INNSPUB

International Journal of Biosciences | IJB |
ISSN: 2220-6655 (Print) 2222-5234 (Online)
http://www.innspub.net
Vol. 24, No. 3, p. 179-186, 2024

RESEARCH PAPER OPEN ACCESS

# Levels of Buga tuber meal (*Dioscorea esculenta*) as replacement of corn in broiler ration

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**Key words:** Buga meal, Corn, Energy, Feed conversion ratio, Formulated ration

http://dx.doi.org/10.12692/ijb/24.3.179-186 Article published on March 15, 2024

## Abstract

The high cost of energy sources for animal ration like corn is contributing much to the cost of animal feeds. Thus, there is a need to explore the potential of tuber crops like *buga* to replace expensive corn for poultry feeds. Hence, this study was conducted to determine the growth performance and profitability of broilers fed with varying amounts of *buga* tuber meal as a partial substitute for corn. Two hundred-day-old broiler chicks were distributed into five treatments following the Randomized Complete Block Design in four blocks. The treatments were Pure Commercial Feeds, 100% Pure Corn, 75% Corn + 25% *Buga* tuber Meal, 50% Corn + 50% *Buga* tuber Meal, and 25% Corn + 75% *Buga* tuber meal. The study was conducted at the Poultry Project-DMMMSU NLUC, Bacnotan, La Union, Philippines from September 10, 2022, to October 15, 2022. Results showed that levels of *buga* tuber meal from 25% to 75% substitution rate fed to broiler was comparable to commercial feeds in terms of feed consumption, feed conversion ratio, and dressing percentage. However, in terms of profit per head, commercial feeds, and 25% *buga* tuber meal gained more profit than the 50% and 75% levels of *buga* tuber meals and 100% formulated corn ration. It is recommended that incorporating 25% *buga* tuber meal into commercial feeds provides comparable profits per head of broiler chicken.

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**Introduction**

In poultry production, feed cost claims the largest share of the total expenses involved in the production process. Feed alone accounts for over 75% of the total cost of production, out of which 50% is accounted for protein and energy sources (Ahaotu *et al.,* 2009). This led to a decrease in the net profit of the animal raisers. Corn makes up the bulk of the ration since it is the main source of dietary energy. It is for this reason that other sources of energy are explored as substitutes for corn in the animal ration. Tubers, roots, and corms have high energy value and can be tapped as possible substitutes. Starchy roots and tubers produced in many tropical areas constitute an important energy source for human and animal feeding. The main nutritional value of roots and tubers lies in their potential ability to provide one of the cheapest sources of dietary energy, in the form of carbohydrates. This energy is about one-third of that of an equivalent weight of grain, such as rice or wheat, because tubers have high water content. In addition, the high yields of most root crops ensure an energy output per hectare per day which is considerably higher than that of grains. National crop statistics (PSA, 2013) included cassava, sweet potato, white potato, *yam* (*Dioscorea esculenta*), *taro* (*Colocasia esculenta*), and *Tania* (*Xanthosoma sagittifolium*) as tubers are grown in the Philippines.

Roots and tubers have been the most important food crops since time immemorial in the tropics and subtropics (Behera *et al.,* 2009). Starchy roots and tubers are plants from diversified botanical sources that store edible starch material in subterranean stems, roots, rhizomes, and corms. Potatoes and yams are tubers, whereas *taro* and *cocoyams* are derived from corms, underground stems, and swollen hypocotyls. *Yam (Dioscorea spp.)* is an energy-rich tuber and provides protein three times higher than the one of cassava and sweet potato according to Ezeocha and Ojimelukwe (2012). The nutritional value of roots and tubers lies in their potential ability to provide one of the cheapest sources of dietary energy in the form of carbohydrates in developing countries (Ugwu, 2009). According to Apata and Babalola (2012), the roots, tubers, and their by-products are valuable sources of nutrients. They share several nutritional characteristics that constitute serious limitations for their practical use in poultry, pig, and fish feeding if they are compared with the cereals that are feed ingredients. According to Reddy and Quadratullah (2006), due to the severe shortage of cereals used in poultry feed and similarly, the cost of conventionally employed vegetable oil meals and animal protein are highly prohibitive and their supply is inconsistent. There is a continuous search for novel energy and protein sources of food for poultry farming such as roots, tubers, molasses, mango seed, kernel, and sal seed meal used by rural household units and scavenging birds in various regions of developing countries.

