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Growth Performance of Mallard Ducks Fed Soybean Curd Residue (SCR) as Partial Replacement for Soybean Meal

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Abstract

To evaluate the production performance of male and female mallard ducks fed soybean curd residue as a partial replacement for soybean meal, a study was conducted from April 6, 2020, to June 6, 2020, at Buhol na Mangga, San Ildefonso, Bulacan. One hundred eighty mallard ducks (90 male and 90 female) were used in the study with a two-factor factorial experiment in Completely Randomized Design (CRD). Factor A was the level of substitution (basal feeds formulated duck starter/grower feeds, soybean curd residue as 15% replacement for soybean meal in formulated duck starter/grower feeds and soybean curd residue as 20% replacement for soybean meal in formulated duck starter/grower feeds) while factor B was the sex of the mallard ducks. The performance of mallard ducks in terms of final weight, weight gain, average feed consumption, feed conversion ratio, dressing percentage, and visceral organs weight both at 15% and 20% inclusion rates of soybean curd residue (SCR) for starter and grower rations are similar to the animals fed of soybean meal. There is a considerable rise, however, in the carcass weight in terms of the sex of the mallard ducks raised. The use of soybean curd residue (SCR) as substitute to soybean meal (SBM) is more profitable for farmers since it reduces the production cost of raising mallard ducks. Conclusively, soybean curd residue is reasonable to use as a substitute for soybean meal.

Keywords: *basal feeds*, *formulated feeds, inclusion, ration*, *substitution*

Introduction

In the Philippines, the duck industry is the second most popular poultry species next to chicken. Farmers or backyard raisers raise more than 75 per cent of the ducks in our country with less than 100 heads per household. Ducks are generally bred for their meat and their eggs. It can live in a wide range of climatic conditions and feeds and is immune to specific avian diseases (Chang *et al*. 2004).

The total duck inventory as of January 2017 stood at 10.84 million birds. It registered an increment of 3.09 percent from the previous year's stocks of 10.52 million birds. Based on the 2019 PSA data, about 68.87 percent of ducks in the country are raised through backyard farming, while the rest, or 31.13 percent, are grown in commercial farms.

The high cost of feeds constitutes one of the main constraints in poultry production. At present, researchers are trying several feedstuffs and supplements to reduce the cost. Proper selection of feed supplements that is readily available in the locality is one of the good factors suggested by experts to give attention to.

Soybean is one of the most frequently or widely used ingredients in feed. Soybean and its components are valuable raw materials for the Philippine food and feed industries and are one of the most popular food crops worldwide today. Based on how it is used, this legume can be categorised as a legume, oil-herb, or even source of fuel. Following extrusion cooking, whole beans are primarily used as full-fat protein meal for livestock. They are also refined into specific food items such as soy milk and tofu, or soybean curd (taho and tokwa). Soya meal, a by-product of oil extraction, is mainly used by the livestock industry as the key source of protein for feed (Enicola, 2008).

Data from the BPI show that the area planted to soybean in the Philippines is a mere 1,000 hectares. For our domestic needs, which exceed as much as 300,000 metric tons annually, the country is currently highly dependent on imports. The primary sources are United States, Brazil, and Argentina. The amount of soybean is estimated to be less than 100,000 tons per year for direct use, whether for feed or food. Food soybeans are mainly sourced from Canada and China (bpi.da.gov.ph.Retrieved March 19, 2019).

Production of soybean products has been growing worldwide, and there has been a related rise in the amount of soybean curd residue (SCR) being discarded. The disposal of the soybean curd residue has become a concern due to its environmental pollution. It is high in fibre (25%), fat (10%), protein (25%), vitamins and trace elements. It has potential for value-added production and consumption that at the same time, carries the promise of increased economic gain and reduced environmental emission potential (Li *et al*. 2013).

This research was, therefore, conducted to find out the growth responses of male and female ducks fed with different levels of soybean curd residue as a partial replacement for soybean meal.

Objectives of the Study

The general objective of this study was to determine the effect of soybean curd residue on the production performance of male and female mallard ducks.

