THE PERFORMANCE OF BROILER CHICKEN FED DIETS CONTAINING VARYING LEVELS OF SORTEX® REJECTED RICE

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ABSTRACT
This study was conducted to determine the performance of broiler chicken fed diets containing varying levels of Sortex® rejected rice (SRR), a by-product of rice milling. A total of 400 Ross 308 broiler day-old chicks were procured and out of this 360, after brooding, were randomly subjected to four levels of SRR inclusion as replacement for maize (T0 = 0%, T1 = 25%, T2 = 50% and T3 = 75%) in a complete randomised design. Birds were placed on the treatments from 4 to 8 weeks after being fed the same start diet for 4 weeks. Each treatment had six (6) replicates with 15 birds per replicate making 90 birds per treatment. The birds had ad libitum access to feed and water. Weekly feed intake and weight gained were recorded throughout the experimental period. The data obtained were used to calculate the feed conversion ratio (FCR). Four (4) birds from each replicate were randomly selected for carcass studies. The data obtained were analysed using the SAS Proc. GLM. The results of the study revealed non-significant (P > 0.05) differences in the weights gained, feed intake and FCR between treatments. The dietary treatments did not exert any significant influence on the carcass parameters measured including the dressed percentage. At the end of the study, no significant (P>0.05) differences were seen in the blood parameters measured except the platelets (PLT) and White blood cells (WBC). The partial inclusion of SRR up to 75% for maize resulted in economic savings of up to Gh¢0.47per kg of feed. It can be concluded that the SRR is a potential alternative for replacing maize as a major ingredient in broiler diet during the finisher stage and reduce the cost of broiler production.

Keyword: *Maize, Sortex® rejected rice, feed intake, body weight, feed conversion ratio*

INTRODUCTION

Many investigations on poultry nutrition fundamentally deal with the replacement of one ingredient by another but making sure of maintaining a well-balanced diet especially for, energy and protein. The above has given way to the assessment of agricultural by-products (non-conventional feed ingredients) and the addition of suitable ones in poultry feeds to reduce the cost of production (Laporte, 2007). The use of agricultural by-products in poultry nutrition indicates valuable means of the secondary production of food from waste with the intention of confront competition between humankind, animals and agro-processing industries (Thirumalaisamy *et al*, 2016).

A typical poultry diet is dominated by cereal grains, especially maize or corn (*Zea mays*) which serves as the main carbohydrate component and serves as the principal energy source in poultry diets (Sittiya and Yamauchi, 2014; Olympio *et al*, 2014). According to Okereke *et al*, (2012), maize is highly palatable and contributes up to 50-55% of poultry and other monogastric feeds, but the increase in demand with the concurrent competition with humans and its production has led to its high price. Also, high consumption by man, in the feed of monogastric animals and utilization by the brewery and biofuel industries creates occasional shortage (Ranum *et al*, 2014). Several types of grains have been proposed as an alternative for corn in broiler chicken diets, serving as alternative sources of dietary carbohydrates. For instance, replacing corn for wheat, barley and rye in broiler diets revealed a depression in body weight gain and FCR (Lázaro *et al*, 2003). However, pearl millet as maize replacer in broiler diets improved production responses without causing any unfavourable consequences for supplement absorbability or fowl wellbeing (Baurhoo *et al,* 2011).

Rice (*Oryza sativa*) is the second most-consumed staple crop in Ghana after maize and the third most grown and consumed staple after wheat and maize in the world Angelucci *et al.,* (2013). It is a very good source of carbohydrate accounting for 90% of the total dry weight and 87% of total caloric content (Arnarson, 1994). Sortex® Rejected Rice (SRR) is the portion of rice that the Sortex® machine rejects during the processing of rice for human consumption in most rice milling areas. Since it has been rejected for human consumption, there is little or no demand for it by humans and industries and therefore competition for it is very low. Besides, it is readily available during most periods of the year. Analysis shows that it contains a very high amounts of crude protein and metabolizable energy that is similar to maize (Tagoe *et al*., unpublished). Rice in general has showed no negative effects in substituting for corn in poultry and other monogastric diets (Alias and Arifin*,* 2008). The objective of the current study was to determine the growth performance of broilers fed diets in which the SRR is replacing maize at various levels during the finisher stage of broiler chicken production.