The *yam*, *Diocorea* sp. is an economically significant food in several tropical countries mainly in South Asia and the Caribbean, where it has cultural and social importance (Manuel *et al*., 2005). According to Coursey (1983), among the 600 species of the genus *Dioscorea*, six are cultivated for their edible corms which constitute a staple food for many people in subtropical and tropical regions of the world. The six most important species of *Dioscorea* include *D. rotundata*, *D. alata*, *D. cayenensis*, *D. dumetorum*, *D. bulbifera* and *D. esculenta*. It is reported that yams generally have high moisture content, and the dry matter is composed primarily of starch, vitamins, sugars, and minerals. As reported by Bourke and Vlassak (2004), *Dioscorea esculenta* (Lour) Burk is the least studied of the major staple yam species, although it is widely cultivated in southern Asia and the Pacific.

*Buga* is a wild variety of *Dioscorea esculenta* and is indigenous to the Philippines. It is almost identical to the *yam* or *ube* (*Dioscorea* sp.). Since these root crops can thrive well in the wild, this means that it is well adapted and resistant to local pests and diseases. Its promising benefits are insured if optimally used and appropriately cultivated. Among the yams, *buga* is considered one of the most productive, producing 4 to 20 tubers per plant.

Usually, *yam* grows with minimal or no intervention at all and thrives well in marginal areas. This growing condition explains the very low yield of yam which is only around 2.6t $ha^{-1}$ – 3.3 $ha^{-1}$ (Legaspi and Beatriz, 2013). The *buga* can also be used as animal feed, particularly for swine, and they are a good source of carbohydrates during the lean months. Proximately, the composition of *buga* (per 100 grams edible portion) includes water (70-80g), protein (1.3 - 2.1g), fat (0.1 - 0.3g), carbohydrates (26-36g), fiber (0.2-1.5g), ash (0.5-1.2g), vitamin A(0.017mg), vitamin B1(0.08g), vitamin B2(0.02mg) and vitamin C (20.3mg) (Dela Cruz, 2004). Today, *Buga* is now being explored and utilized as a source of industrial materials like carbohydrates, mineral and it is also used as food and to a lesser extent for livestock and poultry needs. It is one of the best crops for fattening chicken (Alcedo and Lucero, 1998). For this reason, *buga* tuber meal is explored as a substitute for corn in broiler ration.

**Materials and methods**

The research methodology of this study has been reviewed and approved by the Bureau of Animal Industry (BAI) – Manila. Two hundred (200) day-old broiler chicks were distributed at random in five (5) treatments replicated four (4) times, following the Randomized Complete Block Design (RCBD) in four (4) blocks with 40 birds per treatment.

The treatments are as follows: (a) To– Pure commercial feeds (Control); (b) T1– 100% ground yellow corn (Formulated ration); (c) T2 – 75% corn + 25% Buga tuber meal (Formulated ration); (d) T3– 50% corn + 50% Buga tuber meal (Formulated ration); and (e) T4– 25% corn + 75% Buga tuber meal (Formulated ration).

*Preparation for tuber meal*

Before the start of the study, buga tubers were gathered at Bacnotan and San Gabriel, La Union where they are abundant and washed with running water. The cleaned buga tubers were peeled and sliced into 1 cm size, then sun-dried for 5-7 days. After drying, the dried buga tubers were ground and stocked in a clean polyethylene bag.

*Preparation of the experimental ration*

The prepared *buga* meal was manually mixed based on the computed percentage using the trial-and-error technique as presented in Table 1 and 2. The nutrient composition of the dietary rations was computed based on their proximate analysis of PCAARRD in terms of crude protein (CP), metabolizable energy, calcium, and phosphorus. The formulated rations were given to the birds from brooding to 35 days. Birds in the control group were provided with pure commercial ration (100%).

*Preparation of experimental cages and management practices*

The experimental cages were cleaned by brushing the walls and flooring with soap and disinfected to prevent the growth and multiplication of disease-causing microorganisms. Cages were left for three days to eliminate odor. Brooding cages were installed with an electric bulb as a source of heat during the two weeks of brooding period. Clean empty feed bags were placed at the sides of the cages to maintain 37°C – 37.5°C temperature and to prevent the birds from exposure to draft. The brooder floors were provided with rice hull as beddings and were changed every other day. Strict hygiene and sanitation were properly imposed and observed throughout the experiment. The chicks were purchased from a reliable local dealer. The chicks were brooded in their respective cages with one (1) square foot per chick. A waterer and feeder were available inside their cages. The chicks were provided incandescent light as a source of heat. All birds were provided with uniform care and management. *Ad libitum* feeding was employed in all treatments.

