

Original Research Article

UTILIZATION OF COMPOSITE MANGO (*Mangifera indica*) FRUIT REJECT MEAL IN STARTER BROILER CHICKS FEEDING

ABSTRACT

*The experiment was conducted to determine macro chemical composition of mango (*Mangifera indica*) fruit reject meal (MFRM) and its effects on the performance of starter broiler chicks. 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) in a completely randomized design and fed for 28 days. Results showed that MFRM contained low CP (3.24%). Performance parameters such as feed intake and weight gain were significantly  (P<0.05) from 15% MFRM upward but comparable with control up to 10% MFRM in diets. Cost per kg weight gain was not significantly affected (p>0.05). It was concluded that MFRM has low protein; therefore it is an energy feedstuff and 10% MFRM in broiler chicks' diet was safe and supported growth performance.*

Key words: *Broiler, Chicks, Economics, Mango Fruit Reject, Performance*

1.0 Introduction

Fruit by-products, and or rejects are seriously being investigated as non-conventional feedstuff in livestock nutrition in response to high cost and or scarcity of conventional feedstuff such as maize. This is because most of these fruit by-products could be acquired at little or no monetary cost (1, 2). Fruits by-products such as cocoa pod husk (3), cashew nut-reject (4), citrus fruit peels (5, 6), mango fruit peels (7), mango fruit pulp (8), mango seed kernel (9) and mango fruit reject (2) have been identified as feed resources. Mango (*Mangifera indica*) is produced on a large

scale in several countries of the world, with total world figure put at 38 million metric tones (10). Eighty percent of the world mango is produced in India. Other producers include Thailand, Pakistan, Mexico, Indonesia, Brazil, the Philippines, Bangladesh and Nigeria. Nigeria occupies the 8th position on the list of top-most producers of mango around the world (11). In Nigeria, Benue state is the biggest producer of mango (12) cited by Ugesse and others (13). Most mangoes are consumed locally and only 3% of the production is exported, the main exporters being India and Mexico (11).

However, the fruit could be considered unfit for human consumption due to bruises, infections, improper handling, and activities of animals (especially birds) on the fruit, and as such rejected (2). These rejected fruits, also known as ~~cull~~ fruits (14) litter the ground during its season, thereby constituting environmental menace. As at present, emphasis on the processing of mango fruit has been to generate products for human consumption. Even, value addition to the rejected fruit has been done with more attention given to generation of products for human consumption

~~(15)~~. However, the seed and peel of mango fruits have been utilized in animal feeding, as (7), dried mango peels included in finishing pig diets at 10% had no deleterious effect on feed conversion ratio, animal performance and was cost effective (7). Inclusion rate as low as 5 to 10% of mango seed kernel depressed growth and feed intake in broilers (9). Odunsi (16) reported that growth performance was maintained at 10% inclusion of mango seed kernel meal in laying type birds' diet but egg laying was  depressed even at 5% level of inclusion. Residue from mango juice factory (a mixture of peels, kernels and discarded fruits) has lower value in poultry than the seed kernel alone (17). Feeding trials on broiler chickens with diets balanced for protein and energy resulted in depressed performance at 2.50% level of inclusion of mango fruit residue (17).

Although the seed and peel of mango fruits have been utilized in animal feeding, a large quantity of the pulp and peel of rejected fruits waste away in Nigeria (18). However, considering the high nutrients (energy, vitamin A, vitamin C and polyphenols) value of mango fruits (11), these rejected fruits could serve as a feed resource in animal feeding, mainly as a source of energy because of its high energy - ~~(3527.34 kcal/kg) DM~~ (19), and at the same time serve as a biological measure of handling environmental challenge posed by it.

This research therefore determined nutrient content of mango fruit reject and effect of its inclusion in starter broiler diets on the performance of broiler chicks at the starter growth phase.

2.0 Materials and Methods

2.1 Experimental site

The experiment was conducted at the experimental Poultry house of the Livestock Unit of the Teaching and Research Farm, University of Agriculture Makurdi, Benue State, Nigeria. The area is warm with a minimum temperature range of $24.20 \pm 1.40^{\circ}\text{C}$ and a maximum temperature range of $36.33 \pm 3.70^{\circ}\text{C}$ (20).

