Review Article

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www.imedpub.com

Journal of Animal Sciences and Livestock Production
ISSN 2577-0594

2021
Vol.5 No.4:002

Fresh Grape Fruit Juice Improved the Productivity of Broiler Chickens under Intensive Management

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Citation: Ndelekwute EK, Unah UL, Ogondoekpe R (2021) Fresh Grape Fruit Juice Improved the Productivity of Broiler Chickens under Intensive Management. J Anim Sci Livest Prod Vol.5 No.4: 002.

Received date: April 30, 2021; **Accepted date:** May 13, 2021; **Published date:** May 20, 2021

Abstract

Organic acids are potentially added to broiler diets for improved growth and their natural sources could be explored. Hence a study was carried out in Completely Randomized Design (CRD) to determine the effect of unripe grape juice on growth, apparent nutrient digestibility and meat yield of broiler chickens. One hundred and eighty (180) Ross day old broiler chicks were used. There were five dietary treatments (T1-T5) with T1 as the control. The diets contained grape juice 0 (10%), 10 (1.0%), 15 (1.50%), 20 (2.0%) and 25 ml/kg (2.50%) representing the treatments respectively for both starter and finisher diets. The ascorbic and citric acid content of the juice were determined. Experimental feeding started at day one and lasted for 49 days. Feed and water were offered ad libitum. Results showed that the grape juice contained ascorbic (3.25%) and citric acids (4.13%) with low pH (4.32). At both starter and finisher phases 1.50, 2.0 and 2.50% improved live weight and feed: gain ratio. At the starter phase feed intake was not affected (P>0.05%), but it was reduced by 2.50% at the finisher phase. Digestibility of protein, ether extract, crude fiber and energy utilization was improved by 15, 20 and 25 ml/kg. Also dressed percentage and breast weights were better in 2.0 and 2.50%. It is hence concluded that 2.0% grape juice could be added to diets for broiler chickens for better performance.

Keywords: Nutrient digestibility; Broiler chickens; Meat yield

Introduction

Over the years poultry farmers and nutritionists were worried about high cost of feed and low maximization of profits. Various feeding strategies such as use of potential non-conventional feedstuffs had been considered in order to reduce cost of production because of low prices which non-conventional feedstuffs attract. As researches were going on to unveil the potentials of these feed ingredients, the World Health Organization (WHO) banned the use of antibiotics which hitherto is used as growth promoters in meat animals [1]. This was followed by their ban by European Union in 2006 [2]. Antibiotics are decade long ingredients introduced into feeds for better daily weight gain and conversion of feed to meat. These antibiotics perform by modulating the gut thereby improving the health of the gut. The avian gut plays an important role in the digestion and absorption of nutrients, while exerting an innate barrier function [3]. According to Yang M et al. poor gut health has been observed to have led the broiler industry to face more challenges and this resulted in poor performance of broiler chickens thereby putting more pressure on farmers [3,4].

This critical challenge has necessitated search for ingredients .that can offer alternative to antibiotics. Many reports have suggested among others probiotics, prebiotics, spices, herbs, essential oils, feed grade enzymes and organic acids [4,5-9]. Among these alternatives and recently organic acids are in the prominence. Organic acids such as ascorbic, acetic, butyric, citric and formic acids are weak acids which disassociate in water [1]. They occur in nature in plants and animals and some are products of metabolic processes in the body like citric acid in Kreb cycle, and the short chain fatty acids such as acetic and butyric acids produced by fermentation in the gut. In plants kingdom, citrus species such as lime, lemon and grape fruits are good sources of citric and ascorbic acids [10]. It has been advocated that these sources of organic acids should be explored in poultry nutrition because of their availability, accessibility and sustainability by local farmers [10]. They are rich in ascorbic and citric acids.

Consequently and recently several reports had it that growth performance of broilers, nutrient digestibility and dressed carcass were improved by products of citrus species which include; lime juice, lemon juice, mashed lime juice, dry peel meal and pomade [11-13]. Therefore the objective of this research was to determine the dietary effect of grape juice on growth, apparent nutrient digestibility and meat yield of broiler chickens.

Literature Review

Site of experiment

The experiment was conducted at the Teaching and Research Farm of Department of Nutrition and Forage Science of the Michael Okpara University of Agriculture Umudike; Abia State, Nigeria. Umudike is situated on latitude 5°281N and longitude 7 °321E and lies at an altitude of 122 m above sea level, with average rainfall of 2000 mm. The average relative humidity

during the experiment was 65% and average ambient temperature was 3°C.