*Sensory evaluation*

Sample birds were randomly selected from each block. They were weighed and then humanely euthanatized by cervical dislocation. Experimental birds were bled and scalded with hot water to remove the feathers, and then the dressed weight was taken. The dressing percentage was calculated from the dressed weight.

**Table 1.** Composition of the formulated ration (Booster Ration)

| Feed Ingredients | Commercial feeds(T0) | 100% Corn (T1) | 75% Corn + 25% Buga tubers (T2) | 50% Corn + 50% Buga tubers (T3) | 25% Corn + 75% Buga (T4) |
|---|---|---|---|---|---|
| Base Mix | - | 10.00 | 13.00 | 14.00 | 16.80 |
| Soybean oil meal | - | 25.00 | 21.30 | 20.00 | 16.50 |
| Rice bran,D1 | - | 8.60 | 7.85 | 8.70 | 8.20 |
| Ground yellow corn | - | 50.00 | 37.50 | 25.00 | 12.50 |
| Buga tubers | - | - | 12.50 | 25.00 | 37.50 |
| Salt | - | 0.25 | 0.25 | 0.25 | 0.25 |
| Molasses | - | 5.00 | 6.45 | 5.90 | 7.10 |
| Limestone | - | 0.85 | 0.85 | 0.85 | 0.85 |
| TOTAL | - | 100.00 | 100.00 | 100.00 | 100.00 |
| Nutrient Composition (%) | | | | | |
| Crude Protein | 21.50 | 22.71 | 22.73 | 22.71 | 22.71 |
| Metabolizable Energy | ----- | 2,969.98 | 2,838.17 | 2,976.04 | 2,800.57 |
| Calcium | 0.90-1.10 | 0.88 | 0.88 | 0.89 | 0.89 |
| Phosphorus | 0.55 | 0.49 | 0.48 | 0.47s | 0.45 |

**Table 2.** Composition of the formulated ration (Starter Ration)

| Feed ingredients | Commercial feeds (T0) | 100% Corn (T1) | 75% Corn + 25% Buga tubers (T2) | 50% Corn + 50% Buga tubers (T3) | 25% Corn + 75% Buga (T4) |
|---|---|---|---|---|---|
| Base Mix | - | 11.00 | 12.70 | 16.00 | 16.30 |
| Soybean oil meal | - | 15.00 | 15.80 | 13.80 | 16.80 |
| Rice bran,D1 | - | 12.00 | 10.10 | 10.50 | 7.30 |
| Ground yellow corn | - | 50.00 | 37.50 | 25.00 | 12.50 |
| Buga tubers | - | - | 12.50 | 25.00 | 37.50 |
| Salt | - | 0.25 | 0.25 | 0.25 | 0.25 |
| Molasses | - | 10.60 | 10.00 | 8.30 | 8.20 |
| Limestone | - | 0.85 | 0.85 | 0.85 | 0.85 |
| TOTAL | - | 100.00 | 100.00 | 100.00 | 100.00 |
| Nutrient Composition (%) | | | | | |
| Crude Protein | 21.0 | 19.70 | 19.72 | 19.71 | 19.71 |
| Metabolizable Energy | --- | 2,971.02 | 2,872.48 | 2,702.36 | 2,699.55 |
| Calcium | 0.90-1.10 | 0.89 | 0.89 | 0.89 | 0.89 |
| Phosphorus | 0.55 | 0.49 | 0.49 | 0.44 | 0.45 |

