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Verification of Mungbean and Cowpea in Broiler Chicken Diets

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ABSTRACT

The study aimed to investigate the feasibility of replacing the traditional soybean-based protein source with alternative plant proteins, especially mungbean and cowpea, in broiler diets to support outscaling initiatives in Region 02. Soybean, the prevalent protein source in broiler nutrition, poses economic and environmental challenges. This research addresses the growing need for sustainable and cost-effective alternatives. The control group received a conventional soybean-based diet, while the experimental groups were provided with diets in which soybean was totally replaced by mungbean and cowpea. Key growth performance indicators, such as broiler weight, feed conversion ratio, and mortality rates, were monitored throughout the study. The result revealed that soybean was statistically significant among the two alternative protein sources; however, broilers fed with mungbean and cowpea-based diets demonstrated satisfactory weight gain and feed conversion ratios, with no apparent adverse effects on overall health. This study's findings support the feasibility of reducing dependence on soybean by incorporating mungbean and cowpea as alternative protein sources in broiler diets for outscaling initiatives in Region 02. These findings hold promise for achieving sustainability and cost-efficiency in broiler production, as well as diversifying agricultural practices. While soybeans may show more significant results in terms of traditional metrics such as growth performance indicators, mungbean and cowpea typically had lower production costs compared to soybean. They often require fewer inputs such as fertilizers and pesticides, which can contribute to overall cost savings in cultivation. Mungbean and cowpea, being potentially more adaptable to local climates and conditions, can reduce reliance on expensive imports.

Keywords: *mungbean, soybean, cowpea, feed formulation, protein sources, poultry*

Introduction

Soybean meal is the most important protein source used to feed farm animals. It represents two-thirds of the total world output of protein feedstuffs, including all other major oil meals and fish meals (Oil World, 2015). Its feeding value is unsurpassed by any other plant protein source and it is the standard to which other protein sources are compared (Cromwell, 1999). While it has been an accepted part of livestock and poultry diets in the USA since the mid-1930s (Lewis et al., 2001), soybean feed production took off in the mid-1970s and then accelerated in the early 1990s due to a growing demand from developing countries. The expansion of poultry and prohibitions on the feed use of slaughterhouse by-products has also fueled the demand for this high-quality source of protein (Steinfeld et al., 2006).

China, the top global buyer of soybeans, has slowed purchases in recent months due to poor margins crushing soy into meal and oil to feed livestock. In addition, the scarcity of soybeans in the Philippines was evident because of the escalation in 2022 of the Russo-Ukrainian war. Analysts say shipments to China in 2021 might be less than 100 million tons due to a collapse in hog sector profitability and a sharp rise in the use of wheat for animal feed (Rappler Philippines, 2022). To date, the cost of commercial feeds has increased from P100 to P200 per bag, which the growers have affected and compromised their production and profit.

The Philippines imported 1,520,985.69MT of soybean meal in 2019 and 474,277.86MT in 2020 (BAI, 2021). There is a 69% decrease in soybean meal importation comparing the data for 2019 and 2020. All of the imported soybean meal were utilized by the feed industry. The feed industry is dependent on imported soybean meal in feed production and that is the reason why problems in the supply of soybean meal from other countries greatly affect the price and supply of feed for poultry and swine in the local market.

In addition, chicken production is a lucrative and fast-moving business enterprise in this generation; however, 70% constitutes the feed cost and the shortage of soybeans globally is affecting the production cost and price at the global market. However, Region 02 has vast agricultural land planted with legumes such as mungbean (13,876.03 hectares) and cowpea (186.55 hectares) that can possibly be substituted for soybean because of their high crude protein content. PHILSAN Feed Reference

Standards stated that soybean, mungbean, and cowpea are plant protein sources with CP contents of 47.2%, 22.80%, and 21.50%, respectively.

Based on PSA (2020), the annual volume of production in Region 02 for cowpea is 443.1 MT, and mungbean, is 6,708.6 MT. Between the two (2) leguminous crops, mungbean garnered a regional food sufficiency level of 112.49% (PMED, DARFO2, 2021). The abundance of mungbean and cowpea in the region can possibly address the scarcity of soybean in feed processing for broiler chicken diets.

Methods

The raw materials such as mungbean, cowpea, soybean meal, yellow corn, and rice bran were submitted for proximate analysis as the foundation of feed formulation for each growth stage of the experimental animals, as well as the basis for adjusting the number of raw materials in the diet.