MATERIALS AND METHODS

Location and duration of the experiment

The study was conducted at the Poultry Section of the Department of Animal Science, Kwame Nkrumah University of Science and Technology (KNUST), Kumasi. The study area is located within the semi-deciduous humid forest zone of Ghana which is characterized by a bimodal rainfall pattern with an annual rainfall of 1300mm. Daily temperatures range from 20^{o}C to 35^{o}C with an average of 26^{o}C. The relative humidity varies from 97% during the morning of the wet season to as low as 20% during the late afternoon in the dry season. (KNUST Meteorological report, Unpublished). The study was carried out from 1st August 2018 to 28th August 2018. All experimental procedures followed the appropriate ethical Procedure for Animal Research Ethics Committee (AREC) of the Kwame Nkrumah University of Science and Technology, Kumasi-Ghana (KNUST POLICY 0016) (AREC, 2018).

Experimental birds and design

Four hundred (400) Ross 308 broiler day-old chicks were purchased from Frankason (Importer of day-old chicks from Belgium and dealer in poultry products) in Kumasi. Three hundred and sixty of these with an average weight of 50g were brooded for 4 weeks on the same starter diet. The starter diet had a CP of 20.51% and ME of 3165.35Kcal. The birds were grouped into four (4) dietary treatments with ninety (90) birds per treatment and fed from the 4th to 8th week of production in a completely randomized design. The treatments corresponded to different SRR levels replacing maize at 0% (T0), 25% (T1), 50% (T2) and 75% (T3) (Table 1). Each treatment was replicated 6 times with 15 birds per replicate. The birds had unrestricted access to feed and water for the entire duration of the study and were housed in 24 deep litter pens measuring 1.22m X 2.44m with an average space of 0.198m^2 per bird. Wood shavings was spread to a depth of approximately 2 mm to 3 mm on a concrete floor to serve as litter for the birds. The litter was changed at two weeks intervals. Vaccination and medication programme were planned and followed carefully following the recommendations of the Veterinary Service Directorate of the Ministry of Food and Agriculture (MoFA).

Parameters measured

The parameters measured were feed consumption (feed intake), live weight changes, feed conversion ratio, carcass characteristics, the economics of production, and haematology of the birds. To estimate the feed consumption per bird, the average daily feed consumed per bird was calculated by subtracting feed left in the feeding trough from that given throughout the week and then dividing it by the number of birds in the replicate. For the body weight, the initial live body weights of birds in each replicate were recorded at the beginning of the trial and taken at weekly intervals with a digital scale to the nearest 0.005g. The body weights were calculated per bird. The weight gain was computed by subtracting the initial body weight from the final body weight. The feed conversion ratio was calculated by dividing the feed consumed by the weight gain.

Carcass parameters

Carcass evaluations were done at the end of the experiment. Four birds (two female and two male) from each replicate were randomly selected for carcass evaluation. The birds were starved overnight, and the live body weights measured. Each bird was restrained and exsanguinated by sticking the throat with a sharp knife to drain out the blood. The following measurements were taken for the carcass analysis at various points in the processing of the birds: live weight, bled weight, de-feathered weight, and the weights of

Table 1: Composition of experimental diets Dietary treatments

Item	T0	T1	T2	T3
Maize	54	40.5	27	13.5
SRR	0	13.5	27	40.5
Fish meal	4.5	4.7	3.6	3.5
Soya bean meal	19.1	17.6	17.9	16.8
Wheat bran	19.8	21.05	21.9	23.1
Dicalcium phosphate	0.25	0.25	0.25	0.25
Oyster shell	1	1	1	1
*Premix (vitamins and minerals)	0.25	0.25	0.25	0.25
Lysine	0.2	0.2	0.2	0.2
Methionine	0.2	0.2	0.2	0.2
Common Salt	0.5	0.5	0.5	0.5
Toxin binder	0.2	0.2	0.2	0.2
Total	100	100	100	100
Calculated nutrient composition (% on DM basis)				
CP.	19.42	19.37	19.35	19.30
CF	4.31	4.44	4.57	4.70
Ca	2.83	2.89	2.95	3.01
P	0.95	0.96	0.97	0.98
ME(Kcal)	3089.53	3090.12	3100.08	3103.27