Processing of Grape juice

The grape fruits used to process the juice were obtained from a private citrus farm and processed according to Ndelekwute EK et al. as outlined [14]. The fruits were washed and cut into two with a sharp knife. The juice was expelled manually by squeezing the cut halves with the hand. The juice was collected into a container. The juice containing the seeds and some pulp was filtered in order to have a clear juice. The juice was stored in the refrigerator at the temperature of 4°C. According to Ndelekwute EK et al. this was to reduce oxidation and fermentation [14].

Determination of pH, citric and ascorbic acids content of Grape Juice

This was carried out as described by Ndelekwute EK and Enyenihi GE using a pH Meter (PHep, Hanna Instruments, Italy) by dipping the meter electrode into a glass tube containing 10 ml of the lemon juice [10]. The number at which the pointer was indicating was taken as the pH. The juice was also analyzed for citric and ascorbic acids content by titration according to Novella T [15].

Experimental design experimental diets

The total number of day old chicks (Ross strain) used was one hundred and eighty (180) randomly grouped into five (5) treatments (T1–T5). Each treatment group was further sub-grouped into three as replicates and each replicate contained 12 birds. The experiment was arranged in Completely Randomized Design (CRD). Five experimental starter and finisher diets were formulated and fed to the birds ad libitum. Water was also offered ad libitum. Diet one (T1) which formed the control contained no grape juice, T2–T5 contained 10 ml (1.0%), 15 ml (1.50%) 20 ml (2.0%) and 25 ml/kg (2.50%) grape juice respectively. Both the starter and finisher diets contained the same levels of the grape juice. The birds were exposed to diets for 49 days from day old. The statistical model used was:

$Yij=\mu+Ti+eij$

Where: Yij=Single observation

μ=Overall mean

Ti=Treatment effect (grape juice)

eij=Random error

Diets formulated were soya bean-maize based diets which met the nutrient requirements of broiler chickens in Nigeria as shown in **Tables 1 and 2** [16].

Ingredients (%)	T1	T2	T3	T4	T5
	0.00%	-1.00%	-1.50%	-2.00%	-2.50%
Maize	52	52	51	50	50
Soya bean meal	30	30	30	30	30
Palm kernel cake	10	10	9.5	10	9.5
Fish meal	4	4	4	4	4
Bone meal	3	3	3	3	3
Mashed grape juice	0	1	1.5	2	2.5
Salt	0.25	0.25	0.25	0.25	0.25
Lysine	0.2	0.2	0.2	0.2	0.2
Methionine	0.2	0.2	0.2	0.2	0.2
Premix	0.35	0.35	0.35	0.35	0.35
Total	100	100	100	100	100
Nutrient composition (%)					
Crude protein	22.58	22.58	22.5	22.48	22.36
Ether extract	4.78	4.77	4.78	4.77	4.77
Crude fibre	4.87	4.85	4.82	4.79	4.77
Ash	6.63	6.62	6.63	6.63	6.63
Lysine	1.24	1.24	1.24	1.24	1.23
Methionine	0.38	0.38	0.38	0.38	0.37
Calcium	1.22	1.22	1.22	1.22	1.22
Phosphorus	0.85	0.85	0.85	0.84	0.84
Energy Kcal ME/kg	2888	2856	2855	2834	2834

Table 1: Composition of experimental starter broiler diets.

1 kg of premix contains: Vitamin A (10,000,000 iu), vitamin E(16,000 mg),vitamin k3 (800 mg), vitamins B12 (22,000 mg), niacin (22,000 mg), vitamin B2 (10 mg), folic acid (400 mg), biotin (32 mg), chlorine chloride (200,000 mg) zinc (32,000 mg) iodine (600 mg), cobalt (120 mg), selenium (40 mg), antioxidant (48,000 mg)

Management of birds

The welfare management of the birds was according to the ethics that govern animal welfare as approved by the Research and Ethics Committee of the University. The routine management was according to Ndelekwute and Enyenihi and the Ndelekwute as described [10,14]. At day old, the treatment effect chicks were weighed, after which they were transferred into the

brooding room. They were randomly separated into treatment groups making sure they have similar group average weight. Glucose was added to their drinking water the first day for faster energy intake. From the second day, vitamin and mineral preparation was added to their drinking water for seven days. Heat was supplied to the birds for three weeks by kerosene stove placed under a hover. Feed and water were supplied free choice. Starter feed was fed for four weeks and finisher feed for three weeks. The birds were vaccinated against Newcastle and Gumboro diseases.