In terms of formulation of diets, to determine the least-cost combination of raw materials that satisfies the nutritional requirements of the animals, the Linear Programming Method of formulating rations was used (PHILSAN Feed Reference Standards [3rd Edition], 2003), and the result of the proximate analysis of the raw materials. It can be observed that the amount of soybean utilized was higher compared to mungbean and cowpea due to cost considerations and the presence of other anti-nutritional factors.

Table 1. Ration Formulation of Different Treatments of Broiler Starter Diets (kg)

Ingredients	Treatment 1	Treatment 2	Treatment 3
Yellow Corn	51.820	50.070	62.545
Soybean meal, US	-	-	**24.000**
Mungbean	**22.500**	-	-
Cowpea	-	**24.500**	-
Copra meal	5.000	5.000	5.000
Lacto-fermentation product	10.000	10.000	-
Vitamin & Mineral Conc.	2.500	2.500	2.500
Monodicalcium Phosphate	1.550	1.550	1.550
Coconut Oil	1.250	1.250	1.050
Spray-dried animal blood cells	3.500	3.500	1.500
Limestone, fine	0.500	0.250	0.500
Salt	0.300	0.300	0.300
Toxin Binder	0.200	0.200	0.200
Lysine - HCl	0.350	0.350	0.350
Methionine	0.300	0.300	0.275
Threonine	0.150	0.150	0.150
Zinc amino acid complex	0.050	0.050	0.050
Yeast peptide	0.030	0.030	0.030
Total	**100.00**	**100.00**	**100.000**

Table 2. Ration Formulation of different Treatments of Broiler Finisher Diets (kg)

Ingredients	Treatment 1	Treatment 2	Treatment 3
Yellow Corn	53.395	52.045	63.995
Soybean meal, US	-	-	**24.500**
Mungbean	**16.000**	-	-
Cowpea	-	**17.500**	-
Copra meal	10.000	10.000	4.000
Lacto-fermentation product	10.000	10.000	-
Vitamin & Mineral Conc.	2.500	2.500	2.500
Monodicalcium Phosphate	1.500	1.500	1.550
Coconut Oil	1.500	1.500	1.000
Spray-dried animal blood cells	3.500	3.500	1.000
Limestone, fine	0.550	0.400	0.450
Salt	0.300	0.300	0.300
Toxin Binder	0.200	0.200	0.200
Lysine - HCl	0.200	0.200	0.200
Methionine	0.200	0.200	0.175
Threonine	0.075	0.075	0.050
Zinc amino acid complex	0.050	0.050	0.050
Yeast peptide	0.030	0.030	0.030
Total	**100.00**	**100.00**	**100.000**

Heat Treatment of Legumes

Roasting of grains is required to destroy protease inhibitors that reduce protein digestibility and other anti-nutritional factors. Mungbean and cowpea grains were oven-dried at 125 ^{o}C for 30 minutes (Gonzales-Vega et al., 2011). Overheating significantly reduces protein quality. An enzyme urease is present in grains and very much like trypsin and lectins, its activity is reduced by heating. Urease activity is frequently used as a marker to indirectly reflect the presence of anti-nutritional factors in grains. Historically, urease activities higher than 0.15 in pH suggested under-processing, while lower than 0.05 indicated over-processing.

Feed Milling/ Mixing

The raw materials, especially the alternative protein source, were sourced directly from farmers. The Pagasa7 variety of mungbean seeds was used, which is abundant in the province of Isabela, while the cowpea seeds are abundant in the province of Nueva Vizcaya,

All ingredients conformed to the A.O. 40 Series of 1976 of the Bureau of Animal Industry, namely Rules and Regulations Governing Quality Standards of Commercial Feed Ingredients. The station is equipped with a 90 kW electric motor-powered hammer mill with a capacity of 100 kg of milling per hour and a feed mixer which was used to process the feeds that were used in the trial. Using a homogeneity test, the capacity of the feed mixer has an optimal amount of 200 kg per mixing of feeds to obtain a homologous mixture of the hammermill.

All the macro ingredients (i.e. yellow corn, mungbean seeds, cowpea seeds, soybean seeds, etc.) were crushed or ground with the use of a hammer mill. The ground ingredients and the other micro-ingredients were then placed in the ribbon-typed horizontal mixer and mixed for 15 minutes to attain a homologous mixture. The time was based on the result of the homogeneity test that was conducted on the feed mixer and analyzed by a laboratory facility.

