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Effect of Mashed Lime Fruit Juice on Carcass Yield, Internal Organs, Economics and Nutritive Value of Meat of Broiler Chickens

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ABSTRACT

An experiment was conducted to determine the effect of mashed lime fruit juice on carcass, internal organs weight, nutritive value and the economic benefit of broilers. One hundred and fifty (150) day old unsexed Anak broiler chicks were used. The birds were divided into five treatments (T), each of the treatments was replicated three times with ten birds per replicate. Treatment one was a basal starter diet containing no mashed lime fruit juice which served as control. Treatments (T2 – T5) were formed by adding respectively 10, 15, 20 and 25ml/kg mashed lime fruit juice to the basal starter diet. At the finisher phase the birds were fed finisher diets containing also the same level of the juice as the starter diets. The birds were fed starter diet for the first four weeks and finisher diet for the last three weeks giving seven weeks the experiment lasted. Water was also offered ad libitum throughout the experiment. Results showed that the nutritive value was not affected by the mashed lime juice. Dressed weight, dressing percentage and breast weight were significantly (P<0.05) improved by 20ml/kg, but were reduced (P>0.05) by 25ml/kg. All the levels of the juice produced bigger gizzard and lower gizzard and abdominal fats. The size of small intestine was reduced by all the levels, while above 10ml/kg bile volume was reduced. Both the revenue and gross margin were improved by 20ml/kg. In conclusion, 20ml/kg of mashed lime fruit juice could be added to broiler diets for feed cost minimization and profit maximization.

Keywords: *broilers, carcass, internal organs, economic benefit, mashed lime fruit juice, nutritive value;*

INTRODUCTION

Currently, animal nutritionists especially of swine and poultry have devoted their research interests in search of alternative feed additives to replace antibiotic growth promoters. For decades antibiotics have been a prime feed additive used to improve productivity of swine and poultry especially for their growth. Antibiotics were in the limelight for that long because of their characteristic qualities. It has been reported that antibiotics in the gut reduced the presence of pathogenic micro-organisms such as *Salmonella Spp., Escherichia coli and Campylobacter* giving way for *Lactobacillus Spp* which are friendly bacteria, to thrive especially at the early life of birds (Waldroup *et al*., 1995; Sun, 2004).

In this way the gut is modulated to be able to process without the feed and nutrients being fermented to non-utilizable products such as amines, amides and ammonia. In doing so,the birds can utilize their feed effectively and efficiently, culminating into better performance as earlier reported by Maynard *et al.* (1981).However, despite this good quality, it has been observed that antibiotics have their negative impact because of their residual effect in both animal and human leading to public health concern (Paul *et al*., 2007). For this reason, their use as feed additives are regulated and elsewhere has been banned (Dibner, 2004).

This has necessitated the search for alternatives to antibiotics which plants and their products have been suggested (Windisch *et al*., 2008). Before then, Dibner (2004) gave a detail account of the potential of organic acids to replace antibiotics, because organic acids are also antimicrobial and recommended their use. This was followed by some reports that organic acids such as citric, formic, acetic and ascorbic acids improved the growth of broiler chickens (Nezhad *et al*., 2011; Ndelekwute *et al*., 2015). Nevertheless it has been opined that search for natural source of organic acids is necessary for their sustainability and acceptance (Ndelekwute *et al*., 2015).

According to them citrus *spp* especially their fruits stand a good chance because of their organic acids content and other bioactive compounds such as carotenoids and flavonoids. The peels and seeds contain also essential oils (Bhuiya *et al.*, 2009; Gbolade *et al.*2015). Results of use of lime juice in diets for broilers have been reported. Mohammed (2016) reported that there was no difference in growth and feed: gain ratio when synthetic citric and acetic acids were compared with lime juice in broiler diets. He maintained that dressed percentage was improved by lime juice. Earlier on, Ndelekwute *et al*. (2014) reported contrarily on dressed percentage and suggested that a method should be developed to extract a juice that would contain both the organic acids (citric and ascorbic acids) and other compounds (carotenoids, flavonoids and essential oils) which are contained in the peels and seeds. One of the simple methods will be to mash (grind) whole lime fruits and extract the juice. Therefore the objective of this study was to determine the effect of mashed whole lime fruit juice on carcass, internal organs, nutritive value and economics of broiler chickens.

