third mixture compares well with the recommendations(mixture B). The NRC(1977)recommendation for the micro-nutrients considered are given as follows:
thiamine (vitamin B1, 0.81mg), riboflavine 0.36mg, pyridoxine 0.30mg and niacin 2.70mg, zing 4mg, 0.05mg per 100g diet respectively.

Management of the birds

The broilers were raised in tier-brooder for the first 4 weeks of their lives and transferred to the deep litter after four weeks. Feed and water were supplied *ad-libitum*. Routine vaccination were carried out against Gumboro, Newcastle and Fowl Pox diseases.

At the end of the 4th and 8th weeks, two birds from each replicate were put in metabolic cages and used too determine average daily feed intake, weight gain, energy intake and energy efficiency. Blood samples were collected from the jugular veins and arteries into heparinized plastic vials fitted with caps and mixed properly with the heparin. Other samples were stored in the refrigerator until when needed for analysis. Energy efficiency was calculated as kilocalories of metabolizable energy consumed per gram gained as adopted by Olson, Sunde and Bird (1972).

Chemical Analysis

Experimental diets were analyzed separately for their proximate constituent (Table 3) using A.O.A.C., (1990) methods.

Analysis of blood metabolites and enzymes

Serum glucose was determined using O-toluidine (Toro and Ackermann, 1975) and serum cholesterol by the methods of Abell as described by Toro and Ackermann (1975). Serum triglyceride (STG) was determined using the improved manual spectrophotometric procedure described by Gottfried and Resenberg (1973). In the determination of SGOT and SGPT, blood serum was added to a buffered solution of α-ketoglutarate and aspartate and the resulting oxakoiaetate or pyruvate formed after incubation was measured colorimetrically by reaction with dinitrophenylhydrazine. Incubation was done, 60 minutes for SGOT and 30 minutes for SGPT. Final reading was done using a photometer as described by Schalm (1965).

Statistical Analysis

Results were evaluated by analysis of variance using Randomized Complete Block design (Steel and Torrie, 1980) and Duncan Multiple Range Test (Duncan, 1955) and Gomez and Gomez, (1985) was used to detect the differences among means.

RESULTS

The results of the performance characteristics and energy efficiency are shown in Tables 4 and 5 respectively.

In the starter phase, birds fed diet C had significantly ($P<0.05$) reduced mean body weights and mean feed intake compared to birds fed diets A and B. However, mean weight gain and feed conversion efficiency were not significantly different ($P>0.05$).At the finisher phase, the highest mean feed intake (766,31g/bird)and the highest mean body weight (888.70g/bird) were obtained in birds fed diet B while the least mean feed intake (729.16g/bird) was obtained in broilers fed diet C. High weight gain and feed conversion efficiency observed in broilers fed diet B were not significantly ($P>0.05$) different from the values obtained for diets A and C.

The results of energy efficiency (Table 5) show that birds fed on diet C had lower ($P<0.05$) daily feed intake and energy intake compared to birds in any other group. Feeding diet B improved energy efficiency.

The results of the blood analysis are in Table 6. Feeding diet C resulted in elevated ($P<0.05$) serum glucose and lower serum glutamic oxaloacetate transaminase (SGOT) activities than feeding B or A at both starter and finisher phases. No remarkable differences ($P>0.05$) were observed in the values for serum cholesterol, triglyceride and serum pyruvate transaminase (SGPT) activities.

DISCUSSION

The reduction observed in mean live weight gain and energy efficiency of broilers fed micro-nutrient mixture C compared to broilers fed B or A could be attributed to the imbalances of vitamin k1, zinc and the B-vitamins (Pyridoxine, riboflavin, niacin and thiamine) which are known to affect energy utilization. Mixture C is loaded with a high amount of vitamin K (0.30mg/100g diet) representing 566% of (NRC, 1977) recommendations (Table 2). This unbalanced over dosing might be the cause of the poor performance of the broilers. March, Wong, Sier, Sim and Biely (1973) observed hypervitaminosis in chicks attributable to vitamin E. The findings suggest that excess vitamin E like the other fat-soluble vitamins are potentially toxic. Consequently, the poor performance of broilers fed mixture C in this study could be attributable to hypervitaminosis K. The poor energy efficiency in C-fed broilers could be due to the deficiencies of the B-vitamins and zinc. Mixture C furnishes only 10%, 30% and 69% of the recommended pyridoxine, niacin and riboflavin respectively and only 11% of required zinc (Table 2). Lockhart, Reece, Bryant and Bolin (1966a,b) observed gradual decrease in efficiency of M.E. utilization as pyridoxine, riboflavin, pantothenic acid, niacin or thiamine decreases and that thiamine deficiency had the greatest effect. The poor energy efficiency of the C-fed broilers could be attributable to the deficiency of the four B-vitamins, particularly thiamine.