The panelists were recruited randomly among the faculty and students of Don Mariano Marcos Memorial State University-North la Union Campus, College of Agriculture. Among all those who volunteered, fifty (50) panelists were selected who declared that their senses of taste and smell were not impaired as a result of disease, who declared they consumed poultry meat at least once a week, and who were not allergic to any component of food products and familiar with sensory analyses. They performed sensory evaluations based on eye appeal, flavor, general acceptability, juiciness, and palatability. Fifty (50) cuts of 250 grams of breast meat from the slaughtered chicken were used for sensory evaluation. The cuts in each treatment were cooked without any spices or salt for approximately 30 minutes and kept warm in a food flask before serving. The carcasses were cut into sizeable pieces and were always served. The panelist was informed that the birds were raised with different levels of *buga* tuber meal as feeds while antibiotics had been terminated as per the manufacturer's directives before slaughter. They tasted the meat and noted their perceptions and overall acceptability on a nine-point Hedonic scale with rating expressed as follows: 9.0-8.1= like extremely; 8.0-7.1= like very much; 7.0-6.1= like moderately; 6.0-5.1= like slightly; 5.0-4.1= Neither like/dislike; 4.0-3.1= Dislike slightly; 3.0-2.1= dislike moderately; 2.0-1.1= Dislike very much; 1.0 to -1= Dislike extremely (Uguru *et al*., 2022).

## Results and discussion

*Growth performance*

*Initial weight*

Reflected in Table 3 is the mean initial weight of the birds. The initial weight of experimental birds

assigned in the different treatments had the same average weight of 0.035 kg. This indicates that the weights of the birds assigned to the different treatments are similar at the start of the experiment.

*Final weight*

The average final weight of birds is presented in Table 3. Birds fed with pure commercial feed ($T_0$) produced the heaviest average weight of 1.72 kg while birds fed with 25% corn + 75% *buga* tuber meal ($T_4$) acquired the lowest mean weight of 1.33 kg. A significant difference was noted between the birds fed with commercial ration and birds fed with different levels of *buga* tuber meal. Although birds fed with corn as the only source of energy (T1) acquired a mean weight of 1.45kg, comparison among treatment means showed comparable results to the mean weight of birds fed with 75% corn +25% *buga* (T2) and 50 %corn +50% *buga* which is 1.43kg, 1.45 kg, respectively. This implies that different levels of *buga* tuber meal mixed with corn failed to improve the final weight of birds. The result of the present study contradicts the study of Apata and Babalola (2012), wherein they stated that considering the chemical and nutritional characteristics of available alternative energy supplements (roots, tubers, and their by-products), they have the potential for increased use as alternative energy supplements for non-ruminant production. Furthermore, these materials possess readily digestible energy. However, for improved performance of animals, rations containing roots, tubers, or their by-products must be formulated to contain good protein sources and sufficient sulfur-containing amino acids.

*Gain in weight*

A similar trend is observed **i**n the gain in weight (Table 3). Birds fed with pure commercial feed ($T_0$) recorded the heaviest average gain in weight of 1.69 kg while birds fed with 75% *buga* + 25% corn (T4) had the lowest mean weight gain of 1.30 kg. A highly significant difference was observed between the birds fed with commercial ration and birds fed with different levels of *buga* tuber meal and corn. Although birds fed with 100% ground yellow corn (formulated ration) had an average weight gain of 1.42 kg comparable to the mean weight gain of birds fed with 75% corn + 25% *buga* tuber meal (T2) and 50% corn + 50% *buga* tuber meal (T3) which is 1.40 kg and 1.42 kg, respectively. The result indicates that different levels of *buga* tuber meal mixed with corn failed to improve the gain in weight of birds. The result of the study consonance with the study conducted by Orine and Lucero (2008) in which they found out that the addition of *buga* meal from 15% in the usual ration of broilers had a negative effect on the gain in weight of birds.

*Feed consumption*

The mean total feed consumption of birds is presented in Table 4. The mean average feed consumption of birds fed with varying levels of *buga* tuber meal ranges from 2.76 kg to 2.97 kg. Analysis of variance revealed insignificant results. Though numerically, birds fed with pure commercial feeds (T0) recorded the highest feed intake of 2.97 kg while birds fed with 25% corn + 75% *buga* tuber (T4) obtained the lowest mean feed intake of 2.76 kg. This indicates that the feed intake of experimental birds was not affected by the change in ration containing 25%-75% of *buga* tuber meal mixed with corn and therefore, feeds can be substituted with experimental ration without affecting the feed consumption of birds. This could be attributed to the fact that the *buga* tuber meal has a comparable energy content/level with the commercial feeds. This result is consistent with that of Johnston (2000) who stated that taro can replace almost all of the grain in diets with little reduction in performance, and accordingly, the inclusion of levels up to 65% doesn't seem to affect health carcass quality or overall performance when the diet is carefully balanced.