Proximate Analysis of Mixed Ration

The mixed ration that was used in the diet of the broiler chicken in their grower and finisher was subjected to proximate analysis according to the AOAC procedure at the Regional Feed Chemical Analysis Laboratory of the DA-Cagayan Valley Integrated Agricultural Laboratory (DA-CVIAL), Government Center, Carig, Tuguegarao City. The Metabolizable Energy (ME): protein ratio, amino acids and Energy Ratio Amino Acids: lysine ratio were determined from the proximate analysis. The proximate analysis ensured that the mixed rations conformed to the nutritional standard needed by the animals.

Table 3. Nutrient Analysis of Different Treatments of Broiler Starter Diets

Particulars/ Units	Treatment 1	Treatment 2	Treatment 3
ME, Poultry/ mE/kg	2907.884	2902.839	2894.765
Crude Protein/%	19.9380	19.9320	20.1208
Crude Fat/%	4.1512	4.1244	4.4435
Crude Ash/%	6.0527	5.7357	6.0946
Crude Fiber/%	3.0609	2.8344	2.7785
Calcium/%	0.8775	0.8809	0.8972
Dig Phospor Poultry/%	0.4558	0.4550	0.4506
Sodium/%	0.1676	0.1671	0.1608
Dig Lysine Poultry/%	1.1297	1.1318	1.1054
M+Cd Poultry/%	0.7661	0.7625	0.7676
Dig Threonine Poultry/%	0.7128	0.7127	0.7225
Dry Matter/%	89.4969	89.3561	88.7833

Table 4. Nutrient Analysis of different Treatments of Broiler Finisher Diets

Particulars/ Units	Treatment 1	Treatment 2	Treatment 3
ME, Poultry/ mE/kg	2894.607	2889.588	2901.153
Crude Protein/%	19.3554	19.3592	19.5209
Crude Fat/%	4.8623	4.8402	4.3526
Crude Ash/%	6.1156	5.91819	5.9786
Crude Fiber/%	3.3023	3.1414	2.7189
Calcium/%	0.8770	0.8903	0.8787
Dig Phospor Poultry/%	0.4577	0.4570	0.4503
Sodium/%	0.1719	0.1715	0.1563

Linoleic Acid		1.0244	
Dig Lysine Poultry/%	0.9630	0.9651	0.9648
M+Cd Poultry/%	0.6632	0.6606	0.6688
Dig Threonine Poultry/%	0.6173	0.6175	0.6177
Dry Matter/%	89.7919	89.6958	88.6346

Selection of Test Animals

A total of 90-day-old chick Cobb 500 were used to assess the effectiveness of the different alternative protein sources in the growth performance of broiler chicken.

Feeding Trial

The feeding trial followed a Completely Randomized Design with three (3) treatments and three (3) replications with 10 birds per replicate. This was conducted during the bird's grower and finisher stage. At the starter stage of chicken, commercial feeds were used as feeds. The treatments were as follows for the broiler starter:

Treatment 1: Mungbean as an alternative plant protein source
Treatment 2: Cowpea as an alternative plant protein
Treatment 3: Soybean meal

The treatments are as follows for broiler finisher:

Treatment 1: Mungbean as an alternative plant protein source
Treatment 2: Cowpea as an alternative plant protein
Treatment 3: Soybean Meal

Experimental design and layout for both layer and broiler chicken in the on-farm and on-station trials following the draw lot randomization are illustrated below:

R1			R2			R3		
T1	T3	T2	T2	T1	T3	T3	T1	T2

Data Gathering

The following parameters were gathered to assess the growth performance of broilers and were subjected to statistical analysis:

a. Livability Rate

$$Livability\ \% = \frac{No. of\ birds\ sold\ x\ 100}{No. of\ birds\ at\ the\ beginning}$$

b. Feed Efficiency or Feed Conversion Ratio

$$FCR = \frac{Total\ feed\ consumed\ per\ bird\ in\ Kg}{Mean\ body\ weight\ gain\ in\ Kg}$$

A value of 1.8 or less at 6 weeks of age is preferable.

c. Broiler Performance Efficiency Factor (BPEF)

$$BPEF\ = \frac{Live\ weight\ in\ kg\ x\ 100}{Feed\ efficiency}$$

d. Broiler Farm Economy Index (BFEI)

$$BFEI = \frac{Ave.live\ weight\ (kg)x\ \ \%livability}{Feed\ eff.x\ growing\ period\ (days)}$$

The data for the broiler chicken was analyzed using ANOVA in the STAR software.