MATERIALS AND METHODS

Experimental Site

The experiment was conducted at the poultry unit of Teaching and Research Farm of the University of Uyo, Nigeria, located on latitude $5^0$32'N and longitude 7^0 54' E with average annual rainfall of 1500 mm. The average relative humidity during the experiment was 65% and average ambient temperature of 32^{oC}

Processing of Test Mashed Lime Fruit Juice

The lime juice fruits used were purchased from the market. They were cut into pieces and mashed (ground) using a grinding machine. Cheesecloth was used to extract the juice and stored in a refrigerator at temperature of 4 degree Celsius to reduce oxidation.

Experimental Design and Management of Birds

The experiment was conducted on a Completely Randomized Design (CRD). One hundred of fifty (150)day old Anak chicks were used. There were five (5) dietary treatments (T_1, T_2, T_3, T_4, andT_5) each having 30 chicks. Each treatment was replicated three times. Each replicate had 10 birds. The birds were fed basal starter and finisher diets (Table 1) to which were added 0, 10, 15, 20 and 25ml/kg mashed lime fruit juice representing each treatment respectively. The starter diet was fed for the first four weeks and finisher diet for the last three weeks giving a total of seven weeks which the experiment lasted.

On arrival to the farm the chicks were given glucose solution after they were allotted randomly to the various treatments. Heat was provided using kerosene stove for three weeks. All necessary vaccinations against Newcastle and Gumboro diseases were done under the supervision of veterinary personnel. The birds were raised in an open sided deep litter experimental house. The house was divided into pens each measuring 2.0 x 1.0 m.^{2}Feed and water were provided *ad libitum*.

Carcass and Internal Organs Analysis

At the end of the feeding experiment, 30 birds, two from each replicate of a treatment were used for carcass analysis. The birds were fasted for 18 hours. After weighing of each bird, it was slaughtered by severing the throat with a sharp knife.Hot water was used to loosen the feathers by immersing in 60^{o}C hot water for 30 seconds According to Scott *et al.* (1969) as reported by Ndelekwute*et al.* (2014). The loosed feathers were immediately plucked by hand and washed.

Carcass processing was done as detailed by Ndelekwute *et al*. (2014). The legs, head and the neck were cut and the crop gently removed. The abdomen was cut open and holding the gizzard the viscera was pulled out. The abdominal fat was removed. The wings were removed by cutting anteriorly, severing at the humeo-scapula joint; the drumstick was cut at the tibio-tarso-metatarsus and *humeo-tibia* joints; the thigh cutting was at the *humeo-tibia* and *humeo-ileum* joints. To separate the back cut (distance between the *ileum* and *ischium*) and the breast meat (distance between the sternum and the keel), a cut was made across the rib joints connecting them. Applying a gentle force, they were separated from each other. The internal organs were separated. Weights of the carcass parts, abdominal fat and internal organs were determined. Dressed carcass weight, internal organs and abdominal fat were expressed as percentage live weight while cut-parts were expressed as percentage dressed weight according to Abaza *et al*. (2008).

Table1. *Ingredient and Nutrient Composition of Basal diets*

Ingredients (%)	Starter	Finisher
Maize	51.00	50.00
Soybean meal	30.00	28.00
Palm kernel cake	10.00	15.30
Fish meal	4.00	2.00
Bone ash	4.00	4.00
Salt	0.25	0.25
Lysine	0.20	0.10
Methionine	0.20	0.10
Premix	0.35	0.25
Total	100	100.00
Nutrient composition (%)		
Crude protein	22.00	20.20
Ether extract	3.98	4.68
Crude fibre	4.63	5.06
Total ash	4.40	7.17
Lysine	1.25	1.01
Methionine	0.43	0.38
Calcium	1.25	1.34
Phosphorus	1.07	1.03
Energy (KcalME/kg)	2866	2824

***premix supplied per kg starter diet:** *vitamin A 15,000 i.u., vitamin D_3 13000 i.u, thiamine 2mg, riboflavin 6mg, pyridoxine 4mg, niacin 40mg, cobalamine 0.05g, biotin 0.08mg, choline chloride 0.05g, manganese 0.096g, Zinc 0.06g, iron 0.024g, copper 0.006g, iodine 0.014g, selenium 0.24mg, cobalt 0.024mg and antioxidant 0.125g.*

