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CARCASS YIELD AND PHYSIOLOGICAL STATUS OF BROILER CHICKENS FED DIETS CONTAINING MANGO (*Mangifera indica*) FRUIT REJECT MEAL (MFRM)

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Abstract
The experiment was conducted to determine the effect of mango (*Mangifera indica*) fruit reject meal (MFRM) on the carcass yield and blood profile of finisher broiler chickens. The research was carried out at the Poultry house of the Livestock Unit, Teaching and Research Farm, University of Agriculture Makurdi. Day-old broiler chicks numbering 200, were grouped into five (5) with each group replicated four times and assigned to diets containing 0, 5, 10, 15 and 20% mango fruit reject meal (MFRM) as T_1, T_2, T_3, T_4, and T_5 in a completely randomized design (CRD), and fed to finishing - 63 days. Carcass and blood profile were examined. Results showed that fasted weight significantly reduced ($P < 0.05$), from 2025 to 1737.50g as MFRM increased (0-20%) in diets. Mean relative-dressed weight (60.57-63.09%) were not significantly different ($p>0.05$) across treatment groups. This trend subsisted for the main meat cuts and internal organs. White blood cell count (WBC) varied ($p<0.05$) without pattern, while red blood cell count (RBC) increased ($p<0.05$) as MFRM increased in the diets and both had values within normal ranges. Serum biochemical components were also not significantly different ($p>0.05$) across treatment groups. It was concluded that MFRM has significant effect on fasted weight, decreasing it significantly at levels beyond 15% incorporation in broiler chicken diet. However, dressed weight, main meat cuts, internal organs and blood are not affected by inclusion of MFRM in broiler diets. It was recommended that 15% MFRM be included in broiler chicken diets to serve as an energy source.

Keywords: mango fruit, carcass cuts, internal organs, haematology, serum biochemistry

Introduction

Broiler chicken meat production is an ever selling enterprise that scarcely has a substitute due to its quick turnover and world-wide acceptability. As promising as this enterprise may be, it is not devoid of salient challenges; most conspicuous of which is the unavailability and or high cost of most conventional feedstuff, meant for its production. The use of non-conventional feedstuffs is unarguably a panacea to the challenge of skyrocketing prices of conventional feedstuff, which at the same time have multiple uses that occasion unavoidable competition for their deployment to the various interests of value chain enterprises (Orayaga *et al*., 2018; Orayaga *et al*., 2019). Egbunu *et al*. (2020) have reported a reduction in price of feed and feeding when rice offal was treated with feed enzymes and incorporated into broiler chicken diets to replace maize at graded levels. This indicates that agro-by products are the way out of the high cost of conventional feedstuff. Many such by-products and or waste have been investigated. Culled mango fruits, discarded fruits or processing waste from mango processing factories, have also been exploited in one way or the other and are reported to have reasonable nutritional contents to support growth, health, and productivity of farm animals in no lesser impact (Orayaga, 2016); differently from some other agro-industrial by-products reported to have low nutritional value and impact adversely on the animal's tissue accretion probably because of unbalanced and or low nutrient content, elevated fibre levels, poor palatability or high anti - nutritional factors (Ayuba *et al*., 2021; Orayaga *et al*. 2019). Rejected cashew nuts, bananas, watermelons and avocados are only flabby for human consumption but have shown to have high value for animal nutrition (Orayaga *et al*., 2018). Mango fruits flabby for human consumption are usually rejected and wasted despite the enormous quantity of the material, 56 million metric tonnes (FAO, 2020) which could take the place of conventional energy sources for adequate and quality meat yield (Soomro *et al.,* 2013). While the carcass yield is a function of the growth performance of broiler chickens and describes the pattern of growth in the animal with respect to tissue components accretion, the blood

parameters among other parameters indicate the health status of farm animals. Jain (1993) has detailed some of the blood parameters that tell about the physiological state and welfare of the animals such as red cell count, white cell count, haemoglobin concentration, packed cell volume ete among haematological indices and biochemical parameters such as total protein, albumin, globulin etc. General growth may not detail which of the tissues got built up; whether it is the edible portion or offals. As such different techniques have been deployed to evaluate the carcass characteristics of broiler chickens (Canadian Meat Inspection Agency, 2020; Australian Chicken Meat Federation, 2021; Aduku and Olukosi, 2000). Though there are little variations among these methods of chicken carcass evaluation, a greater aspect of the processes is the same with each of them involving the dressed weight, major cuts such as drum sticks, thighs and breasts. This study therefore investigated the effect of mango fruit reject meal based diets on the carcass yield and blood profile of broiler chickens.