2.2 Preparation of Mango fruit reject meal and diets

Half-ripe mango fruit rejects (~~test ingredient~~) were collected (plate I) without reference to variety from mango tree stands and fruit markets around Makurdi town and environs in its season which is between February and May of the experimental ~~environment~~. The composite rejected mango fruits comprising more than four varieties were first cleaned dry, sliced manually using kitchen knife to a thickness of 1-3mm, such that peel and pulp together, and the seed discarded. Slices (peel and pulp together) were sun dried for seven days when it attained about 10% moisture (plate II) and stored in polyethylene sacks to the time it was used. Before the composite mango

fruit reject was ~~incorporated~~ into the diets, it was milled using corn milling machine to obtain mango fruit reject meal (MFRM) ~~shown in plate III~~. This was sub- sampled for determination of proximate composition, calcium, and phosphorus using the procedure outlined by AOAC (21). Mango fruit reject meal was then ~~incorporated~~ in broiler starter diets at 0, 5, 10, 15 and 20% respectively ~~with 0% MFRM (T1) serving as the control~~ (Table 1). The control diet was formulated based on the nutrient recommendation guide of the Nigerian Industrial Standard (22), and the formulation was done manually, using the Pearson square method as outlined by Aduku (23).



Plate I: Mango fruit rejects



Plate II: Sliced and sun-dried mango fruit rejects



Plate III: Mango fruit reject meal (milled mango fruit reject)

Table 1: Composition (%) of experimental diets for starter broiler chicks

Ingredients	Experimental Diets				
	T1	T2	T3	T4	T5
Maize	46.78	41.78	36.78	31.78	26.78
Soybean meal (44% CP)	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 (ash, 0%CP)	2.50	2.50	2.50	2.50	2.50
Limestone	0.50	0.50	0.50	0.50	0.50
Blood meal (75.77% CP)	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
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
NFE (%)	51.42	51.23	51.03	50.84	50.64
Ash	6.30	6.28	6.26	6.25	6.23
Calcium (%)	1.23	1.23	1.23	1.23	1.23
Phosphorus (%)	0.84	0.84	0.84	0.84	0.84
Lysine (%)	1.40	1.40	1.30	1.30	1.30
Methionine (%)	0.63	0.63	0.62	0.61	0.60
1. MFRM= Mango fruit reject meal, NFE= Nitrogen free extract, 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 2. Premix*= Animal care vitamin/mineral premix included at 0.25%, translating to 24000iu vitamin A, 6000iu vitamin B, 60mg vitamin E, 5mg vitamin K₃, 2mg Folic acid, 80mg niacin, 4mg vitamin B₁₂, 10mg Vitamin B₂, 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					

2.3 Experimental birds, design and duration

Two hundred (200) day-old *Marshall* broiler chicks having an initial body weight of 40.23 ± 0.33g were obtained from Obasanjo Farm, Ota, Ogun State and used in the experiment which lasted for four weeks (28 days). Forty broiler chicks formed a treatment group which was

exposed to one of five treatment diets and each group was replicated four times with each replicate containing ten (10) chicks; in the completely randomized design (CRD).

2.4 Management of experimental birds

The broiler chicks were raised in a deep litter half -walled house, having its upper half covered with wire mesh. The stocking density was 0.046 square metres per broiler chick. Feed and clean cool drinking water were supplied to the birds *ad libitum* all through the brooding period which lasted for twenty-eight days. Newcastle (i/o) vaccine was given at day old, gumboro vaccine was administered at day 14 and newcastle vaccine in drinking water was given at day 21, as recommended by National Veterinary Research Institute, Vom, Nigeria. Anti-stress (vitalyte-electrolyte and energy replacement formulation, containing vitamins, minerals, trace elements, and some amino acids) was given pre and post vaccination and or/ handling of birds. Emberzine and sulfacox were administered via drinking water every other week against coccidiosis. Antibiotics were also given along with the anti-coccidiosis ~~concurrently~~. The litter material was maintained in a dry condition throughout the experiment.