1 kg premix contained: vitamin A (10,000,000 iu), vitamin D3 (1,000,000 iu), vitamin E (16,000 mg), vitamin k3 (800 mg), vitamins B2 (22,00 mg), niacin (22,00 mg), vitamin B12 (10 mg), Folic Acid (400 mg) Biotin (32 mg), Chlorine chloride (200,00 mg), Zinc (32,000 mg) iodine (600 mg), cobalt (12 mg), selenium (40 mg), antioxidant (48,000 mg).

Ingredients (%)	T1	T2	T3	T4	T5
	0.00%	-1.00%	-1.50%	-2.00%	-2.50%
Maize	52	52	51	51	50.5
Soya bean meal	28	28	28	28	28
Palm kernel cake	14.3	13.3	13. 80	13.3	13.3
Fish meal	2	2	2	2	2
Bone meal	3	3	3	3	3
Mashed grape juice	0	1	1.5	2	2.5
Salt	0.25	0.25	0.25	0.25	0.25
Lysine	0.1	0.1	0.1	0.1	0.1
Methionine	0.1	0.1	0.1	0.1	0.1
Premix	0.25	0.25	0.25	0.25	0.25
Total	100	100	100	100	100
Nutrient composition (%)					
Crude protein	20.23	20.23	20.15	20.1	20.02
Crude Fibre	6.64	6.62	6.59	6.57	6.54
Ether extract	4.78	4.79	4.77	4. 75	4.75
Ash	5.23	5.27	5.27	5.27	5.27
Lysine	1	1	1	1	1
Methionine	0.32	0.32	0.32	0.32	0.32
Calcium	1.01	1.01	1.01	1.01	1.01
Phosphorus	0.72	0.72	0.72	0.72	0.72
Energy Kcal ME/kg	2930	2916	2916	2902	2902

Table 2: Composition of experimental finisher broiler diets.

Collection of data

Live weight was measured weekly and feed intake daily. The live weight and feed intake were used to calculate the feed: gain ratio and protein efficiency ratio.

Digestibility trial

The apparent nutrient digestibility was determined according to as modified by [14,17]. One bird from each of the replicates was used for the digestibility trial. There were housed in metabolism cages that were thoroughly washed and disinfected. The birds were acclimatized for four days during which their respective feeds were given to them. Thereafter, they were fed ad libitum, a known quantity of their respective diets for another four days during which faecal collection was carried out daily. Plastic trays were placed under the cages to collect the faeces. Collected samples were quickly taken to the laboratory and dried to a constant weight in an oven. The proximate composition was determined according to the methods of AOAC [18]. The apparent nutrient digestibility was calculated as shown below;

Apparent nutrient digestibility (%)=Nutrient i n feed–nutrient in faces x 100

Nutrient in feed 1

Carcass analysis

At the end of the feeding experiment, 15 birds, one from each replicate of a treatment were used for carcass analysis. The birds were fasted for 18 hours. The birds were slaughtered by severing the throat with a sharp knife after recording the weight. The killed birds were immersed in 60O℃ hot water for 30 seconds according to Scott, et al. [19]. The feathers were plucked by hand. Carcass processing was done as detailed by Ndelekwute et al. [20]. The legs, head and the neck were cut and the crop to gently removed. The abdomen was cut open and holding the gizzard the viscera was pulled out. The abdominal fat was removed. The different carcass parts (breast, thigh, drumstick, wing and back) were separated. Weights of the carcass parts and abdominal fat were noted. Dressed carcass weight, and abdominal fat were expressed as percentage live weight while cut-parts were expressed as percentage dressed weight as reported by Abaza et al. [21].

Statistical analysis

All data collected were subjected to One Way Analysis of Variance (ANOVA). Significant means were separated using Duncan New Multiple Range Test according to Snedecor and the Cochran [22].

Results

The results obtained indicated that the grape juice was acidic with pH value of 4.32 this emanated from its content of citric acid (4.13%) and ascorbic acid (3.25%). Considering the effect of the juice on growth traits, at the starter phase **Table 3.** grape juice significantly (P<0.05) influenced final live weight, daily, feed: gain ratio a nd protein efficiency ratio. Its effect on total feed intake, daily feed intake and daily protein intake was not significant (P>0.05). Beyond 1.0% (10 ml/kg) the effect of grape juice clearly manifested relative to the control. Live weight and feed: gain ratio showed similar trend. Addition of 1.50, 2.0 and 2.50% grape juice improved final live weight, d aily weight gain and feed: gain ratio a nd protein efficiency ratio. Except the result of protein efficiency where th e va lue of 1. 0% was significantly (P<0.05) better th an th e control, th e va lues in live weight, daily gain and feed: gain ratio recorded i n 1.0%treatment group were similar (P>0.05) to those of control.