Materials and Methods

Experimental Location

The experiment was conducted at the Experimental Poultry House of the Livestock Unit, on the Teaching and Research Farm, Federal University of Agriculture, Makurdi, Benue State, Nigeria. The area is warm with a minimum temperature range of 21.71 $\pm$ 3.43°C and a maximum temperature range of 32.98 $\pm$ 2.43°C (TAC, 2011).

Preparation of Mango Fruit Rejects and Diets

Mango fruit rejects (test ingredient) were collected from mango tree stands of mixed varieties around Makurdi town and environs in its season (February through May). The composite rejected mango fruits were cleaned and sliced; peels and pulp together (about 3mm thick), using a kitchen knife and the seeds left out. Sliced pieces of composite mango fruit reject were sun-dried until it attained moisture content of less than 10% and milled using a corn milling machine, to obtain the mango fruit reject meal (MFRM). Before MFRM was incorporated in the diets, it was sub-sampled for determination of proximate composition according to standard procedures (AOAC, 2005), and integrated in broiler finisher diets at 0, 5, 10, 15 and 20% to give diets coded T_1, T_2, T_3, T_4, and T_5, respectively with 0% MFRM (T_1) serving as the control (Table 1).

Experimental Birds, Design and Management

Two hundred (200) 28 day-old *Arbor Acre* broiler chicks were used in the experiment which lasted for sixty-three (63) days. The broiler chicks were randomly allocated to 5 dietary treatments, balancing for body weight. Each treatment group, forty (40) birds, was replicated four times and each replicate had ten (10) birds, in a completely randomized design (CRD). Standard management procedures as outlined (Olomu, 2011) were followed and vaccines were administered as recommended by the National Veterinary Research Institute, Vom, Nigeria, for broiler chickens. Feed and clean drinking water were supplied to the birds *ad libitum* all through the experimental period, which was 63 days.

Carcass Evaluation

The carcass evaluation was done on the last day of the experiment, when the feeding trial was being terminated. The birds were deprived of feed but given water for 18 hours prior to carcass evaluation. Four birds were selected per treatment group with one bird carefully selected per replicate such that its weight was similar to the average weight of the replicate group and processed according to standard procedure (Australian Chicken Meat Federation, 2020). Carcass cuts, internal organs and offals were separated and weighed using a sensitive digital weighing scale. The weight and length of the entire gastro-intestinal organ and its constituent parts namely large intestine, small intestine and caeca were measured for morphometric evaluation. The dressed percent was determined using the formula:

$$\text{Dessed\%} = \frac{\text{dressed weight (g)}}{\text{fasted weight (g)}} \text{ X } 100$$

Other carcass parts and organ relative weights were also determined using the formula:

$$\text{Carcass part \%} = \frac{\text{weight of part (g)}}{\text{fasted weight (g)}} \text{X } 100$$

$$\text{Organ \%} = \frac{\text{weight of organ (g)}}{\text{fasted organ (g)}} \text{X } 100$$

Blood analysis

Haematological and serum biochemistry constituents of the birds' blood were determined at the end of experiment.

Haematology

On the last day of the feeding trial, four broiler finisher chickens per treatment; one per replicate, which had been fasted for carcass analysis had their blood collected into sample bottles containing about 2mg of ethylene diamine tetraacetic acid (EDTA**)** and taken immediately to the laboratory for analysis. Haematological indices analyzed included red blood cell count (RBC), haemoglobin concentration (Hb), mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH), mean corpuscular haemoglobin concentration (MCHC) , packed cell volume (PCV), RDW- CV and RDW-SD, using Mindray Authomatic blood analyzer and MCV, MCH and MCHC were determined by the same machine based on the formulae of Ritchie *et al*. (1994):

$$\text{MCV} = \frac{\text{Hematocrite value} \times 10}{\text{Erythrocyte count}}$$

$$\text{MCH} = \frac{\text{Hemoglobin g L}^{-1} \times 10}{\text{Erythrocyte count}}$$

and

$$MCHC = \frac{\text{Hemoglobin g } L^{-1} \times 100}{\text{Hematocrite value}}$$

Serum biochemistry

During blood collection at the end of the experiment, a second set of EDTA free blood sample tubes were also used to collect blood to determine the serum biochemical indices. The following parameters were determined: total protein, albumin, globulin, total bilirubin, and direct bilirubin, Alanine aminotransferase (ALT), Aspartate aminotransferase (AST), and Alkaline phosphatase (ALP).

Data analysis

Data generated were subjected to analysis of variance using statistical software [SPSS, 2004], which was configured to automatically separate means that were significantly different, using the Duncan Multiple Range Test of the same software – SPSS (2004). All data in percentages were first transformed using arcsin transformation before they were subjected to statistical analysis.