Micro-nutrient mixture A was lacking in thiamine, vitamin K and zinc (Table 2). These deficiencies acting indirectly through a reduction in feed intake might be the cause of the lower performance of A-fed broilers compared to B-fed broilers at the finisher phase. The reduced energy efficiency could be due to absence of thiamine (Lockhart *et. al.*, 1996a,b).

The poor energy utilization of C-fed broilers was confirmed by the analysis of the blood components. The high blood glucose of C-fed broilers could be the result of poor utilization of glucose for energy. Church and Pond (1982) stated that thiamine deficiency seriously disturb carbohydrate metabolism because pyruvic acid is a key metabolite in energy utilization. In the process, thiamine functions physiologically as coenzyme called Thiamine pyrophosphate (TPP). Both riboflavin and pyridoxine take part in oxidation reactions involving the intermediate metabolites in the Tricarboxylic acid cycle (TCA) and reactions involving utilization of carbohydrates and glycogen break down such that energy is supplied at a faster rate. The deficiency of these vitamins would lead to poor energy utilization and low activities of the enzymes involved in such processes as evidenced in C-fed broilers. The deficiency of the vitamins could be the cause of the low activities of SGOT observed in C-fed broilers.

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Table 1. Composition of Experimental diets

Ingredients (%)	Starter Diets			Finisher Diets		
	A	B	C	A	B	C
Maize	47.00	47.00	47.00	46.00	46.00	46.00
Groundnut Cake	24.00	24.00	24.00	24.00	24.00	24.00
Fish Meal	4.00	4.00	4.00	3.00	3.00	3.00
Brewer's Dry Grain	7.00	7.00	7.00	9.00	9.00	9.00
Corn Offal	7.00	7.00	7.00	7.00	7.00	7.00
Blood Meal	3.00	3.00	3.00	3.00	3.00	3.00
Oyster Shell	3.00	3.00	3.00	3.00	3.00	3.00
Bone Meal	4.00	4.00	4.00	4.00	4.00	4.00
Salt	0.30	0.30	0.30	0.30	0.30	0.30
Methionine	0.30	0.30	0.30	0.30	0.30	0.30
Premix1,2,3	0.40	0.40	0.40	0.40	0.40	0.40

The following micro-elements are furnished by the premixes per 100g of diet:

Premix1 - Vitamin A 1800iu, Vitamin D3 250iu, Vitamin E 1.4iu, Choline Chloride 48mg, Manganese 12mg, Iodine 0.22mg, Selenium 0.02mg, Copper 1.00mg, Iron 7mg.

Premix2 - Vitamin A 1250iu, Vitamin D3 275iu, Vitamin E 1.50iu, Biotin 0.005mg, Calcium pantate 1.00mg, Choline Chloride 0.10mg, Vitamin B12 0.002mg, Vitamin C 2.50mg, Manganese 10mg, Cobalt 0.022mg, Iodine 0.155mg, Selenium 0.01mg, Copper 0.20mg, Iron 5mg.

Premix3 - Vitamin A 800iu, Vitamin D3 150iu, Vitamin E 0.30iu, Calcium pantothenate 0.30mg, Vitamin B12 0.80mg, Manganese 1.0mg, Cobalt 0.002mg, Iodine 0.015mg, Selenium 0.001 mg, Copper 0.02mg, Iron 0.50mg.

Table 2. The Micro-Nutrient that affect Energy Utilization contained in 100g of each of the Diets.

