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Effects of Squash (*Cucurbita maxima*) Meal on Growth and Performance in Broiler Chicken Diets

Marianne A. Fernandez, Julius T. Vergara*
College of Agricultural Sciences, Guimaras State University, San Lorenzo, Guimaras, Philippines

*Corresponding Author Email: julius.vergara@gsu.edu.ph

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Abstract. This study examines the potential benefits of incorporating squash (Cucurbita maxima) meal into broiler chicken diets to enhance growth performance and feed conversion efficiency. Using a randomized complete block design, the research evaluated four different treatments: a control diet with 100% formulated feed, and three experimental diets with 5%, 10%, and 15% squash meal (SM) inclusion. Over a 20-day feeding period, various metrics were assessed, including initial weight, final weight, weight gain, feed consumption, and feed conversion efficiency (FCE). The findings revealed that higher levels of squash meal supplementation, particularly at 15% inclusion, significantly increased final weight, weight gain, and feed conversion efficiency. Notably, feed consumption remained consistent across all treatments. The research highlights the promising potential of squash meal, especially at a 15% inclusion rate, as an effective dietary supplement for promoting broiler growth. However, further studies are needed to explore the optimal balance between growth enhancement and feed consumption.

Keywords: Feed inclusion; Feed supplement; Feeding; Nutrition; Poultry feed; Vegetable powder.

1.0 Introduction

Various factors, including local farming practices, genetic resources, and environmental conditions, influence broiler production in the Visayas region of the Philippines. The region's unique agricultural landscape supports diverse poultry production systems, particularly in areas like Western Visayas and Eastern Visayas. (Cabarles, 2012). The nutrient requirements of broiler chickens are critical for optimizing growth performance, feed efficiency, and overall health. These requirements encompass a range of essential nutrients, including amino acids, energy, vitamins, and minerals, which must be balanced to achieve optimal production outcomes. Amino acids play a pivotal role in broiler nutrition, particularly lysine and threonine. Lysine is recognized as a key amino acid for muscle protein synthesis, and its dietary supply is crucial for the growth performance of broilers. Studies have shown that adequate levels of lysine are necessary to support muscle development and overall growth, with recommendations suggesting that dietary lysine should be maintained at around 1.2% to 1.5% for optimal performance (Cemin et al., 2017).

The synergy of proper nutrition, management practices, and animal welfare has been shown to yield better returns in broiler production. Effective nutritional strategies can reduce feed costs while ensuring optimal health and growth performance (Ajide et al., 2023). Furthermore, the careful consideration of indigenous knowledge can lead to innovative feed solutions that improve economic benefits and poultry health (Sankara et al., 2018). The

integration of these diverse approaches emphasizes a balanced, holistic dietary management system that supports sustainable poultry farming.

The incorporation of squash meal as a feed supplement in broiler chicken diets has garnered attention due to its potential nutritional benefits and cost-effectiveness. Squash (Cucurbita spp.) is rich in carbohydrates, vitamins, and minerals, making it a valuable addition to poultry diets. Its use can enhance growth performance, improve feed efficiency, and contribute to the overall health of broilers. Nutritionally, squash meal is characterized by a high carotenoid content, particularly beta-carotene, a precursor of vitamin A. This vitamin is essential for various physiological functions, including vision, immune response, and skin health. Research has shown that the inclusion of carotenoid-rich ingredients in broiler diets can improve growth rates and feed conversion ratios (FCR) (Cabarles, 2012).

The antioxidant properties of carotenoids may also enhance the immune function of broiler chickens, thereby reducing the incidence of disease and improving overall flock health (Come & Zamora, 2014). Moreover, squash meals can serve as a source of dietary fiber, which is beneficial for gut health. The presence of fiber in the diet can promote better digestion and nutrient absorption, thereby improving growth performance. Studies have indicated that dietary fiber can enhance gut morphology and microbial balance, which are crucial for optimal nutrient utilization (Ratilla et al., 2018). The fermentation of plant materials, including squash, has been shown to further enhance their nutritional value by reducing anti-nutritional factors and improving digestibility (Cemin et al., 2017).