**Vitamin A–8,000,000 IU, Vitamins D_3 –3,000,000 IU, Vitamins E–8,000, Vitamin K –2,000mg, Vitamin B_1– 1000mg, Vitamin B_2–250mg, Vitamin B_{12}–5000mg, Nicotinamide –10,000mg, Selenium–100mg, Ca Pantothenate – 5,000, Folic acid –500mg, Choline Chloride –150,000,mg, Iron – 20,000mg, Manganese –80,000mg, Copper –8,000mg, Zinc –50,000mg, Cobalt –225mg, Iodine –2,000mg Antioxidant – 100ppm* the shank, head, neck, heart, liver, lungs, empty gizzard, empty intestine, drum stick, wing and thigh. The dressing percentage was calculated as follows: the weight of the eviscerated carcass divided by the live weight and multiplied by 100.

Economics of production

Economics of production was calculated based on the feed cost per kg diet and feed cost per kg live weight gain. Feed costs per kg for the experimental diets were calculated based on the prevailing prices of the ingredients at the time of the experiment. Feed cost per kg live weight gain was calculated for individual dietary treatments as a product of the feed cost and the feed conversion ratio. The profit was computed by subtracting the cost of producing a kg carcass from the cost of carcass per kg (Table 2).

Statistical analysis

The data obtained were analyzed using the SAS Proc. GLM (SAS, 2014) procedure and means separated using the SNK test at 5% significant level.

RESULTS AND DISCUSSION

Growth performance of Ross 308 broiler Fed SRR

The different dietary treatments of SRR did not exert any significant (P>0.05) effect on feed intake of the birds. The daily feed intake was almost the same among all the treatments consuming 0.13kg a day except for T1 which consumed 0.12kg a day (Table 3). The result of this study confirms the study of Nanto *et al*, (2012) when they investigated the effects of dehulled, crushed and untreated whole-grain paddy on the growth performance of broilers. Filgueira *et al*, (2014) also recorded non-significant (p>0.05) differences in the daily feed intake in meat-type quails when corn was replaced with broken rice between 7 and 49 days of age.

Table 2: Prices of Feed Ingredients Used (GH¢ Per Kg)

Item	Price per kg (GH¢)
Maize	1.6
SRR	0.6
Fish meal	5.7
Soya bean meal	2.8
Wheat bran	0.72
Dicalcium phosphate	5
Oyster shell	0.3
Premix	12
Lysine	14
Methionine	30
Toxin binder	6
Salt	2.5

On weight gain, the different dietary treatments did not exert any significant (P>0.05) effect of the birds (Table 3). From Fig. 1, it can be seen that all birds were growing at an increasing rate except for T2, which reduced in the rate of gain at the end of 4th week. At the end of the 2nd week, while T3 gained 0.37kg the rest of the birds gained 0.39kg. At the end of the 3rd week, T2 had the highest (0.58kg) gain followed by T0 (0.56kg) and T1 (0.55kg). At the end of the 4th week, T3 gained significantly (0.64kg) from the rest of the treatment (Fig 1). Though the rate of gain of T3 was slower than the rest of the treatment, its appreciable gain in the 4th week resulted in the final weight gain not being significant (p>0.05) from the other treatments. This result is an indication that SRR will not have any negative influence weight gain of broilers. The result also confirms the report of Sittiya and Yamauchi (2014) and Filgueira *et al,* (2014) but contradicts the report of Nanto *et al*, (2012).

The average feed conversion efficiency (FCR) was not significantly (p>0.05) different among the treatments. The T2 however, appeared to record the highest (1.96) FCR while T1 recorded the least (1.87) with T0 and T3 recording the same FCR (1.91) (Table 3).

Carcass parameters

All the carcass parameters measured did not show any significant (P>0.05) differences between the dietary treatment (Table 4). The results could indicate that SRR will not influence carcass parameters negatively. The result of this study confirms that of Kim *et al*, (2016) and Ashour et al, (2015) when they replaced corn with broken rice in meat-type quail diets. Nanto *et al*, (2014) also recorded non-significant differences between treatment means for carcass parameters when they studied the effects of whole-grain paddy rice on growth performance, oxidative stress and morphological alterations of the intestine in broiler chickens exposed to acute and chronic heat stress.