Micro-Elements	Mixture A		Mixture B	Mixture C
	Starter	Finisher	Starter and Finisher	(Starter and Finisher)
Thiamine	-	-	0.15mg	-
Thiamine(as % of NRC* recommendation)	-	-	83	-
Vitamin K	-	-	0.20mg	0.30mg
Vitamin K (as % of NRC* recommendation)	-	-	400	566
Riboflavin	1.20mg	1.00mg	0.60mg	0.25mg
Riboflavin (as % of NRC* recommendation)	333	277	166	69
Pyridoxine	2.80mg	2.00mg	0.35mg	0.03mg
Pyridoxine (as % of NRC* recommendation)	933	666	116	10
Niacin	4.40mg	4.00mg	3.50mg	0.08mg
Niacin (as % of NRC* recommendation)	163	148	130	30
Zinc	-	-	4.50mg	0.45mg
Zinc (as % of NRC* recommendation)	-	-	112	11

*NRC, 1977

Table 3. Proximate Composition of the Diets

Parameters (%)	Starter Diets			Finisher Diets		
	A	B	C	A	B	C
Dry Matter	88.85	88.81	88.86	88.79	88.85	88.84
Ash	8.01	8.11	8.15	8.22	8.19	8.32
Crude Fibre	5.46	5.49	5.47	5.50	5.48	5.45
Crude Protein	22.98	22.97	22.98	18.80	18.87	18.89
Ether Extract	4.03	4.01	4.05	4.06	4.06	4.03
Nitrogen free Extractives	59.52	59.39	59.35	63.42	63.40	63.31

Table 4. Performance Characteristics

Parameters	Starter Diets				Finisher Diets			
	A	B	C	SEM	A	B	C	SEM
Mean live weight (g/bird)	195.20[a]	199.30[a]	177.50[b]	±4.34	856.90[b]	888.90[a]	823.70[c]	±5.43
Mean Feed intake (g/bird)	235.08[a]	251.19[a]	225.26[b]	±11.72	754.08[b]	766.31[a]	729.16[c]	±10.14
Mean weight gain (g/bird)	98.20	101.50	88.30	±4.14	157.70	170.70	159.70	±4.08
Feed efficiency	2.45	2.45	2.66	±0.13	4.73	4.51	4.55	±0.10

Values denoted with different superscripts in the same row differ significantly ($P<0.05$).

Table 5. Energy Efficiency

Parameters	Starter Diets				Finisher Diets			
	A	B	C	SEM	A	B	C	SEM
Mean Daily feed intake (g) (DM basis)	46.70[a]	68.26[a]	62.26[b]	±1.10	117.41[a]	118.84[a]	114.47	±0.76
Mean Daily ME intake (Kcal/bird)	194.10[a]	204.79[a]	187.18[b]	±3.31	340.49[a]	344.66	332.82[b]	±2.22
Mean Daily weight gain (g/bird)	22.93[b]	24.93[a]	21.51[c]	±0.45	26.56[b]	28.70[a]	26.31[b]	±0.39
Energy efficiency	8.46	8.21[c]	8.70[a]	±0.05	12.81[a]	12.01[b]	12.65[a]	±0.16

Values denoted with different superscripts in the same row differ significantly ($P<0.05$).

Table 6. Some Selected Blood Components of Broilers given different Micro-Nutrient Mixtures.

Parameters	Starter Diets				Finisher Diets			
	A	B	C	SEM	A	B	C	SEM
Serum Glucose (mg/dl)	147.92[b]	121.42[b]	168.27[a]	±9.60	135.51[b]	130.04[b]	172.82[a]	±2.21
Serum Cholesterol (mg/dl)	114.55	118.30	94.90	±6.12	119.50	153.39	122.00	±14.71
SGPT (sf Units/ml)	18.00	17.00	15.00	±3.00	18.50	21.50	18.00	±1.89
SGOT (sf Unit/ml)	29.50[a]	30.00[a]	24.00[b]	±2.50	36.50[a]	38.00[b]	30.50[b]	±3.47
STG (mg/dl)	34.50	30.00	29.00	±8.30	111.00	120.00	106.00	±8.29

Values denoted with different superscripts in the same row differ significantly ($P<0.05$).