2.5 Data Collection and Analysis

Data were collected on growth performance parameters; weekly live body weight, feed consumption and water intake.  Weight gain, feed conversion ratio (the ratio of feed consumed to weight gain) and water-feed ratios were determined. A record of mortality was also kept to determine livability. Mean values of collected data were subjected to analysis of variance using the SPSS (24) software which was also configured to automatically separate means that were significantly different using its Duncan Multiple Range Test. Growth pattern was traced using SPSS.

All experimental procedures were followed as approved by the Nigerian Institute of Animal Science (NIAS).

3.0 Results and Discussion



The proximate constituents, energy content, calcium level and total phosphorous in MFRM were recorded: 11.5% moisture, 3.24% crude protein, 3.53% crude fibre, 1.57% ether extract, 0.97% ash, and 79.19% nitrogen free extract. Metabolizable energy; calculated from the proximate components using the formula of Ponzenga (24) was 3059.55 kcal/kg, while calcium and phosphorous were 0.49% and 0.04% respectively. The 3.24 %CP of sundried composite mango fruit reject is lower than 4.70%CP of mango fruit reported by Palma Castillo and Hurtado (25), but higher than 1.94+0.04 - 2.36+0.01% reported by Imran and others (26) for fruit peels alone. On a contrary wise, crude protein of mango fruit peel alone was reported as 4.60 – 9.10% (27). This finding was however within <5% reported by Kansci and others (28), who also reported great variability in mango fruit chemical composition of even same fruit parts of different batches. It may therefore be normal to have differences among different reports. It is also likely that the factors making the mango fruits to be rejected by humans such as bruises, premature falling of the fruit, improper handling etc contribute in reducing the protein content of composite mango fruit reject. Also, by-products reported above are not completely the same with MFRM, so their composition is likely differ from it. Varietal differences could be largely responsible for the reported differences. Ether extract of 1.57%, fibre 3.53% and ash 0.97% were all below the reported values of 5.30%, 14.60% and 7.70% respectively (25). Factors suggested to be responsible for variation of the protein level in this research to other reports may apply to the other proximate components. Nitrogen free extract of 79.19% was high compared to the 67.70% reported by Palma Castillo and Hurtado (25). Naveen and others (29) reported the proximate of

mango fruit pulp alone as 4.20% CP, 6.90% crude fibre, 2.40% EE and 83.3%NFE. The metabolisable energy value of 3059.55kcal/kg is less than 17.90 MJ/kg (4182.24 kcal/kg) reported by Palma Castillo and Hurtado (25). Reasons suggested for lower value of mango fruit reject proximate components hold for energy as well. While calcium level of 0.49% in MFRM is higher than 2.30g/kg reported by Palma Castillo and Hurtado (25) and phosphorous level of 0.04% is less than 1g/kg (0.10%) of their report.

The performance of the broiler chicks is presented in Table 2 and the relationship between level of MFRM in diets and some parameters which were not significantly different ($P>0.05$) on analysis of variance is in Table 3. Performance parameters namely final live body weight, total live body weight gain and daily weight gain had a similar pattern of being significantly depressed ($p<0.05$) from 15% MFRM. Average daily feed intake significantly decreased ($P<0.05$) at 20%, while feed intake at 15% MFRM was similar to all to treatments. The depression in weight from 15% might be as a result of the relatively low protein and energy of the diets containing mango fruit rejects meal. 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 (23). Mango pulp (25) and peel (27) are reported to be low in crude protein; 2.7 to 6% and 4.7 to 9%, respectively. As a result, inclusion of MFRM which contained peel and pulp lowered the protein content of the diet thereby making it to be relatively low in crude protein. Though the metabolisable energy of mango fruit reject (3059.55kcal/kg) was also lower than that of maize (the major source of energy in the diets) with a metabolisable energy of 3432 kcal/kg (23), it is not likely to be the reason for the depressed performance of the chicks since the energy requirement was met by all the diets. Feed intake declined at T5 (20% MFRM). This means that palatability was compromised consequent upon