Aside from the squash meal's nutritional potential, the exact level at which it will be added to broiler feeds has yet to be established. This study aimed to assess the growth and performance effects of squash meal on broiler chicken diets, focusing on (a) initial weight, (b) final weight, (c) average weight gain, (d) feed consumption, and (e) feed conversion efficiency.

2.0 Methodology

2.1 Experimental Design and Layout

This research used a randomized complete block design (RCBD) with four treatments, each replicated three times (Figure 1). Each treatment comprised three (3) birds per replicate.

D	C	B
C	D	A
A	B	D
B	A	C

Figure 1. *Experimental Layout*

Legend: Treatment A - Control (100% Formulated Feeds)
Treatment B - 5% Squash Meal + 95% Formulated Feeds
Treatment C - 10% Squash Meal + 90% Formulated Feeds
Treatment D - 15% Squash Meal + 85% Formulated Feeds

2.2 Preparation of Experimental Treatments

Raw materials utilized in the preparation of locally designed feeds were sourced from a reputable agricultural supplier: treatments B, C, and D comprised squash meal and homemade feed. We acquired and gathered squash from a nearby farm. The squash was sun-dried for five days to extract dry matter, and the resultant squash meal was processed into squash sauce. All materials were meticulously combined in a single container. Squash meal was manually included in the formulated diets at inclusion rates of 5%, 10%, and 15%.

2.3 Feeding Management

All birds were provided with booster mash during the brooding phase. On day 12, all birds underwent transition feeding, during which locally prepared feeds supplemented with squash meal were blended with formulated feeds to acclimate their digestive systems to the new diet. Subsequently, transition feeding was the sole practice in the control group (Treatment A). The experimental birds were provided with locally formulated feed enriched with squash meal throughout the study. Feed quantities were quantified based on daily nutritional needs.

2.4 Preconditioning

Throughout the conditioning phase, the researchers provided the designed feed containing squash meal in a modified quantity. Table 2 presents the percentage of locally mixed feeds (L.M.F.) incorporating squash meal

(S.M.) combined with booster mash for broiler chicks. The experiments were conducted for three days before the commencement of the study, or the raising phase, which began on the 16th day, to facilitate the experimental birds' adaptation to the treatments.

Table 1. *Feed Formulation of Different Treatments*

	Treatments			
Ingredients	**A**	**B**	**C**	**D**
Soybean Meal (kg)	23.0	23.0	23.0	23.0
Corn Grits (kg)	26.0	26.0	26.0	26.0
Rice Bran D1 (kg)	27.5	27.5	27.5	27.5
Copra Meal (kg)	15.0	15.0	15.0	15.0
Squash Meal (kg)	0	5.0	10.0	15.0
Molasses (kg)	7.0	7.0	7.0	7.0
Limestone (kg)	0.75	0.75	0.75	0.75
Monodical Phosphate (kg)	0.25	0.25	0.25	0.25
Vitamins & Minerals Premix (kg)	0.25	0.25	0.25	0.25
Salt (kg)	0.25	0.25	0.25	0.25
Total (kg)	**100.0**	**100.0**	**100.0**	**100.0**
Nutrient Composition				
Crude Protein (%)	20	20	20	20
M.E./Kcal	2800	2800	2800	2800

Table 2. *Preconditioning Table*

Day	Levels of Locally Mixed Feeds (L.M.F.) with S.M. to Booster Feeds
13th Day	25% LMF + 75% Booster
14th Day	50% LMF + 50% Booster
15th Day	75% LMF + 25% Booster

2.5. Data Gathering

The metrics utilized in data collection included final weight, weight gain, feed consumption, and Feed Conversion Efficiency (F.C.E.).