Haematological responses of broilers fed SRR dietary treatments

Before the start of this experiment, with the exception of mean cell haemoglobin concentration (MCHC), which showed significant (P<0.05) difference between T0 and T1, all other parameters measured did not show any significant (P>0.05) differences (Table 5). This shows that the birds were within the same haematological range (Sakas, 2002). Treatment T0 birds has higher MCHC than those fed the SRR based diets. This means the average concentration of haemoglobin inside a single red blood cell was higher in T0 than those fed SRR. At the end of the experiment, no significant (P>0.05) differences were seen in the blood parameters measured except the platelets (PLT) and White blood cells (WBC). For the WBC, the significant (P<0.05) differences existed between T0, T1 and T2, T3 (Table 5). The low value in T2 and T3 shows that birds on that treatment may have been vulnerable to disease infection in case of an outbreak. With regard to the PLT, significant (P<0.05) differences existed between T0, T1 and T2. T0 had the lowest (46.83) PLT with T2 having the highest (99.11). The significant (P<0.05) difference of WBC and PLT were seen as the levels of SRR increased. The result of this study contradicts the findings of Mir *et al*, (2017) when they fed broken rice to poultry.

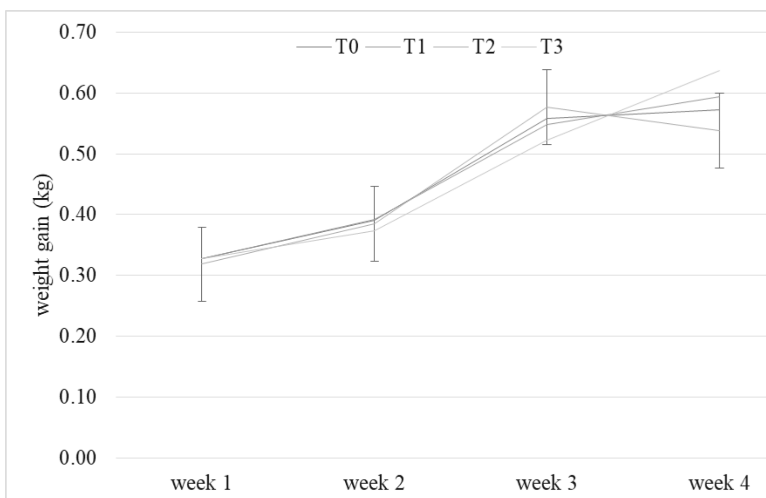

Fig. 1: The rate of weight gain of birds fed SRR

Table 3: Growth Performance of Ross 308 broiler birds Fed SRR

Parameter	T0	T1	T2	T3	SEM	P-value
Daily feed intake (kg)	0.13	0.12	0.13	0.13	0.0014	0.416
Initial body weight (kg)	0.53	0.53	0.52	0.53	0.0120	0.999
Final weight (kg)	2.37	2.39	2.34	2.38	0.0397	0.851
Weight gained (kg)	1.85	1.86	1.82	1.86	0.0385	0.857
Feed conversion ratio	1.91	1.87	1.96	1.91	0.0466	0.584

Table 4: Carcass parameters of birds fed SRR Dietary Treatments

Parameters	T0	T1	T2	T3	SEM	P-value
Live weight (Kg)	2.230	2.214	2.257	2.146	0.0431	0.3122
Head weight (Kg)	0.046	0.049	0.052	0.047	0.0019	0.1086
Neck weight (Kg)	0.102	0.103	0.100	0.099	0.0025	0.6106
Shank weight (Kg)	0.080	0.082	0.086	0.077	0.0029	0.1617
Gizzard weight (Kg)	0.040	0.043	0.042	0.036	0.0019	0.0952
Proventriculus weight (Kg)	0.015	0.036	0.011	0.012	0.0095	0.2017
Heart weight (Kg)	0.011	0.011	0.010	0.010	0.0004	0.0696
Liver weight (Kg)	0.042	0.041	0.042	0.038	0.0018	0.3218
Intestine weight (Kg)	0.139	0.093	0.135	0.069	0.0359	0.4569
Spleen weight (Kg)	0.002	0.002	0.003	0.003	0.0002	0.1214
Carcass weight (Kg)	1.603	1.555	1.601	1.523	0.0352	0.3117
Breast weight (Kg)	0.588	0.570	0.588	0.556	0.0139	0.3162
Drumstick weight (Kg)	0.233	0.226	0.232	0.217	0.0069	0.3094
Wing weight (Kg)	0.174	0.169	0.174	0.164	0.0043	0.3271
Thigh weight (Kg)	0.231	0.224	0.231	0.217	0.0060	0.3155
Dressing%	71.85	70.17	71.07	70.95	0.8391	0.5765