Ethical Considerations

The researchers had considered certain principles to observe ethical consideration in their study. First is the principle of proportionality or the responsibility for considering and balancing suffering and benefit. The researchers considered the risk that laboratory animals experience pain and other suffering and assess in relation to the value of the research for animals, people, or the environment. Second is the responsibility for minimizing the risk of suffering and improving animal welfare. The researchers minimized the risk of suffering and provide good animal welfare. Third is the responsibility for openness and sharing of data and material. The researchers ensured that there is transparency about research findings and in facilitating the sharing of data and material from experiments on animals.

Results and Discussion

Livability Rate

The livability rate of chickens typically refers to the percentage of chicks that survive from hatching to a certain age, such as reaching maturity or a specific growth stage. Based on the parameters set for the study, the animals under consideration were in optimal conditions and the absence of threats that might harm or endanger the animal populations being assessed. Food supply and clean water resources are consistent and adequate. There were no documented or observed deaths among the experimental animals during the trial.

Feed Efficiency or Feed Conversion Ratio

A value of 1.8 or less at 6 weeks of age is preferable.

Table 5. FCR of Broilers Fed with Different Plant Protein Sources

Particulars	Mungbean	Cowpea	Soybean
Total feed consumed per bird (kg)	3.035	3.115	3.248
Mean body weight gain (kg)	1.47567	1.549	1.80367
Feed Efficiency	**2.06**	**2.01**	**1.80**

Table 5 presents the FCR of the broilers fed with different plant protein sources. The FCR of broilers shows how the birds effectively convert the feed they consume into body weight or meat. It is an essential factor in poultry farming as it directly affects the cost of production and profitability. A lower FCR means a higher feed efficiency. Based on the table, several key findings emerge. Firstly, soybean treatment's total feed consumed per bird is the heaviest of the three treatments, indicating a higher feed consumption. However, in the same treatment, the bird gained the most body weight, which is an important parameter in the study.

The table also illustrates the difference in the feed conversion ratio of the treatments. Soybean has the most preferable or lowest conversion ratio of 1.80, followed by cowpea with a 2.01, and mungbean having the highest conversion ratio of 2.06. A standard of 1.5-2.0 conversion ratio and less at 35-day-old chicken is preferred; however, only the soybean is able to meet the standard, while mungbean and cowpea have exceeded the standard conversion ratio. In addition, the acceptability of the animals in the different feeds was observed, soybean has the lowest feed refusal followed by mungbean, and the highest refusal recorded is the cowpea. Higher FCR compared to the standard can have significant implications for both the economic viability and sustainability of the production operations.

Broiler Performance Efficiency Factor (BPEF)

Table 6. Broiler Performance Efficiency Factor (BPEF) of Broilers Fed with Different Plant Protein Sources

Particulars	Mungbean	Cowpea	Soybean
Live weight in Kg	4.56	4.78	5.54
Feed Efficiency	2.06	2.01	1.80
BPEF	**221.41**	**237.81**	**308.00**

Table 6 provides the Broiler Performance Efficiency of the three different plant protein sources (mungbean, cowpea, and soybean) with respect to live weight and feed efficiency. In live weight parameter, it shows the average weight of broilers that were harvested at 35 days. Broilers fed with mungbean has an average live weight of 4.56 kilograms, those fed with cowpea has 4.78 kilograms, and those fed with soybean has an average of 5.54 kilograms. Soybean obtained the highest average live weight among the three treatments, indicating that it produces heavier broilers on the said duration of harvest.

Using the feed efficiency of treatments in Table 6, soybean has the best efficiency of 1.80 indicating that it is the most efficient at converting inputs into meat weight among the three treatments.

The broiler Performance Efficiency Factor is a composite metric that considers both biological (weight performance) and economic factors (feed efficiency) to assess the overall performance efficiency of broilers (M. Murugan et.al.). Higher BPEF values typically indicate a more efficient and economically viable plant protein source. Mungbean has a BPEF of 221.41, cowpea has 237.81, which is slightly higher than mungbean, and soybean has the highest BPEF of 308.00, suggesting that it is the most bio-economically efficient of the three protein sources.

D. Broiler Farm Economy Index (BFEI)

Table 7. Broiler Farm Economy Index (BFEI) of Broilers Fed with Different Plant Protein Sources

Particulars	Mungbean	Cowpea	Soybean
Livability	100	100	100
Average Live weight	1.52	1.59	1.85
Feed Efficiency/ FCR	2.06	2.01	1.80
Growing Days	35	35	35
BFEI	**2.17**	**2.33**	**3.02**

Table 7 provides a comparison of broiler performance and economic efficiency when different plant protein sources (mungbean, cowpea, and soybean) were used in the broiler diet. The data suggests that broilers fed with soybean have the highest average live weight, the best feed efficiency/ FCR, and the highest BFEI, indicating potentially better economic performance in broiler farming.