Results and Discussion

Results

Carcass evaluation

The average fasted weight(g), bled, plucked, eviscerated, dressed, breast, thigh, drumstick, back, neck and wing weights expressed as percentage of live weight (%LW) are presented in Table 3. Apart from the fasted weight, none of these carcass parameters was significantly different ($p>0.05$) among the dietary treatment groups. The fasted weights which varied from 1737.50g - 2025.00g were however significantly different ($P<0.05$); decreasing as the level of MFRM increased in the diets. The dressed percent ranged from 60.57% to 63.09%.

Internal organs

Result of the relative weights of internal organs is presented on Table 4. The mean weight of internal organs namely heart, liver, proventriculus, empty gizzard, spleen, pancreas, gall bladder, lungs and kidney expressed as percentage live weight (%LW) were similar ($p> 0.05$) across treatment groups.

Haematological indices

The data on haematological parameters are presented in Table 5. The white blood cell count (WBC) and red blood cell count (RBC) were significantly affected ($P<0.05$) by the experimental diets. While WBC varied without pattern, RBC increased with increase in MFRM in diets. Meanwhile, the packed cell volume (PCV), haemoglobin concentration (Hb), mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH), RDW-CV , RDW-SD and mean corpuscular haemoglobin concentration (MCHC) did not differ significantly ($P>0.05$) among the dietary treatment groups.

Serum Biochemical indices

The result of the serum biochemical indices are presented in Table 6. Total protein, Alanine aminotransferase (ALT), Aspartate aminotransferase (AST), and Alkaline phosphatase (ALP), albumin, total bilirubin, direct bilirubin, and globulin were not significantly affected ($P>0.05$) by the experimental diets.

Discussion

The significant decline in fasted weight could be attributed to relatively low protein and energy of the diets containing MFRM. These nutrients reduced as the level of MFRM increased in the diets. The mango fruit reject used in this experiment had low protein content (3.24%) compared to maize with 9% CP reported by NIAS (2019). Mango fruit reject is reported to be low in protein; 4.38% (Orayaga and Sheidi, 2018) compared to 9% in maize respectively**.** Therefore every level of increase in MFRM which contains peel and pulp lowered the protein content of the diet relatively. Though the metabolisable energy of mango fruit reject (3019.96kcal/kg) was also lower than 3420 kcal/kg in maize (Aduku, 2004), the major source of energy in the diets, it may not be responsible for the depressed fasted weight since the energy requirement for broiler chickens was met by all the diets. Mango peels are known to contain tannins (Orayaga *et al*. 2018), and tannins have been reported to reduce feed consumption by poultry (Oluremi *et al*., 2010) and or adversely affect feed utilization. Marquardt *et al*. (1977) reported that 1.7%, 0.5% and 0% tannins in chick diets resulted in corresponding daily weight gains of 4, 13 and 24g respectively. The presence of tannins in mango fruit reject (Orayaga *et al*., 2018) could be responsible for the decline in fasted weights of birds as the level of mango fruit reject meal increased. Fasted weights of 1737.50g to 2025.00g recorded in this study were less than the report of Soomro *et al*. (2013) which put it at 2149.4g to 2254.3g when broiler chickens were fed diets containing mango fruit pulp meal. Fasted weight or final weight is usually affected by some of the factors that affect the growth performance of the broiler chickens. The above mentioned reasons may have been responsible for decline in final weight as the level of MFRM increased in the diet. Relative plucked weight, bled, and eviscerated weights, dressed and carcass cuts were not affected significantly by the dietary treatments, possibly because feather development, blood volume, and internal organ weights in these broiler chickens were not adversely affected by the incorporation of MFRM in their diets. The dress percent being similar across treatment groups means meat parts were not disproportionate to the overall weight of the birds in any of the groups occasioned by the diets. Dress percent range of 63.09 and 60.57% were normal, depending on the method of carcass evaluation. Oluremi *et al*. (2010) reported a dressing percent of between 56.56 and 60.14 when 30% of fermented SOPM substituted maize in broiler diets, while Soomro *et al*. (2013) reported relative dressed weight of 50.71 to 58.19 when mango fruit pulp was included in broiler ration. These were

lower than the dressed percent of 60.57 to 63.09 obtained in this study. Dressed percent of 60.96 – 64.67, reported by Ndelekwute *et al.* (2015), when broiler chickens were fed diets containing organic acids were similar to this report. Dressing percent may vary due to the parts of the birds that have developed better. If the offals develop more than the carcass cuts, the dressing percent may be lower. Also the dressing method can affect the dressing percent because the parts which are considered to be offals in some methods may not be considered as offals in some. For instance, whereas Aduku and Olukosi (2000) would include even the giblets (neck, heart and liver) and head as part of dressed weight, the Australian Meat Federation (2020) does not consider the head as part of the dressed percent but includes the giblet and the wings. The Canadian Meat Inspection Agency (2018) on the other hand, would not include the head, neck, wing and internal organs as part of dressed weight. None of the carcass cuts evaluated in this study was significantly affected by the dietary treatments. Having similar relative weights despite significant variation in the fasted weights shows that tissue accretion across treatment groups for the various body parts was similar irrespective of live weight differences. If some treatments groups were affected such that offals were developed more because of the test material, relative weights of meat parts would decrease significantly. This means that though the diets affected the fasted weight, proportionate weight increase was maintained during growth.