*Conversion ratio*

The average feed conversion ratio of birds is presented in Table 4. The amount of feed consumed to produce a kilogram gain in weight ranges from 1.77 kg to 2.13 kg. Insignificant result was obtained in the analysis of variance which indicates that the feed conversion ratio of birds fed with different levels of *buga* tuber mixed with corn were statistically comparable to the birds fed with commercial feeds and pure corn. The result is parallel to the results of feed consumption.

**Table 3.** Average initial weight, final weight and average gain in weight of broiler chickens after 35 days

| Treatment | Average Initial Weight (kg) | Average Final Weight (kg) | Average Gain in Weight (kg) |
|---|---|---|---|
| $T_0$-Pure commercial feeds (Control) | 0.035 | 1.72 [a] | 1.69 [a] |
| $T_1$ - 100% corn | 0.035 | 1.45 [b] | 1.42 [b] |
| $T_3$ -50% corn + 50% *Buga* tuber meal | 0.035 | 1.45 [b] | 1.42 [b] |
| $T_4$ -25% corn + 75% *Buga* tuber meal | 0.035 | 1.33 [c] | 1.30 [c] |

Means with different superscript letters in the same column are significantly different at α=5%(Tukey's HSD)

**Table 4.** Average amount of feeds consumed for 35 days per treatment group.

| Treatment | Feed consumption for 35 days (kg/head) | Average FCR (kg feed/kg of weight gain) | Average dressing percentage *(%)* |
|---|---|---|---|
| $T_0$ -Pure commercial feeds (Control) | 2.97 | 1.77 | 77.98 |
| $T_1$ - 100% corn | 2.78 | 1.96 | 79.99 |
| $T_2$ -75% corn + 25% *Buga* tuber meal | 2.78 | 1.99 | 80.30 |
| $T_3$ -50% corn + 50% *Buga* tuber meal | 2.83 | 2.00 | 78.78 |
| $T_4$ - 25% corn + 75% *Buga* tuber | 2.76 | 2.13 | 79.35 |

**Table 5.** Profit above feed, medicine and stock cost of broilers as affected by *buga* tuber (Php).

| Treatment | Average Profit per Head (PhP) |
|---|---|
| $T_0$ - Pure commercial feeds (Control) | 16.43 [a] |
| $T_1$ - 100% corn | 12.30 [b] |
| $T_2$ - 75% corn + 25% *buga* tuber meal | 15.71 [a] |
| $T_3$ - 50% corn + 50% *buga* tubers meal | 11.56 [bc] |
| $T_4$ - 25% corn + 75% *buga* tubers meal | 10.37 [c] |

Means with different superscript letters are significantly different at α=5% (Tukey's HSD)

**Table 6.** Sensory evaluation of broiler as affected by *buga* tuber.

| Treatment | Eye appeal | Flavor | General acceptability | Juiciness | Palatability |
|---|---|---|---|---|---|
| $T_0$ - Pure commercial feeds (Control) | 7.52 [a] | 7.42 [ab] | 7.55 [a] | 7.41 | 7.38 |
| $T_1$ - 100% corn | 7.12 [c] | 7.17 [c] | 7.36 [ab] | 7.33 | 7.13 |
| $T_2$ - 75% corn + 25% *Buga* tuber meal | 7.46 [ab] | 7.25 [bc] | 7.52 [a] | 7.49 | 7.29 |
| $T_3$ - 50% corn + 50% *Buga* tuber meal | 7.33 [b] | 7.23 [bc] | 7.26 [b] | 7.34 | 7.21 |
| $T_4$ - 25% corn + 75% *Buga* tuber | 7.43 [ab] | 7.50 [a] | 7.55 [a] | 7.43 | 7.32 |

Hence, the same reason is applicable, and it is supported by the study of Apata and Babalola (2012), that the comparable performance of pigs and poultry fed varying levels of roots and tubers and their by-products with those maintained on maize showed that they can be used as substitutes in non-ruminants diets at certain levels without detrimental effects. It can be suggested that feeding broilers with rations containing 25-75% *buga* tuber meal as a partial substitute for corn would result in a comparable feeding efficiency observed in birds fed with full-corn and commercial feed rations.