Table 8. Table of Means Weight Gain Booster

Alternative Protein	Weight Gain Booster Means
Mungbean	320.33
Cowpea	321.33
Soybean	308.33

In this study, an ANOVA analysis was conducted to examine the impact of different protein sources on the growth performance of broilers. At this stage, the chicks were fed with commercial feeds. Weighing of chicks was done before the feeding trial for the initial weight. Table 8 illustrates the weight gain of broilers in the booster stage. The analysis yielded a p-value of 0.0536, indicating that there are no significant differences in the weight gain among the groups. The mean weight gain values for each group were as follows: mungbean – 320.33, cowpea – 321.33, and soybean – 308.33.

Table 9. Table of Mean Weight Gain Starter

Alternative Protein	Means	N group
Mungbean	693.67	3 b
Cowpea	697.67	3 b
Soybean	862.67	3 a

Means with the same letter are not significantly different

Table 9 presents the ANOVA of broiler weight gain in the starter stage. The F-statistics, which measures the ratio of variability between groups to within groups, is 46.79. This F-statistics is associated with a p-value of 0.0002. The small p-value (typically 0.05) suggests that there are statistical differences in the different protein sources among the treatments.

These tests revealed that soybeans are significantly higher than mungbeans and cowpeas. However, no statistical difference was observed between mungbean and cowpea. These study findings were conclusive to the study of Defang (2008), which claimed that toward the starter period, feed intake and weight gain were significantly ($P < 0.05$) higher for broilers fed the control diet compared to those broilers fed with cowpea. On the other hand, no significant ($P > 0.05$) difference was observed between treatment groups for feed conversion ratio and feed cost for the production of 1 kg of live body weight.

Table 10. ANOVA Table of Weight Gain Finisher

Alternative Protein	Weight Gain Finisher Means
A1	461.67
A2	539.00
A3	632.67

Table 10 illustrates the ANOVA of broiler weight gain in the finisher stage. The values represent the mean or the average weight gain in all the treatments. No statistically significant difference was observed among the treatments. However, based solely on the means, soybean appears to have the highest weight gain observed at approximately 461.67, cowpea has an intermediate average weight gain of approximately 539.00, and mungbean has the lowest average weight gain of approximately 461.67.

Table 11. ANOVA Table Final Weight Gain

Alternative Protein	Means	N group
Mungbean	1475.67	3 b
Cowpea		1549.00
Soybean	1803.67	3 a

Means with the same letter are not significantly different

Table 11 shows the ANOVA of broiler final weight gain. The F- statistics measure is 15.05 and the p-value is 0.0046, which means there is a statistical difference observed among the treatments. It reveals that soybean is significantly higher than mungbean and cowpea; however, there is no significant difference between mungbean and cowpea. Thus, mungbean is an excellent poultry feedstuff as an alternative source of protein, but it is not recommended to be used as the main source of protein in poultry diets because of its low content of sulfur amino acids. Therefore, in order to improve the amino acid pattern of MBS, it can be used either in combination with other protein sources or after dietary supplementation with methionine (Hemid et al., 2007).

Conclusion and Future Works

In conclusion, the study comparing the production performance in broiler weight when fed with soybean, mungbean, and cowpea revealed an interesting outcome. While soybean appeared to have a higher overall performance of broilers compared to mungbean and cowpea, it is crucial to note that the differences in means between these three legumes were relatively small.

The research outcome indicates that although soybeans contributed to slightly greater average weight gain in broilers, alternative protein sources, such as mungbean and cowpea, offer a viable solution. Despite soybeans' marginal advantage, adopting these alternative sources presents an opportunity to reduce reliance on soybeans while ensuring satisfactory broiler growth and performance. Furthermore, the economic index of treatments indicates the financial efficiency of different treatments in broiler farming. Soybean demonstrated superior economic performance compared to mungbean and cowpea, respectively. This underscores the potential for diversification in broiler nutrition, enhancing sustainability and resilience in the poultry industry.

With this, the researchers recommend for the outscaling of the mungbean-formulated feed diet for broiler production in starter and finisher stages. They likewise suggest for capacitaty development among mungbean FCAs in seed production to ensure available planting and feed raw materials. Moroever, there is a need to have a grading system solely for animal use and to lower the price of mungbean to be used as a material for animal diets. Lastly, they recommend the mainstreaming of the POT of alternative proteins in the regular program interventions of livestock and HVCDP.

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