Internal organs' proportion

The weight of none of the visceral organs expressed as percentage live weight was significantly affected by the experimental diets among the treatment groups. Internal organs such as gall bladder and the liver would vary by way of enlargement if some of the diets contain poisonous substances (Butcher *et al*., 2013). A situation where significant differences did not occur implies that the MFRM did not introduce poisonous substances in the diets. Similarity among treatment groups for empty gizzard and proventriculus suggests that fibre contents of MFRM based diets seemed MFRM did not make the diets to be higher in fibre, though the proximate revealed its relatively higher fibre (3.53%) content compared to maize – 2%. This condition is normal since calculated crude fibre for all the diets was still within the normal level of 5% recommended by Nigerian Industrial Standard (1989). Abnormal blood circulation would cause variation in the size of the heart (Frandson, 1986). Non-significant difference among the treatment groups for heart (percent live weight) indicates a normal blood circulation among all the dietary groups. The pancreas is the site for production of many of the digestive enzymes. There was no significant difference in percent pancreas weight among the treatments. This suggests that digestion especially in the small intestine was not obstructed in any form as a result of the test ingredient (MFRM) inclusion in the diets. The kidney is an excretory organ and was not overloaded, therefore resulting to similar relative weights across all the treatment groups.

Haematological indices

Haematological values were significant among the treatment groups for WBC and RBC. Both of them tended to increase as the level of MFRM increased. Mango fruit pulp is known to contain vitamin A, C, Mg and iron at higher concentration than maize. These are body and blood building compounds and elements (Aduku, 2004) and it is therefore suggested that their presence probably enhanced erythropoiesis and therefore RBC. The RBC values of 2.20 $X10^{12}$/L and 2.19 $x10^{12}$/L in T_1 and T_2, respectively were below the normal range of 2.5 $x10^{6}$µL to 3.5$x10^{6}$µL reported by Jain (1993). Meanwhile the significantly higher values of 2.49 $x10^{12}$/L, 2.42 $x10^{12}$/L and 2.62 $x10^{12}$/L for T_3, T_4 and T_5 respectively attained the normal range of Jain (1993). The reason for increase in the WBC is not clear. The range of 206.55 $x10^{9}$ /L to 227.43 $x10^{9}$ /L is within the normal range of 1.2 $x10^{4}$µL to 3 $x10^{4}$µL (Jain, 1993). All the hematological values are also similar with the range of values: 8-10% PCV, 2 x 10^{6}-3x 10^{6} µL RBC, 1.6$x10^{4}$x - 2.5$x10^{4}$µL WBC, 28 – 37% PCV, 126 – 163fl, 35 – 45% MCH and 24-31 g/dl MCHC reported by Simaraks *et al.* (2004). It is likely that increase in WBC here is not an indicator of a health challenge but blood well-fortified to defend the body against sickness, since there significant difference was still within the normal range. All the other haematological parameters, namely Hb, PCV, MCV, MCH, MCHC, RDW-CV and RDW-SD having value ranges of 12.35g/dl – 14.25g/dl, 29.70% - 33.88%, 129.30fl – 138.67fl, 54.43pg – 58.30pg, 41.55g/dl – 42.20g/dl, 7.95% – 8.27% and 41fL – 52.60fL were not significantly affected. This means that the dietary replacement of maize with MFRM did not pose health hazard on the birds. Apart from the health and diets of birds, variations in blood parameters are attributed to differences in laboratories, age and breed (Pratt, 2010). The production of these health indicators in the bone marrow (red blood cells and haemoglobin) seemed normal. Nutritional deficiencies resulting in abnormal development of red blood cells affect the size and shape of the erythrocyte released into the blood system because *erythropoiesis* is dependent on adequate supply of iron and protein; and on copper, cobalt and vitamins such as pyridoxine, folic acid, riboflavin, and cyanocobalamin for normal red cells and haemoglobin production (Pflanzer, 1982). The normocitic and normochromic appearance of the blood of these birds fed diets containing MFRM as reflected by the MCV and MCH values is an indication that MFRM did not negatively interfere with absorbability of nutrients required for blood formation and function by broiler birds neither did it present poisonous treats to broiler birds fed with MFRM based diets. Red blood cells carry oxygen from your lungs to the rest of your body. Abnormal red blood cell levels might be a sign of anemia, dehydration (too little fluid in the body), bleeding, or another disorder. White blood cells are part of the animal's immune system, which fights infections and diseases. Abnormal white blood cell levels might be a sign of infection, blood cancer, or an immune system disorder. Haemoglobin is an iron-rich protein in red blood cells that carries oxygen. Abnormal haemoglobin