which performance dropped. Although there was no significant difference among treatment groups for protein conversion efficiency on analysis of variance, there was a significant negative relationship ($P<0.05$) between level of MFRM inclusion and protein conversion efficiency (Table 3). Mango peels are known to contain tannins (30) which have been reported to reduce feed consumption by poultry (1). Thus, feed utilization by birds is affected by tannin levels in the diet. Marquardt and others (31) reported that 1.7%, 0.5% and 0% tannins in chick diets resulted in corresponding daily weight gains of 4, 13 and 24g, respectively. This might be responsible for the lowered feed intake and consequent **depressed** weight gain. Also, mango fruit reject meal could only be milled to powder and as its inclusion rate increased, the particle size of the diets containing MFRM observably and progressively became smaller than the control. This may be one of the reasons for **depressed** weights observed on birds fed diet containing 15% and 20% MFRM. Both particle size and shape affect broiler chicken performance (32). Amerah and others (33) reported that the optimum particle size for poultry is 600 μm to 900 μm and the MFRM was milled to powder, therefore lowering the particle size below the choice level ($< 500 \mu\text{m}$) and reducing feed intake. However, reported that particle size uniformity was the most important factor that influences feed utilization (34). These authors reported significantly better gain and feed efficiency with birds fed diets having low particle geometric standard deviation. They went further to explain that birds do not waste energy searching for larger grains when particle size is uniform. This might be one reason why the treatment groups fed 15% and 20% MFRM had depressed weights as earlier stated, since there was variation in particle size as a result of uniformity of particle size disappearing as the level of MFRM increased.

Final body weight range was 436.22 to 564.95g and was significantly **depressed** beyond 10% MFRM in diets. This may not be unconnected to the depressed feed intake which is a function of

weight gain where other factors such as absorption of nutrients are not hindered. Feed conversion ratio of 1.96 to 2.41 is within the acceptable range (35). Water:feed ratio varied between 1.61 to 1.71 and was less than a ratio of 2 or more (36, 37) probably because this experiment was done during the peak of the rainy season which is from August to September in the local climate. Though, water consumption is reported to be a function of dry matter intake (35), environmental temperature and relative humidity are other factors that influence water intake (37). Regressing and correlating feed intake against water consumption, it was found that no significant relationship and concluded that high temperature and not dry matter intake was responsible for the greater percentage of the water consumed (37). Correlation and regression done on parameters some parameters (Table 3) showed that protein efficiency was significantly inversely related to level of MFRM in the diets. Though this protein conversion efficiency was not significantly affected on analysis of variance based on completely randomized design, its steady decrease was not a chance, hence the significant inverse relationship. This may be due to increase in level of anti-nutritional factors with increased level of inclusion of MFRM since it is reported to contain anti-nutrients such as tannin (30). The growth performance result revealed that 10% inclusion was a safe level of inclusion in broiler chick diets. The growth pattern of the chicks across the treatments groups (figure 1) showed an increasing rate all through the experimental period. This agrees with past report (35) and means that the diets did not adversely affect the pattern of growth in broiler chicks.

The effect of MFRM on economics of production is in Table 4. The cost per kg diet steadily decreased (\$0.56 to \$0.50) as the level of MFRM increased. There was no significant difference among the treatments groups for feed cost per kg weight gain. This means MFRM supported weight gain less than maize did, because the cost per kg of maize as an ingredient was far higher

than the cost per kg of MFRM. Therefore, if MFRM had supported weight gain as did maize, the cost per kg weight gain of the birds fed diets containing MFRM would have been lower as the level of MFRM increased in the diets. However, due to the low cost per kg of MFRM, its economic effect became similar to maize. The cost of feed for producing a chick at starter phase was significantly ($P<0.05$) decreased as the percentage of dietary MFRM increased, resulting to significantly higher benefits per chick as the level of MFRM in the diets increased. The total cost of production per starter broiler and the feed cost expressed as a percentage of total cost of producing a chick followed the same trend as the feed cost per chick. Feed cost represented 19.47% to 24.81% of the total cost of producing a chick on average compared to 49.77% to 53.30% costs of day-old chicks expressed as percent of total cost of production. This showed that currently, the cost of day-old broiler chicks constitute about 50% of the total cost of production at the chick stage in Nigeria.