Final Weight: At the end of the study, chickens were weighed.
Weight Gained: The weight gained (in grams) by the chickens was determined using the formula:

$$Weight\ Gained = Final\ Weight - Initial\ Weight$$

Feed Intake: At the start of the rearing period, feed consumption per replication was recorded daily and was computed by subtracting the feed remaining from the given amount of feed daily using the formula:

$$Feed\ Intake = Feed\ Given - Feed\ Remained$$

Feed Conversion Efficiency (FCE): This is the ability of birds to convert a kilo of feed into live weight.

$$F.C.E. = \frac{Feed\ Consumed}{Weight\ Gained}$$

$$Average\ Feed\ Consumption = \frac{Total\ Feed\ Given - Feed\ Remain}{No.\ of\ Heads\ Per\ Replicate}$$

2.6 Statistical Analysis

Upon conclusion of the study, all data were documented, organized, and analyzed utilizing the mean and one-way Analysis of Variance (ANOVA) with a Completely Randomized Design.

3.0 Results and Discussion

3.1 Final Weight

The data in Table 3 show that incorporating squash meal at varying levels into broiler chicken diets affects final body weight. Broilers fed with 100% formulated feeds (Treatment A) had the lowest mean weight of 1770.0 grams, serving as the control group. When 5% squash meal was added to the feed (Treatment B), the final weight increased slightly to 1860.0 grams, though this change was not statistically significant compared to the control. A further increase to 10% squash meal inclusion (Treatment C) resulted in a mean weight of 2003.0 grams, indicating a gradual improvement in weight gain. However, it was still not significantly different from the control or the 5% inclusion group.

Table 3. *Final Weights of Broiler Chickens*

Treatment	Mean Weight (g)
Treatment A - Control (100% Formulated Feeds)	1770.0 b
Treatment B - 5% Squash Meal + 95% Formulated Feeds	1860.0 b
Treatment C - 10% Squash Meal + 90% Formulated Feeds	2003.0 b
Treatment D - 15% Squash Meal + 85% Formulated Feeds	2605.3 a
F-test	**
CV%	6.60%

However, a notable and highly significant increase was observed when a 15% squash meal was added to the diet (Treatment D), with broilers reaching an average final weight of 2605.3 grams. This weight was significantly higher than all other treatments, indicating that higher levels of squash meal supplementation positively influenced the growth performance of the chickens. The results suggest that while low to moderate levels of squash meal (5-10%) may improve broiler growth, the most significant benefit was observed at 15% inclusion, where final weight was significantly higher. This may be attributed to the potential nutritional benefits of squash meal, including additional fiber, vitamins, minerals, and bioactive compounds, which could enhance digestion, nutrient absorption, or feed palatability. The control group, which received only the standard formulated feed, showed the poorest growth performance, indicating that formulated feeds alone may be less effective at promoting maximum weight gain than partially replacing them with squash meals.

Overall, the data support the idea that incorporating squash meals into broiler diets, particularly at higher levels, can enhance growth performance, making it a potentially valuable feed ingredient for poultry production. As published by Nworgu et al. (2007), the proximate analysis revealed higher crude protein (C.P.), moisture, and mineral content in C.P. than in conventional feed raw materials. High feed conversion and body weight gain were observed in broilers fed squash meal. Martinez et al. (2010) also reported that the 10% inclusion of squash meal in broiler chicken diets served as a suitable substitute for soybean meal, enhancing growth performance and improving organoleptic meat quality. This implies that squash meal will increase the final weight of broiler chickens. The coefficient of variation is 6.60%.

3.2 Weight Gained

The data provided reflect the weight gain of broilers fed diets containing different levels of squash meal as a partial replacement for formulated feeds. In Treatment A (the control group), broilers fed 100% formulated feed achieved a final mean weight of 1499.7 grams, the lowest weight gain among all treatments. This indicates that while the formulated feed provided adequate nutrition, it may not have fully supported optimal growth potential. When 5% squash meal was introduced in Treatment B, the broilers showed a slight improvement, reaching a mean weight of 1612.7 grams. This suggests that even a small inclusion of squash meal may have contributed to a modest increase in weight gain, potentially due to improved palatability or additional nutrients it provides.