levels might be a sign of anemia, sickle cell anemia, thalassemia , or other blood disorders. Excess glucose (sugar) in the blood can attach to haemoglobin and raise the level of haemoglobin. Haematocrit (PCV) is a measure of how much space red blood cells take up in the blood. High haematocrit level might mean dehydration has occurred. A low haematocrit level might means there is anemia. Abnormal haematocrit levels also might be a sign of a blood or bone marrow disorder. Mean corpuscular volume (MCV) is a measure of the average size of the red blood cells. Abnormal MCV levels might be a sign of anemia or thalassemia (National Institute of Health, 2012), the values in this result were normal.

Serum biochemical constituent of broiler chickens

None of the serum biochemical parameters was significantly different among the treatment groups. This means that the liver, kidney, blood, and body fluids were not adversely affected. Their values were in the range of 2.71g/L -3.20g/L total protein, 219.93 – 330.35 AST, 0.65 – 2.00 ALT, 0.085 – 0.34 total bilirubin, 646.75 – 1597.28 ALP, 1.18-1.43 ALB, 1.54 – 1.79 globulin and 0.055 – 0.243 direct bilirubin. These were all within normal ranges (Jain, 1993). Albokhadaim (2012) reported normal Saudi broiler chicken blood protein, albumin and globulin levels of 3.30 to 3.80g/L, 1.60g/L – 1.90g/L and 1.60g/L to 1.90g/L, respectively. None significant differences and the similarity of these biochemical indices to normal ranges is an indication that the health of the birds was compromised as a result of MFRM inclusion in the diets. Bilirubin is a yellowish pigment found in bile, a fluid made by the liver. A small amount of older red blood cells are replaced by new blood cells every day. Bilirubin is left after these older blood cells are removed. Bilirubin circulates in the blood stream in two forms: direct and indirect (or unconjugated) bilirubin. This form of bilirubin does not dissolve in water (it is insoluble). Indirect bilirubin travels through the bloodstream to the liver, where it is changed into a soluble form (direct or conjugated). Total bilirubin and direct bilirubin levels are measured directly in the blood, whereas indirect bilirubin levels are derived from the total and direct bilirubin measurements. The liver helps break down bilirubin so that it can be removed from the body in the faeces. When this process is hindered, large amounts of bilirubin enter the blood leading to jaundice, a yellow color in the skin, mucus membranes, or eyes. A bilirubin test is done to check liver or gallbladder problems. It is normal to have some bilirubin in the blood. Normal levels are: direct (also called conjugated) bilirubin: 0 to 0.3 mg/dL, total bilirubin: 0.3 to 1.9 mg/dL. Normal value ranges may vary slightly among different laboratories (Pratt, 2010). Jaundice can also occur when more red blood cells than normal are broken down. This can be caused by *erythroblastosis fetalis* or haemolytic anemia. The following liver problems may also cause jaundice or high bilirubin levels: Cirrhosis (scarring of the liver), hepatitis, liver disease, and Gilbert's disease. Also, the following problems with gallbladder or bile ducts may cause higher bilirubin levels: biliary, cancer of the pancreas or gallbladder gallstones, blockage of the tubes (bile ducts) that allow bile to pass from the liver to the small intestine (Pratt, 2010). Low levels of bilirubin in these birds show that their heart, liver, blood, pancrease, gallbladder and gallbladder ducts were not negatively affected by MFRM. An aspartate aminotransferase (AST) test measures the amount of this enzyme in the blood. AST is normally found in red blood cells, liver, heart, muscle tissue, pancreas, and kidneys and also was called serum glutamic oxaloacetic transaminase (SGOT). Low levels of AST are normally found in the blood. When body tissue or an organ such as the heart or liver is diseased or damaged, additional AST is released into the bloodstream. The amount of AST in the blood is directly related to the extent of the tissue damage. After severe damage, AST levels rise in 6 to 10 hours and remain high for about 4 days. AST test may be done at the same time as a test for alanine aminotransferase, or ALT. The ratio of AST: ALT sometimes can help determine whether the liver or another organ has been damaged. Both ALT and AST levels can test for liver damage. Therefore, an aspartate aminotransferase (AST) test is done for the following reasons: to check for liver damage; help identify liver disease, especially hepatitis and cirrhosis. Liver disease may produce symptoms such as pain in the upper abdomen, nausea, vomiting, and sometimes jaundice. Alanine transaminase (ALT) is an enzyme found in the highest amounts in the liver. Injury to the liver results in release of the substance into the blood. The normal range depends on many factors, including age and gender. Normal value ranges may also vary slightly among different laboratories (Berk and Korenblat, 2011). Increased levels of ALT often mean that liver disease is present. Liver disease is even more likely when levels of other liver blood tests are also increased. An increase in ALT levels may be due to: Cirrhosis (scarring of the liver), death of liver tissue (liver necrosis), Hepatitis, *haemochromatosis*, lack of blood flow to the liver (liver ischemia), liver tumor or cancer, medications that are toxic to the liver, mononucleosis ("mono"), pancreatitis (Berk and Korenblat, 2011). Alkaline phosphatase (ALP) is a protein found in all body tissues. Tissues with higher amounts of ALP include the liver, bile ducts, and bone. Higher-than-normal ALP levels, means, biliary obstruction, bone conditions such as osteoblastic bone tumors, osteomalacia, a fracture that is healing, liver disease or hepatitis, high fatty diets, hyperparathyroidism, leukemia, lymphoma, paget's disease, rickets, and sarcoidosis. Lower-than-normal ALP levels means, hypophosphatasia, malnutrition, protein deficiency Wilson's disease. Other conditions for which the test may be done include gallstones, giant cell (temporal, cranial) arteritis , pancreatitis and renal cell carcinoma (Afdhal, 2011). Total protein test measures the total amount of two classes of proteins found in the fluid portion of the blood. These are albumin and globulin. Proteins are important parts of all cells and tissues. The normal range of total protein here indicates that the birds were not malnourished and had none of the disease conditions responsible for its abnormality on them. Normal value ranges may vary