4.0 Conclusion and recommendation

Ten percent (10%) MFRM in broiler diets had no adverse effect on the performance of broiler chicks. It was therefore concluded that mango fruit reject meal is an energy source with very low crude protein and a potential feed resource in broiler chicks' diets.

It is recommended that further studies be done to evaluate the effect of composite mango fruit reject meal on performance of starter broiler chicks between 10 and 15% inclusion of MFRM to establish the optimum level of MFRM in starter broiler diets.

Table 2: Performance of broiler chicks fed diets containing mango fruit reject meal

Parameters	Experimental diets					SEM
	T1	T2	T3	T4	T5	
Initial weight (g)	40.24	40.25	40.25	40.25	40.00	-
Final weight (g)	557.19 ^a	564.93 ^a	538.95 ^a	483.30 ^b	436.22 ^b	17.39*
Total weight gain (g)	516.94 ^a	528.68 ^a	498.70 ^a	443.05 ^b	396.22 ^b	17.28*
Daily weight gain (g)	18.46 ^a	18.74 ^a	17.81 ^a	15.82 ^b	14.15 ^b	0.62*
Daily feed intake (g)	36.94 ^a	36.59 ^a	36.31 ^a	35.40 ^{ab}	32.74 ^b	0.98*
Feed conversion ratio	2.01 ^a	1.96 ^a	2.04 ^a	2.25 ^{a b}	2.41 ^b	0.10*
Daily protein intake (g)	8.18 ^b	9.20 ^a	8.52 ^{ab}	8.12 ^{b c}	7.51 ^c	0.22*
Protein conversion efficiency	2.26	2.05	2.09	1.95	1.89	0.09 ^{ns}
Daily water intake (ml)	59.03	61.32	58.70	58.94	56.04	2.79 ^{ns}
Water:feed ratio (ml/g)	1.61	1.68	1.69	1.59	1.71	0.07 ^{ns}
Livability %	92.5	92.52	87.5	90	95	-

1. SEM= standard error of mean, ^{ns}= no significant difference (P>0.05), *= significant (P<0.05)
2. ^{a,b,c} means in the same row with different superscripts are significantly different (P<0.05),
3. 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 3 : The relationship between performance parameter (y) and mango fruit reject meal levels (x) that was not significant on analysis of variance

Parameter	r	R ²	Prediction equation	S _{yx}	P
Protein conversion efficiency	-0.93	0.87	Y = 2.22 - 0.0168X	0.06**	0.02
Average daily water intake (ml)	-0.71	0.50	Y= 60.5 - 0.167X	1.53ns	0.81
Water/feed ratio (ml/g)	0.33	0.11	Y= 1.63 + 0.0022X	0.06ns	0.59

r=correlation coefficient, R² = coefficient of determination, S_{yx} = standard error of prediction
P = probability, **= significantly related (P<0.05), ns= not significantly related (P<0.05)