Table 4. *Weight Gain of Broiler Chickens*

Treatment	Mean Weight Gained (g)
Treatment A - Control (100% Formulated Feeds)	1499.7 b
Treatment B - 5% Squash Meal + 95% Formulated Feeds	1612.7 b
Treatment C - 10% Squash Meal + 90% Formulated Feeds	1760.0 b
Treatment D - 15% Squash Meal + 85% Formulated Feeds	2340.7 a
F-test	**
CV%	8.30%

A further increase to 10% squash meal in Treatment C led to a mean weight of 1760.0 grams, continuing the trend of increased weight gain with higher levels of squash meal inclusion. However, the weight gains in Treatments A, B, and C were not statistically different from one another, indicating that the inclusion of up to 10% squash meal did not result in a significantly higher weight gain than the control.

The most significant weight gain was observed with Treatment D, in which 15% of the formulated feed was replaced with squash meal. Broilers in this group reached a mean weight of 2340.7 grams, which was significantly higher than all other treatments. This indicates that broilers in Treatment D experienced the highest weight gain, demonstrating that a higher level of squash meal inclusion can significantly enhance broiler growth performance. The substantial weight gain in Treatment D may be attributed to the nutritional composition of squash meal, which may provide additional fiber, vitamins, minerals, and bioactive compounds that improve digestive health and feed efficiency.

Overall, the data show a clear relationship between increasing levels of squash meal and improved weight gain, with 15% inclusion resulting in significantly better growth. This suggests that squash meal can be an effective alternative feed ingredient, particularly at higher inclusion levels, helping to enhance weight gain and potentially reduce feed costs in broiler production. As supported by Patagao et al. (2018), the inclusion of ten percent (10) to twelve percent (12) squash meal as a feed supplement consistently resulted in significant body weight gain. Research by Nworgu et al. (2007) and reported by Omenka and Anyasor (2010) showed that high feed conversion and body weight gain were observed in broilers fed squash meals. This implies that squash meal supplementation affects the average weight gain of broiler chickens. The coefficient of variance is 8.3%.

3.3 Feed Consumption

The data presented show feed consumption of broilers fed diets containing different levels of squash meal as a partial replacement for formulated feeds. Across all treatments, feed consumption remained relatively consistent, with only minimal differences between the groups. In Treatment A, the control group fed with 100% formulated feeds, broilers consumed an average of 2800.8 grams of feed. Broilers in Treatment B, where 5% of the formulated feed was replaced with squash meal, consumed 2795.6 grams, which is almost identical to the control. Similarly, Treatment C (10% squash meal) and Treatment D (15% squash meal) showed feed consumptions of 2802.2 grams and 2801.1 grams, respectively.

Table 5. *Feed Consumption of Broiler Chickens*

Treatment	Mean Feed Consumption (g)
Treatment A - Control (100% Formulated Feeds)	2800.8
Treatment B - 5% Squash Meal + 95% Formulated Feeds	2795.6
Treatment C - 10% Squash Meal + 90% Formulated Feeds	2802.2
Treatment D - 15% Squash Meal + 85% Formulated Feeds	2801.1
F-test	NS
CV%	0.10%

These values indicate that the inclusion of squash meal at varying levels had no notable effect on overall feed intake, suggesting that its addition did not negatively affect palatability or acceptability. This stable feed consumption across treatments also implies that any differences in growth performance or weight gain observed in other datasets are likely due to improved feed efficiency or nutrient utilization rather than changes in feed intake.

Overall, the data support the idea that squash meal can be incorporated into broiler diets at levels up to 15% without negatively affecting feed consumption, making it a viable alternative feed ingredient. As reported by Gernat (2006), management and the environment play important roles in controlling feed intake. Many factors can influence feed intake. Correcting poor feed intake is often easier when a comprehensive review of feed and management practices is conducted. Management and flock health issues are typically more likely to reduce feed intake than dietary factors. Dietary factors that influence feed intake are common among all flocks within a complex rather than among individual flocks. In contrast, environmental or immunological stresses have the most significant effect on flock variation in feed intake. This implies that squash meal supplementation does not affect the feed consumed by broiler chickens. The coefficient of variance is 0.10%.