slightly among different laboratories. Albumin helps prevent fluid from leaking out of blood vessels. Globulins are an important part of the immune system. Higher-than-normal levels may be due to the following; chronic inflammation or infection, multiple myeloma, waldenstrom's disease and dehydration occasioned by some disease, nutritional or environmental factors. Lower-than-normal levels may be due to *gammaglobulinemia*, bleeding (hemorrhage), burns (extensive) *glomerulonephritis*, liver disease, malabsorption, malnutrition, nephrotic syndrome and protein-losing enteropathy (Klein, 2011).

Conclusion

MFRM had significant effect on fasted weight, decreasing it significantly at levels beyond 15% incorporation in broiler chicken diet. Dressed weight, main meat cuts, internal organs were not affected by inclusion of MFRM in broiler diets. Blood parameters were not affected adversely by inclusion of 20% MFRM in broiler diets. Based on the results, Mango Fruit Reject Meal (MFRM) should be used as an energy feedstuff in broiler chicken nutrition. Mango Fruit Reject Meal (MFRM) should be included in broiler chicken diets at 15% level, for optimal carcass yield and good health. It is also recommended that MFRM be used to reduce environmental pollution caused by the mango fruit rejects during its peak season.

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Table 1: Composition (%) of Experimental Diets for Starter Broiler Chickens

Ingredients	**Experimental Diets**				
	T_1	**T_2**	**T_3**	**T_4**	**T_5**
Maize	46.78	41.78	36.78	31.78	26.78
Soybean meal	34.22	34.22	34.22	34.22	34.22
Maize offal	7.00	7.00	7.00	7.00	7.00
Brewers dried grain	5.00	5.00	5.00	5.00	5.00
MFRM	0	5.00	10.00	15.00	20.00
Bone meal	2.50	2.50	2.50	2.50	2.50
Limestone	0.50	0.50	0.50	0.50	0.50
Blood meal	3.00	3.00	3.00	3.00	3.00
Methionine	0.30	0.30	0.30	0.30	0.30
Lysine	0.20	0.20	0.20	0.20	0.20
Common Salt	0.25	0.25	0.25	0.25	0.25
Vitamin/mineral Premix*	0.25	0.25	0.25	0.25	0.25
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**
Calculated Values					
M.E (kcal/kg)	2886.87	2866.24	2845.62	2825.00	2804.37
Crude protein	24.00	23.71	23.42	23.14	22.85
Crude fibre	4.87	4.90	4.93	4.96	4.99
Crude fat	4.09	3.91	3.73	3.55	3.37
Calcium	1.23	1.23	1.23	1.23	1.23
Phosphorus	0.84	0.84	0.84	0.85	0.85
lysine	1.40	1.40	1.30	1.30	1.30
Methionine	0.63	0.63	0.62	0.61	0.60