At the finisher phase **Table 4** above 1.0% inclusion, grape juice significantly (P<0.05) produced better final live weight and feed: gain ratio compared to the control. There were no significant (P>0.05) differences between control and 1.0% in final live weight and feed: gain ratio. There were no differences (P>0.05) in daily weight gain, daily feed intake and protein efficiency ratio. However, 2.5% affected total feed intake and daily protein intake negatively (P<0.05).

Parameters	T1	T2	T3	T4	T5	SEM
	0.00%	-1.00%	-1.50%	-2.00%	-2.50%	
Initial live weight (g)	44.1	44.5	44.98	44	44.65	4.2
Final live weight (g)	705.00^{b}	720.00^{b}	800.00^{a}	801.00^{a}	800.00^{a}	71.04
Daily weight gain (g)	23.60^{b}	25.71^{ab}	26.96^{a}	27.04^{a}	26.98^{a}	6.21
Total feed intake (g)	1054	1052	1064	1070	1100	77.08
Daily feed intake (g)	37.64	37.57	38	38.21	39.29	4.44
Feed: gain ratio	1.59	1.46^{ab}	1.41^{b}	1.41^{b}	1.46^{b}	0.09
Dailyprotein intake (g)	8.45	8.48	8.55	8.59	8.79	1.02
Protein efficiency ratio	2.80^{b}	3.03^{a}	3.15^{a}	3.15^{a}	3.15^{a}	0.18

ab Means along the same row with different superscripts are significantly different (P<0.05).

Table 3: Effect of grape juice on growth performance of starter broiler chicks.

Effect of grape juice on apparent nutrient digestibility of broilers

Effect of grape juice on apparent nutrient digestibility is shown on **Table 5** The Except crude fibre other digestibility parameters were significantly (P<0.0%) influenced by grape juice. Above 1.50% (15 ml/kg) digestibility of dry matter, crude protein, ether extract, ash and energy utilization were improved relative to control. It was further noticed that there were no significant (P>0.05) differences in dry matter and crude protein digestibility of 1.0%. 150% and control, while 1.50% produced better ether extract, ash and energy utilization than 1.0% and control. Nevertheless, There were no significant (P>0.05) differences between 1.0% and control in all the parameters.

Parameters	T1	T2	T3	T4	T5	SEM
	0.00%	-1.00%	-1.50%	-2.00%	-2.50%	
Initial live weight (g)	705^{b}	720.00^{b}	800.00^{a}	801.00^{a}	800.0^{a}	71.04
Final live weight (g)	2100^{b}	2136^{b}	2232^{a}	2250^{a}	2245^{a}	86.34
Daily weight gain (g)	66.43	67.43	68	69	69	5.04
Total feed intake (g)	3750^{a}	3748^{a}	3704^{a}	3710^{a}	3502^{b}	155
Daily feed intake (g)	179	178	176	177	167	20.77
Feed: gain ratio	2.69^{a}	2.64^{a}	2.24^{b}	2.34^{b}	2.42^{b}	0.38
Daily protein intake (g)	36.21^{ab}	36.10^{ab}	35.46^{ab}	35.58^{ab}	33.43^{b}	2.51
Protein efficiency ratio	1.83	1.78	1.91	1.9	2.06	0.43

ab Means along the same row with different superscripts are significantly different (P<0.05).

Table 4: Effect of grape juice on growth performance of finisher broiler chickens.

Parameters	T1	T2	T3	T4	T5	SEM
	0.00%	-1.00%	-1.50%	-2.00%	-2.50%	
Dry matter (%)	65.04^{b}	66.11^{b}	65.04^{b}	70.34^{a}	72.50^{a}	4.88
Crude protein (%)	65.00^{b}	68.29^{b}	76.35^{a}	78.33^{a}	77.34^{a}	5.05

Crude fibre (%)	42	42.08	42.65	42.45	42.31	4.26
Ether extract (%)	75.62^{b}	76.19^{b}	87.14^{a}	86.19^{a}	85.90^{a}	7.75
Ash (%)	51.16^{b}	53.49^{b}	66.79^{a}	65.81^{a}	66.79^{a}	6.11
Energy utilization (%)	68.012^{b}	67.89^{b}	75.44^{a}	74.89^{a}	76.08^{a}	5.67

ab Means along the same row with different superscripts are significantly different (P<0.05).