Table 5: Haematological responses of broilers fed SRR Dietary treatments

Parameter		T0	T1	T2	T3	SEM	P-value
Hb (g/dl)	Initial	10.50	9.66	10.46	10.31	0.3193	0.2250
	Final	11.22	11.08	10.81	10.92	0.1326	0.1428
HCT (%)	Initial	0.34	0.33	0.35	0.34	0.0104	0.4232
	Final	36.29	35.97	34.99	35.73	0.4168	0.1624
RBC ($x10^{12}$/l)	Initial	2.43	2.31	2.51	2.38	0.0759	0.3295
	Final	2.64	2.61	2.56	2.58	0.0342	0.3987
WBC ($X10^{9}$/l)	Initial	256.47	248.93	259.59	256.82	7.4404	0.7698
	Final	270.37^{a}	271.34^{a}	266.46^{b}	266.07^{b}	1.1269	0.0016
MCV (Fl)	Initial	141.96	133.58	141.67	142.14	4.0153	0.3632
	Final	136.88	137.86	137.22	137.48	0.9598	0.9056
MCH (Pg)	Initial	35.94	40.14	41.99	41.28	2.3381	0.2692
	Final	42.56	42.37	42.68	42.38	0.3129	0.8724
MCHC (g/dl)	Initial	32.46^{a}	28.078^{b}	30.57^{ab}	30.12^{ab}	1.0805	0.0484
	Final	30.93	30.79	30.84	31.54	0.3143	0.3112
PLT	Initial	20.61	16.50	24.00	20.11	2.12	0.1089
	Final	46.83^{a}	60.11^{a}	99.11^{b}	72.00^{ab}	10.8381	0.0086

HCT-Haematocrit, Hb-Haemablobin, MCH-Mean cell haemoglobin, MCHC-Mean cell haemoglobin concentration, MCV-Mean cell volume, RBC-Red blood cells, WBC-White blood cells, PLT- Platelet, LYM- lymphocyte, %-percentage, g/dl-gram per decilitre, l-litre, fl-femtoliter, pg-picogram
a-b: Means in the same row followed by different superscripts are significantly ($P< 0.05$) different.

Economic Viability

As stated earlier, the end of the study, there were no significant (P>0.05) differences in feed intake and weight gain (Table 3) and cost of feed reduced as SRR inclusion level in the diet increased (Table 6). Farmers would be saving between GH¢0.15 and GH¢0.47 on every kg of feed prepared with SRR inclusion. Feed cost accounts for 60 to 70% of the total cost of production (Banson *et al,* 2015). Therefore, in comparing the profit to be made as a result of including SRR in poultry diet, an equation $Pi= (Ai \times T) - Ni - 8$ could be formulated.

Where P=Profit, i=treatment diet, A=weight again; T=cost of broiler per kg (¢18.00); N= cost of feed consumed; 8= cost of other production factors (D.O.C., drugs and medication and transportation).

The SRR appears to be an economically viable feedstuff for the poultry industry. A farmer using SRR will make an extra profit between 0.62 to 1.89 Ghana Cedis depending on the level of maize replacement (Table 6). And profit was made even with T2 which had the least weight gain. The result of this study confirms the report by Filgueira *et al*, (2014) and Ashour *et al*, (2015) when they replaced corn with broken rice in meat-type quail diets.

CONCLUSION

It can be concluded that the SRR is a potential alternative replacement for maize as a major ingredient in broiler diet replacing maize up to 75% during the finisher stage and reducing the cost of feed.

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Table 6: Economic viability of using SRR

Parameters	T0	T1	T2	T3
Feed cost per Kg (GH¢)	1.97	1.82	1.65	1.50
Savings per Kg of feed (GH¢)	0	0.15	0.32	0.47
Total feed intake (kg)	3.64	3.36	3.64	3.64
Total weight gain (kg)	1.85	1.86	1.82	1.86
Total cost of feed consumed (GH¢)	7.17	6.12	6.01	5.46
Price per weight gain (GH¢)	33.3	33.48	32.76	33.48
Profit ($Pi= (Ai \times T) - Ni - 8$	18.13	19.36	18.75	20.02
Economic benefit (GH¢)	0	1.23	0.62	1.89

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