MFRM= Mango fruit reject meal, T1= 0% MFRM, T2= 5% MFRM, T3= 10% MFRM T4= 15% MFRM, T5= 20% MFRM

Premix*= Animal care vitamin/mineral premix®, included at 2.50 g/kg, translating to 7.20mg retinol, 0.15mg cholecalciferol/ergocalciferol, 40.02mg D-α-tocopherol, 5mg vitamin K3, 2mg folic acid, 80mg niacin, 4mg vitamin B1, 10mg vitamin B, 7mg Vitamin B6, 0.04mg Vitamin B12, 0.16mg biotin and 250mg antioxidant per kg Diet. The minerals values per kg diet were: cobalt 0.5mg, copper 16mg, selenium 0.5mg, iodine 24mg, iron 80mg, manganese 140mg, zinc 120mg and chloride 400mg

Table 2: **Composition (%) of Experimental Diets for Finisher Broiler Chickens**

Ingredients	Experimental Diets				
	T_1	T_2	T_3	T_4	T_5
Maize	54.86	49.86	44.86	39.86	34.86
Soybean meal	24.69	24.69	24.69	24.69	24.69
Maize offal	9.00	9.00	9.00	9.00	9.00
Brewers dried grain	5.00	5.00	5.00	5.00	5.00
MFRM	0	5.00	10.00	15.00	20.00
Blood meal	2.50	2.50	2.50	2.50	2.50
Bone meal	2.50	2.50	2.50	2.50	2.50
Oyster shell	0.50	0.50	0.50	0.50	0.50
Methionine	0.25	0.25	0.25	0.25	0.25
Lysine	0.20	0.20	0.20	0.20	0.20
Common Salt	0.25	0.25	0.25	0.25	0.25
Vitamin/mineral Premix*	0.25	0.25	0.25	0.25	0.25
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**
Calculated Values					
M.E (kcal/kg)	3107.92	3087.92	3067.92	3047.92	3027.92
Crude protein	20.41	20.12	19.83	19.55	19.26
Crude fibre	4.95	4.98	4.99	5.00	5.12
Crude fat	4.12	4.00	3.98	3.96	3.94
Calcium	1.30	1.30	1.30	1.30	1.30
Phosphorus	0.85	0.85	0.86	0.86	0.86
lysine	1.10	1.08	1.08	1.06	1.06
Methionine	0.58	0.58	0.57	0.57	0.56

MFRM= Mango fruit reject meal, T1= 0% MFRM, T2= 5% MFRM, T3= 10% MFRM T4= 15% MFRM, T5= 20% ***MFRM***

Premix*= Animal care vitamin/mineral premix®, included at 2.50 g/kg, translating to 7.20mg retinol, 0.15mg cholecalciferol/ergocalciferol, 40.02mg D-α-tocopherol, 5mg vitamin K3, 2mg folic acid, 80mg niacin, 4mg vitamin B1, 10mg vitamin B, 7mg Vitamin B6, 0.04mg Vitamin B12, 0.16mg biotin and 250mg antioxidant per kg Diet. The minerals values per kg diet were: cobalt 0.5mg, copper 16mg, selenium 0.5mg, iodine 24mg, iron 80mg, manganese 140mg, zinc 120mg and chloride 400mg

Table 3: Effect of MFRM on Carcass Cuts of Finisher Broiler Chickens (% Live Weight)

	Experimental diets					
Carcass part (%)	T_1	T_2	T_3	T_4	T_5	**SEM**
Fasted weight (g)	2025.00[a]	2007.50[a]	1990.00[a]	1875.00[ab]	1737.500[b]	51.40*
Bled weight	93.22	95.84	95.39	96.13	96.45	1.73[ns]
Plucked weight	89.09	92.40	90.40	93.07	91.13	1.58[ns]
Evisc. Weight	77.54	79.00	75.61	78.95	79.12	1.27[ns]
Dressed weight	62.77	63.09	60.57	62.80	62.21	0.85[ns]
Breast weight	20.66	19.76	20.87	19.55	19.36	0.48[ns]
Thigh weight	11.30	12.00	11.15	11.73	11.57	0.70[ns]
Drum stick	10.61	11.28	10.63	11.23	11.03	0.38[ns]
Back and ribs	10.62	10.83	10.75	10.98	10.27	0.43[ns]
Neck	6.43	7.06	6.18	6.99	6.41	0.26[ns]