***premix supplied per kg finisher diet:** *vitamin A 10, 000 i.u., vitamin D_3 12,000 i.u. vitamin E 20 i.u., vitamin K2.5mg, thiamine 2.0mg, riboflavin 3.0mg, pyridoxine 4.0mg, niacin 20mg, cobalamin 0.05mg, pantothenic acid 5.0mg, Folic acid 0.5mg, Biotin 0.08mg, choline chloride 0.2mg, manganese 0.006g, Zinc 0.03g, copper 0.006g, iodine 0.0014g, selenium 0.24g, cobalt 0.25g and antioxidant 0.125.*

Determination of Carcass Nutritional Value

Carcass nutritional value was determined by conducting the proximate analysisof the meat. The pH of the meat was also determined. One bird from each replicate was slaughtered and the feathers removed by dry method. That is, the feathers were plucked without using hot water in order not to exaggerate the moisture content of the meat (Ndelekwute*et al*., 2016). The meat from the breast, thigh and drumstick were used to determine the crude protein, ether extract, crude fibre and ash content. Skin of each mentioned cut parts was gently removed and 20g of meat from each was removed and all homogenized together. Proximate determination was according to AOAC (2000).

The meat pH was determined by dipping the electrode of pH meter (Havana Micro computer pH meter, model H18424, made in Romania) into 10g of the homogenized meat which was mixed with 90ml deionized water and the reading taken.

Data Transformation and Statistical Analysis

Data collected and analyzed in percentages were transformed using Arc sine method as outlined by Preston (1996). All data were then subjected to analysis of variance (ANOVA). Significant means were separated using Duncan New Multiple Range Text according to Steel and Torrie (1980).

Economic Analysis

Economic analysis was performed according to Ndelekwute*et al*. (2016) as shown below.

Cost/kg Feed = Summation of (price per kg of eachfeed ingredient x its proportion in the feed formula) ÷ 100.

Feed cost/bird = cost/kg feed x total feed intake + cost of juice consumed per bird.

Feed cost/weight gain = cost/kg feed x feed: gain ratio

Feed cost differential = feed cost of control – Feed cost of individual treated groups.

Feed cost benefit= feed cost of control – Feed cost of individual treated groups X 100

Feed cost of individual treated group 1

Revenue/bird = price/kg dressed carcass x dressed carcass weight

Gross margin/bird = revenue/bird – feed cost/bird.

Results and Discussion

Carcass Yield

Table 2 shows the effect of mashed lime fruit juice on carcass yield of finisher broilers. It indicated that all the parameters; dressed weight, dressing percentage, breast cut, thigh, drumstick, back-cut, wing, gizzard, gizzard fat and abdominal fat were significantly ($p<0.05$) influenced. Both the dressed weight and dressing percentage were significantly and positively influenced by 20ml/kg compared to control and 25ml/kg. At 25ml/kg, the two parameters were negatively affected. There were no significant differences ($p<0.05$) in both dressed weight and dressing percentage of control, 10 and 15ml/kg. Dietary level of 25ml/kg juice significantly ($p<0.05$) reduced breast weight compared to other levels and control which were similar. However, thigh weight was significantly higher at 25ml/kg juice compared to control, 10ml/kg and 15ml/kg, but was similar to 20ml/kg.

Table2. *Effect of Mashed Lime Fruit Juice (ml/kg Diet) on Carcass Yield of Broilers*

Parameters	T_1(0)	T_2(10)	T_3(15)	T_4(20)	T_5(25)	SEM
Dressed weight (g)	1174^{c}	1258^{b}	1282^{b}	1432^{a}	1108^{d}	60.39
Dressing percentage (%)	65.12^{b}	68.32^{ab}	67.09^{ab}	70.23^{a}	60.23^{c}	4.77
Breast weight (%)	33.61^{a}	33.02^{a}	34.66^{a}	33.01^{a}	29.99^{b}	0.81
Thigh Weight (%)	17.93^{c}	18.77^{bc}	18.89^{bc}	20.65^{ab}	21.30^{a}	0.61
Drumstick (%)	12.81^{b}	13.26^{b}	11.80^{b}	13.24^{b}	15.28^{a}	0.51
Back-cut (%)	25.52^{ab}	27.48^{a}	23.69^{bc}	21.88^{c}	22.51^{c}	0.82
Wing (%)	9.95^{b}	10.48^{ab}	10.97^{ab}	11.13^{a}	10.68^{ab}	0.31
Gizzard (%)	1.80^{b}	2.34^{a}	2.38^{a}	2.36^{a}	2.38^{a}	0.09
Gizzard fat	0.34^{a}	0.10^{b}	0.03^{b}	0.10^{b}	0.01^{b}	0.08
Abdominal fat	1.03^{a}	0.70^{b}	0.64^{b}	0.54^{a}	0.25^{c}	0.29
Mortality (%)	2(6.67%)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	-