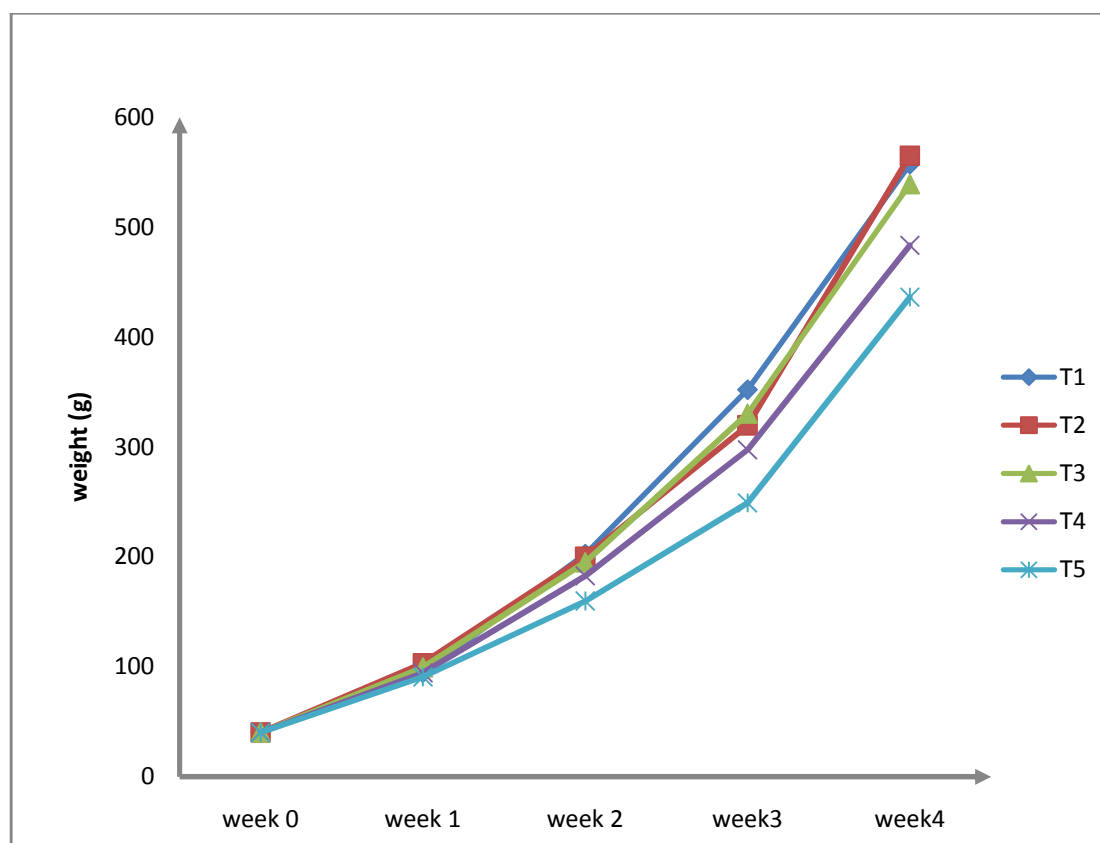


Fig. 1: Growth pattern of broiler chicks

Table 4: Effect of mango fruit reject meal on the economics of producing broiler chicks

Economic Parameters	Experimental diets					SEM
	T1	T2	T3	T4	T5	
Cost of feed consumed Per chick (\$)	0.58 ^a	0.55 ^{ab}	0.52 ^{bc}	0.49 ^c	0.43 ^d	0.01 *
Cost per kg weight gain (\$)	1.13	1.06	1.05	1.06	1.12	0.05 ^{ns}
Operational cost per chick (\$)	0.60	0.60	0.60	0.60	0.60	-
Cost per day-old chick (\$)	1.17	1.17	1.17	1.17	1.17	-
Total cost of production per chick (\$)	2.35 ^a	2.32 ^{ab}	2.29 ^{bc}	2.25 ^c	2.19 ^d	0.01 *
Percentage cost of consumed feed	24.81 ^a	23.82 ^{ab}	22.87 ^{bc}	21.57 ^c	19.47 ^d	0.31 *
Percentage cost of operational cost	25.42 ^d	25.27 ^{cd}	26.08 ^{bc}	26.52 ^b	27.23 ^a	0.10 *
Percentage cost of day-old Chick	49.77 ^d	50.43 ^{cd}	51.05 ^{bc}	51.91 ^b	53.30 ^a	0.31 *

Revenue per chick (\$)	3.30	3.30	3.30	3.30	3.30	-
Benefits per chick (\$)	0.95 ^d	0.98 ^{cd}	1.01 ^{bc}	1.05 ^a	1.11 ^a	0.01*
Cost/benefit ratio	2.47 ^a	2.28 ^b	2.26 ^b	2.15 ^b	1.98 ^c	0.05*

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1. SEM= standard error of mean, ns= no significant difference (P>0.05), *= significant
 2. ^{a,b,c,d} means in the same row with different superscripts are significantly different (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
 3. \$= US dollar valued at ₦197 exchange rate at time of research

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