[a,b,c] Means on the same row with different superscripts are significantly different (p<0.05), SEM= standard error of mean, [ns=] no significant difference (p>0.05), *= significant (0.05), T1= Diet containing 0% MFRM, T2 = Diet containing 5% MFRM, T3 = Diet containing 10% MFRM, T4= Diet containing 15% MFRM, T5 = Diet containing 20% MFRM

Table 4: Effect of MFRM on Internal Organs of Finisher Broiler Chickens (% Live Weight)

Organ (%)	Experimental Diets					
	T_1	T_2	T_3	T_4	T_5	SEM
Heart	0.43	0.53	0.56	0.47	0.46	0.38^{ns}
Kidney	0.48	0.61	0.57	0.57	0.64	0.26^{ns}
Lungs	0.54	0.55	0.59	0.68	0.52	0.19^{ns}
Full gizzard	2.49	2.59	2.35	2.63	2.37	0.13^{ns}
Empty gizzard	1.88	1.95	1.77	1.89	1.80	2.28^{ns}
Proventriculus	0.46	0.52	0.48	0.51	0.51	0.14^{ns}
Spleen	0.20	0.18	0.17	0.16	0.17	0.20^{ns}
Gall bladder	0.14	0.19	0.14	0.18	0.16	0.42^{ns}
Pancrease	0.24	0.20	0.25	0.28	0.25	0.24^{ns}
Liver	1.71	2.21	1.89	2.00	1.77	2.38^{ns}

SEM= standard error of mean, $^{ns=}$ no significant difference (p>0.05)
T1= Diet containing 0% MFRM, T2 = Diet containing 5% MFRM, T3 = Diet containing 10% MFRM, T4= Diet containing 15% MFRM, T5 = Diet containing 20% MFRM

Table 5: Effect of MFRM on the Haematological Indices of Finisher Broilers Chickens

Parameter	Experimental diets					
	T_1	T_2	T_3	T_4	T_5	SEM
WBC ($x10^9$/l)	212.90^{bc}	206.55^{c}	214.88^{abc}	227.43^{a}	222.03^{ab}	3.96*
Hb (g/dl)	12.70	12.35	13.63	13.40	14.25	0.61^{ns}
RBC ($x10^{12}$/l)	2.20^{b}	2.19^{b}	2.49^{ab}	2.42^{ab}	2.62^{a}	0.12*
PCV (%)	30.23	29.70	32.25	32.20	33.88	0.82^{ns}
MCV (fl)	138.67	136.30	129.68	132.95	129.68	3.00^{ns}
MCH (pg)	58.30	56.48	54.70	55.25	54.43	1.33^{ns}
MCHC (g/dl)	41.87	41.58	42.20	41.55	42.05	0.66^{ns}
RDW-CV (%)	8.27	8.08	7.95	8.18	7.95	0.23^{ns}
RDW-SD (fl)	52.60	48.55	45.00	46.93	41.00	2.51^{ns}

^{abc} Means on the same row with different super scripts is significant (p<0.05), SEM= standard error of mean, $^{ns=}$ no significant difference (p>0.05), WBC= white blood cell count, RDW-SD= red cell size (width) standard deviation
T1= Diet containing 0% MFRM, T2 = Diet containing 5% MFRM, T3 = Diet containing 10% MFRM, T4= Diet containing 15% MFRM, T5 = Diet containing 20% MFRM

Table 6: Serum Biochemical Constituents of Finisher Broilers Chickens

Serum biochemical constituent	Experimental Diets					
	T_1	T_2	T_3	T_4	T_5	SEM
Total protein x10 (g/l)	3.18	2.84	3.20	2.71	3.02	0.19^{ns}
Aspartateaminotransferase (iu/l)	330.35	320.38	292.83	219.93	268.38	34.53^{ns}
Alanine transaminase x10 (g/l)	1.85	2.00	0.65	0.88	1.33	0.40^{ns}
Total bilirubin (Umol/l)	0.340	0.265	0.140	0.085	0.098	0.14^{ns}
Alkaline phosphatase (iu/l)	1295.50	646.75	1282.25	1597.25	1278.50	328.91^{ns}
Albumin (iu/l)	1.40	1.23	1.43	1.18	1.23	1.07^{ns}
Globulin (iu/l)	1.78	1.61	1.77	1.54	1.79	0.15^{ns}
D-bilirubin (Umol/l)	0.135	0.055	0.120	0.243	0.178	0.07^{ns}

$^{ns=}$ No significant difference (p>0.05), SEM= Standard Error of Mean, AST= aspartate aminotransferase, ALT= Alanine transaminase , ALP= Alkaline phosphatase
T1= Diet containing 0% MFRM, T2 = Diet containing 5% MFRM, T3 = Diet containing 10% MFRM, T4= Diet containing 15% MFRM, T5 = Diet containing 20% MFRM