abc means along the same row with different superscripts are significantly ($p<0.05$) different. SEM: Standard error of mean

Also similarities were observed between 10ml/kg, 15ml/kg and 20ml/kg. Weight of thigh in 10mlkg and 15ml/kg was the same as control. A significant difference was observed in drumstick which was higher in dietary group fed 25ml/kg compared to other treated groups including control which were similar. The weight of the back-cut was best at 10ml/kg compared to 15ml/kg, 20ml/kg and 25ml/kg which were similar. Nevertheless, similarities occurred between 10ml/kg and control.

Feeding of 20ml/kg led to higher weight of wing compared to control and there was no difference among the treated groups. Inclusion of 10ml/kg, 15ml/kg and 25ml/kg produced similar results as control. All the inclusion levels improved gizzard weight over the control. There was no difference among the treated groups. The test mashed lime fruit juice significantly ($p<0.05$) reduced gizzard fat at all levels. Observing the weight of abdominal fat, it was noticed that it was reduced by all the inclusion levels with 25ml/kg recording the least.

From the present result, it can be established that addition of mashed lime fruit juice did not affect total meat yield (dressed weight) negatively. Generally it can be ascertained that the juice did not show negative impact on the cut parts. The reduction in dressed weight, dressing percentage and breast weight at 25ml/kg could be as a result of the reported reduction of body fat in human by lime juice (Jordan, 2015). Another important dressed cut-part that the juice improved at all levels was the gizzard which could be linked to the ability of the juice to reduce fat deposit on the gizzard. This could have improved gizzard protein accretion.

Reduction in abdominal fat by the juice could be that the juice gave a platform for efficient energy utilization giving no room for excess energy to be converted to fat and deposited in the abdomen. This could have made possible by the content of lime fruits which include essential oils, carotenoids, flavonoids, fatty acids, citric and ascorbic acids. This was in line with

Windisch *et al*. (2008) who stated that essential oils improved nutrient utilization for better performance. Also Dibner (2004) had stressed the importance of organic acids such as citric acids in nutrient utilization which will result to better productivity.

Internal Organs

The effect of mashed lime fruit juice on the internal organs of finisher broilers is presented in Table 3. It indicates that heart, small intestine and bile volume were significantly different ($p<0.05$). Also, there was no difference ($p>0.050$ in liver, *pancreas*, kidney, spleen and *caecum*. From the table, it was observed that above 10ml/kg the weight of heart was increased. There was no difference between the weight of control and 10ml/kg. The small intestine was significantly bigger in 25ml/kg group than other treated groups and control which were all similar. Bile volume followed the same trend as heart where the control and 10ml/kg were similar but higher than other treated groups which were also the same.

Table3. *Effect of Mashed lime Juice (ml/kg Diet) on Internal Organs of finisher broiler chickens*

Parameters	T_1(0)	T_2(10)	T_3(15)	T_4(20)	T_5(25)	SEM
Liver (%)	1.78	1.53	1.54	1.63	1.85	0.20
Pancreas (%)	0.23	0.26	0.21	0.21	0.26	0.03
Kidney (%)	0.19	0.22	0.28	0.17	0.20	0.02
Spleen (%)	0.08	0.06	0.05	0.07	0.06	0.001
Heart (%)	0.35^b	0.31^b	0.41^a	0.38^a	0.42^a	0.03
Small Intestine (%)	4.15^a	3.14^b	3.12^b	3.11^b	3.08^b	0.21
Caecum (%)	0.64	0.52	0.75	0.87	0.70	0.12
Bile Volume (%)	0.12^a	0.13^a	0.09^b	0.07^b	0.08^b	0.02

ab means along the same row with different superscripts are significantly ($p<0.05$) different.