Table 5: Effect of grape juice on apparent nutrient digestibility of broiler chickens.

Effect of grape juice on meat yield of broilers

The effect of grape juice on meat yield or carcass of the broiler chickens is indicated in **Table 6** Grape juice had no effect (P>0.05) on thigh, drumstick, back-cut and wing. However, significant (P<0.0%) effects were recorded on dressed percentage, breast weight and abdominal fat.

Above 1.0% the dressed percent was improved over the control. There was no difference in dressed percentage of 1.0% and control. More also, 2.0 and 2.50% levels positively influenced breast weight generating better breast weights compared to 1.0, 1.50% and control which were similar. Only 2.50% significantly (P<0.05) reduced the abdominal fat. The influence exerted by 1.0, 1.50 and 2.0% on abdominal fat was similar (P>0.05) to that of control.

Parameters	T1	T2	T3	T4	T5	SEM
	0.0 (%)	-1.00%	-1.50%	-2.00%	-2.50%	
Dressed percentage	64.33^{b}	63.00^{b}	69.51^{a}	68.14^{a}	68.04^{a}	4.75
Breast weight (%)	34.99^{b}	36.48^{b}	36.65^{b}	40.56^{a}	41.79^{a}	3.86
Thigh (%)	16.24	15.22	15.56	15.56	15.12	2.06
Drumstick (%)	12.67	12.8	13.06	13.45	12.3	2.58
Back-cut (%)	26.03	25.07	23.05	23	24.06	2.09
Wing (%)	11.01	12.03	11.71	11.9	10.28	1.88
Abdominal fat (%)	1.21^{a}	1.20^{a}	1.22^{a}	1.02^{a}	0.56^{b}	0.31

abc. Means along the same row with different superscripts are significantly (P<0.05) different

Table 6: Effect of grape juice on meat yield of Broiler chickens.

Discussion

The result of pH, ascorbic and citric acid estimation is an indication that grape juice is acidic in nature containing organic acids. This in line with the reports of and that citrus juices such as lime, lemon and grape have low pH and contain citric and ascorbic acids [11,14]. Due to this opined that citrus juices have the potential to be used in diets for broiler chickens for better performance [12].

Effect of grape juice on final live weight and feed: gain ratio at both the starter and finisher phases is a clear indication of the viability of its bioactive composition especially citric and ascorbic acids. It showed that grape juice could have aided in nutrient utilization as shown in the apparent nutrient digestibility of the vital nutrients (crude protein, ether extract and energy utilization). Good example is the lower total feed intake and better final live weight recorded by 2.50% at finisher phase. It is expected that lower feed intake would have resulted in poor live weight, but reverse was the case. It is a clear indication of potential of grape juice to aid feed utilization. According to Olomu jm and Oluyemi ja and Roberts fa live weight or growth has positive relationship with nutrient digestibility [16,23].

The result of the apparent nutrient digestibility recorded in this present work which was improved by grape juice could have been due to the acidic nature of the juice. For instance acidic gastric medium is needed for proper protein digestion [1].

Several explanations have been given on the mode of action of organic acids in poultry nutrition. It has been reported that organic acids are antibacterial both in the feed and in the gastro intestinal tract. Going by this, pathogenic bacteria like E. coli, salmonella and campylobacter which are implicated in fermentation in gut are controlled [23,24]. Other of action includes improvement on villi height, villi number, reduction of gastric pH and increase in intestinal secretions [1,2,4].

Improved meat yield especially dressed percentage and breast weight could be linked to better digestibility and energy utilization. Energy is vital for building of muscle tissues in the body. Generally the present report is in accordance with the reports of [1,10,15].

Conclusion

The present results clearly present grape juice as a potential feed additive for better broiler growth and carcass performance. The effects of grape juice on the live weight, digestibility and meat yield especially at 2.0 and 2.50% inclusion levels were encouraging results and clearly revealed the potentials of grape as natural growth promoter. Whereas grape fruits are around in our ecosystems and its production can be sustained, it could be concluded that 20 ml/kg or 2.0% of grape juice be included in diets for broiler chickens for growth and meat yield.

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