*Dressing percentage*

Table 4 presents the average dressing percentage of birds per treatment. The average dressed weight of the birds ranged from 77.98% to 80.30%. Analysis of variance revealed insignificant results. The result implies that feeding 100% formulated pure corn and different levels of *buga* tuber meal has a comparable effect on the dressing percentage of birds fed with commercial feeds.

*Potential profit per head*

The average profit per head with different levels of buga tuber meal as a feed substitute is presented in Table 5. The table shows that Pure commercial feeds ($T_0$) have the highest average profit per head of P16.43 comparable to the birds fed with 75% corn + 25% *buga* tuber meal (T2) with an average profit of P15.71 while birds fed with 25% corn + 75% *buga* tuber meal ($T_4$) got the least average profit per head of P10.37.

Analysis of variance shows highly significant results. Comparison among treatment means shows that pure commercial feeds and 25% *buga* tuber meal gained the highest average profit per head than the birds fed with 100% corn (T1), 50% *buga* tuber meal (T3), and 75% *buga* tuber meal (T4). It implies that the inclusion of 50% corn + 50% *buga* tuber meal and 25% corn + 75% *buga* tuber meal in the feed ration of birds increased the expense of feeds same as to 100% formulated corn ration. This does not agree with Adebayo *et al.* (2002) and Adesehinwa *et al.* (1996) who reported that On Farm Feeds (formulated) are cheaper than commercial feeds, since in this study, formulated ration gained the lower profit. The reason might be the feed ingredients used in the study were purchased at retail price which had a higher cost. It should be emphasized that the *buga* tuber used in this study was intended for human consumption; hence, it commanded higher costs. The market price of *buga*-based feeds is expected to reduce with the growing supply of *buga* tubers for animal production purposes.

*Sensory evaluation*

The effect of the experimental diets on the sensory evaluation of the breast meat of the broiler is shown in Table 6. The Juiciness score ranges from 7.33 to 7.49 and the Palatability score ranges from 7.13 to 7.38. The panelists did not observe any difference in the Juiciness and Palatability of the breast meat among treatments. However, the highest appearance score was observed in birds fed with 100% commercial feeds (T0) with a mean score of 7.52 and it is comparable to the mean score of birds fed with 75% corn and +25% *buga* tuber meal (T2) and 25% corn +75% *buga* tuber meal (T4) while birds fed with 100% corn ranked lowest with the average mean score of 7.12. A parallel result was obtained in the flavor. The General acceptability of the birds fed with 100% commercial feeds (T0) and 25% corn + 75% *buga* tuber meal (T4) had the most elevated acceptability score of 7.55. The results imply that the eye appeal, flavor, and general acceptability scores of the breast of birds ranked higher for those fed with Pure commercial feeds (T0) and 25% corn +75% *buga* tuber meal (T4) while 100% corn ranked lower (T1). Analysis of variance revealed that the Panellist found significant differences in eye appeal, flavor, and general acceptability. It appears that 75% replacement of corn with *buga* tuber meal positively affected the eye appeal, flavor and general acceptability of the breast meat. The higher appearance score for the breast broiler chicken fed with different *buga* tuber meals could be credited to its light-yellow tone. According to Uguru *et al.* (2022), increasing levels of fermented cassava tuber meal appeared to influence positively the deposit of fatty tissue in the breast, mostly in the intramuscular fat depot therefore improve the aroma and juiciness. Hence the total cholesterol and high HDL content probably influence the flavor in the breast of the broiler fed with different *buga* tuber meals given that cassava and *buga* are both tuber crops.

**Conclusion**

Based on the results of the study, the following conclusions were drawn:

Levels of *buga* tuber meal from 25% to 75% substitution rate fed to broiler was comparable to commercial feeds in terms of feed consumption, feed conversion ratio, and dressing percentage.

In terms of Final weight and gain in weight the commercial feed obtained the highest mean weight than the different levels of *buga* tuber meal but comparable to the 100% formulated corn ration. While in terms of profit per head, commercial feeds and 25% *buga* tuber meal gained more profit than 50%, and 75% level of *buga* tuber meal and 100% formulated corn ration.

**Recommendation(S)**

Based on the conclusions derived, the researcher recommends an addition of *buga* tuber meal at 25% inclusion as a substitute in corn as an energy source without adverse effects in the production performance of broiler chickens.

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