SEM: Standard error of means.

Insignificant differences in liver, pancreas, kidney and spleen is an indication that the mashed lime fruit juice was not detrimental to this important organs. This could have been the reason why carcass yield was not significantly altered. Smaller intestine posted by all the levels of the juice was according to the report of Ndelekwute *et al*. (2015b) which stated that lime juice reduced the weight of small intestine and ascribed it to antibacterial effect of lime juice. Reduction of bile volume by levels above 10ml/kg was not in line with the report of Roizman (2017).

In addition, report of Ndelekwute *et al*. (2015b) indicated improved bile volume by lime juice fed to broilers. Mortality which was not recorded by mashed lime juice treated groups is an indication that the juice could have imparted positively on the health of the chickens.

Lime juice has been reported to be antibacterial and has been used to sanitizer drinking water and according to Organic Facts (2018) it is used to control Vibrio cholera and other bacteria in human.

Table4. *Effect of Mashed Lime Fruit Juice (ml/kg diet) on Nutritive Value and pH of Broiler meat*

Parameter	**T_1(0)**	**T_2(10)**	**T_3(15)**	**T_4(20)**	**T_5(25)**	**SEM**
Crude protein (%)	23.85	23.90	23.98	23.88	23.87	4.01
Ether extract (%)	1.05	1.01	1.06	1.09	1.11	0.21
Crude fibre (%)	0.20	0.21	0.19	0.18	0.21	0.05
Ash (%)	1.22	1.25	1.19	1.20	1.23	0.09
pH	6.06	5.98	5.97	6.02	5.99	0.61

Nutritive Value of Meat

The effect of mashed lime fruit juice on the nutritive value of the carcass is indicated on Table 4. The values of protein, ether extract, crude fibre, ash and pH did not indicate significant differences between the control and treated groups. Similarity in pH of the different meat samples strongly indicate that the acid contained in the juice did not accumulate in the meat. This revealed the fact that the organic acids could have well metabolized by the body.

Economic Benefit of Mashed Lime Fruit Juice on Broilers

The economy of mashed lime fruit juice on finisher broiler chickens is shown in Table 5.

There was no difference in cost per kilogramme of feed because the birds consumed the same basal diet irrespective of treatment group. The result also shows that feed cost per bird was lowered by 20 and 25ml/kg despite extra cost of the juice indicating effectiveness of the juice for productivity.

Feed cost per weight gain was reduced as the level of the juice was increased. The lower feed cost per weight gain is advantageous in that it took lower feed cost to produce a unit gain in weight when juice was added to the feed. The feed cost differential of 20 and 25ml/kg indicated positive values which resulted to 1.19 and 2.34% feed cost benefit respectively. The revenue and gross margin were improved by all the levels except 25ml/kg, but highest in 20ml/kg. The result of the economic benefit is in accordance with Ndelekwute *et al*. (2015b) who stressed the economic importance of lime juice in broiler production.

Table5. *Effect of Mashed Lime Fruit Juice (ml/kg diet) on*

Parameters	**T_1(0)**	**T_2(10)**	**T_3(15)**	**T_4(20)**	**T_5(25)**
Juice consumed/bird(₦)	0.00	5.50	8.44	11.67	14.23
Cost/kg feed (₦)	103.47	103.47	103.47	103.47	103.47
Feed Cost/bird (₦)	248.40	250.87	250.50	245.49	242.71
Feed cost /gain (₦)	355.59	353.04	328.00	310.41	316.70
Revenue / bird (₦)	1409	1500	1538	1718	1330
Gross margin/bird (₦)	1161	1249	1288	1473	1087
Feed cost differential/bird (₦)	-	-2.07	-2.10	+2.91	+5.69
Feed cost benefit/bird (%)	-	0.83	0.84	1.19	2.34

(₦)= Naira (Nigeria currency: ₦305.00 = USD1.00)

CONCLUSION

Juice from mashed lime fruits at below 25ml/kg in this study proved to be non-detrimental to the meat yield,internal organs weights,nutritive value and economic benefit of the broiler chickens. Addition of the juice led to profit maximization and no mortality recorded by mashed lime juice groups is added advantage. Nomortality means that more meat could be produced using the juice.Therefore addition of 20ml/kg mashed lime fruit juice in diets for broiler chickens could be regarded as good practice and is advocated.

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