3.4 Feed Conversion Efficiency

The data presented reflects the Feed Conversion Efficiency (FCE) of broilers fed with diets containing varying levels of squash meal as a partial replacement for formulated feeds. Feed Conversion Efficiency measures how efficiently broilers convert feed into body weight; lower FCE values indicate greater efficiency. In Treatment A (the control group fed 100% formulated feeds), the FCE was 1.91, the least efficient of all treatments. This indicates that the broilers in this group required more feed to gain a unit of body weight, demonstrating relatively poor feed utilization. In Treatment B, where 5% squash meal replaced formulated feeds, the FCE improved to 1.74, showing that broilers in this group used their feed more efficiently than the control group. However, the difference was not statistically significant.

Table 6. *Feed Conversion Efficiency of Broiler Chickens*

Treatment	Mean FCE (g)
Treatment A - Control (100% Formulated Feeds)	1.91 b
Treatment B - 5% Squash Meal + 95% Formulated Feeds	1.74 b
Treatment C - 10% Squash Meal + 90% Formulated Feeds	1.60 b
Treatment D - 15% Squash Meal + 85% Formulated Feeds	1.20 a
F-test	**
CV %	11.60%

Further improvement was observed in Treatment C, where 10% squash meal inclusion resulted in an FCE of 1.60, again demonstrating better feed efficiency than the control, though still not significantly different from Treatments A and B. The best feed efficiency was observed in Treatment D, where 15% squash meal was added, resulting in an FCE of 1.20, which was highly significantly different from the other treatments. This means that broilers in Treatment D were the most efficient in converting feed into body weight, requiring the least amount of feed per unit of gain.

The trend of improving FCE with increasing levels of squash meal suggests that its inclusion enhances nutrient utilization, digestibility, or overall feed efficiency. This could be due to the nutritional profile of squash meal, which may contribute beneficial nutrients, fiber, or bioactive compounds that support digestion and metabolism. In conclusion, the data indicate that increasing the level of squash meal in the broiler diet improves feed conversion efficiency, with 15% inclusion demonstrating the most efficient feed utilization. This highlights the potential of squash meal as a valuable feed ingredient for improving the cost-effectiveness of broiler production.

The result was supported by Lacy's (2000) findings, which indicated that some significant factors affecting feed conversion efficiency include the physical form and composition of the feed. The smaller the conversion of feed, the more efficient the feeding of rations is, but if the conversion of rations is enlarged, then there has been wastage. Feed conversion was affected by several factors, including age at strain, ration nutritional content, temperature, and state. As supported by Aguilar et al. (2011), the nutritional profile of squash meal, including essential fatty acids and vitamins, contributes to its effectiveness as a dietary supplement. The presence of these nutrients can enhance the overall metabolic processes in broilers, leading to improved growth performance and feed efficiency. This suggests that squash meal supplementation influences the feed conversion efficiency of broiler chickens. The coefficient of variance is 11.6%.

4.0 Conclusion

The results of the study demonstrate that incorporating squash meal into broiler diets can positively influence growth performance and feed efficiency without negatively affecting feed intake. Broilers fed diets containing up to 15% squash meal exhibited significantly higher final weights and better feed conversion efficiency than those fed only formulated feeds. The consistent feed intake across all treatments suggests that squash meal is palatable and well-accepted by the broilers, making it a viable feed ingredient. Furthermore, the improved feed conversion efficiency at higher levels of squash meal inclusion indicates that broilers effectively utilized the nutrients in squash meal, potentially benefiting from the additional fiber, vitamins, and bioactive compounds. Overall, the inclusion of squash meal at appropriate levels can enhance broiler growth performance while improving feed utilization, contributing to more efficient and cost-effective poultry production.

Based on the findings, it is recommended to incorporate squash meal into broiler diets at levels up to 15%, as this level provides the best growth performance and feed conversion efficiency. Lower inclusion levels (5-10%) can

also be used, but the benefits are less pronounced. Further studies can be conducted to assess the long-term effects of including squash meal, including its impact on meat quality, gut health, and economic returns. Lastly, it is recommended to ensure proper formulation of diets to maintain balanced nutrient levels when substituting formulated feeds with squash meal to achieve optimal broiler performance.

5.0 Contributions of Authors

This paper is co-authored. The authors conducted editing, writing, data analysis, and encoding.

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7.0 Conflict of Interests

The authors declare no conflicts of interest concerning the research, authorship, and publication of this article.

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