Specifically, it aimed to determine the production performance including the gain in weight, feed consumption, final weight, feed conversion ratio, dressing percentage, carcass, organ weight, and cost and return analysis

Materials and Methods

Locale of the Study

The experiment was conducted at Barangay Buhol na Mangga, San Ildefonso, Bulacan. It has a sandy clay loam soil type that is suitable for agricultural production.

The area is described as having pronounced wet and dry seasons that fall under the Type I category of the Modified Corona Philippine Climate Classification (Provincial Planning and Development Office, 2013).

Experimental Birds

A total of 180 fourteen-day-old male and female mallard ducklings (90 male and 90 female) were used in the study.

Collection of Test Material

The soybean curd residue (SCR) was collected at Sumandig, San Ildefonso, Bulacan. The samples were sun-dried for three days and subjected to proximate analysis at the Department of Agriculture Feed Chemical Analysis Laboratory, DA RFO III, City of San Fernando, Pampanga.

Experimental Design and Treatments

A two-factor factorial experiment in Completely Randomized Design (CRD) was used in the study. Factor A was the level of substitution of soybean curd residue in the diet, while Factor B was the sex of ducks. Six treatment combinations with three replications each were used in the study.

Management Practices

Housing

The housing used in the study was made of coco lumber and net. The house measured 41.4 square meters. There were ten ducks per pen per replication.

Preparation of the Ration

Soybean curd residue samples were gathered from Sumandig, San Ildefonso, Bulacan. The samples were dried and pulverized. The replacement of soybean meal with the experimental treatment was based on what has been specified in the treatment. Proper weighing and proportioning of feed ingredients were done, and these were immediately mixed using a feed mixer to avoid poor distribution of ingredients. The maximum moisture content of the experimental treatment ration did not exceed 12%.

Feeding Trial

Two types of feeds were fed to the ducks throughout the study. Feeds were offered ad libitum from the start until the end of the study.

The schedule of feeding was as follows: day 21-55 will use formulated duck starter mash type of feeds while day 56-81 will use formulated duck grower mash instead.

Formulated duck starter mash ration was fed according to treatments during the start of the study up to 55 days old, and formulated duck grower mash ration were fed from 56 days old up to the end of the study.

The birds were fed ad libitum and were given fresh water at all times during the study.

Table 1

Nutrient Specifications for Ducks

Nutrient	Starter	Grower
Energy, ME Kcal/kg	2800-2900	2800-3000
Crude Protein %	19-22	15-16
Crude Fat%	4.0 – 4.5	4.0 – 4.5
Crude Fiber	NMT 8	NMT 8
Calcium %	0.90-0.95	1.0-1.1
Phosphorus, available %	0.40-0.44	0.40-0.44

Reference: Feed Reference Standards 4th Edition PHILSAN

Table 2

Ingredients Composition of Starter Ration

Ingredient %	T1 (Control)	T2 (15% SCR)	T3 (20% SCR)
Corn, yellow	54.50	49.20	44.65
Rice bran (D1)	3.50	-	-
Molasses	4.00	5.00	9.0
SBM, USHP	23.08	18.00	18.70
SCR	-	12.60	16.74
Fishmeal Peruvian	6.32	6.50	5.41
Wheat Pollard, Hard	-	7.00	3.50
Copra meal	7.0	-	-
Limestone (C)	1.10	1.18	1.00
Monocalcium phosphate	0.50	0.40	0.75
DL-methionine	-	0.12	0.15
L-lysine	-	-	0.10
Total	100	100	100
Calculated Analysis			
ME, kcal/kg	2835	2829	2831
Crude Protein, %	21.41	21.40	21.37
Crude Fat, %	4.19	4.05	4.02
Crude Fiber, %	2.96	4.09	4.23
Ca, %	0.93	0.92	0.90
P, Av.%	0.43	0.42	0.44

Table 3

Ingredients Composition of Grower Ration

Ingredient %	T1 (Control)	T2 (15% SCR)	T3 (20%SCR)
Corn, yellow	64.65	60.88	58.00
Rice bran (D1)	5.00	-	1.95
Molasses	5.10	6.00	8.00
SBM, USHP	12.50	10.00	9.40
SCR	-	9.12	12.15
Fishmeal Peruvian	4.00	2.30	3.05
Copra meal	4.00	6.00	-
Limestone (C)	1.45	1.40	1.50
Monodicalcium phosphate	0.80	1.20	1.10
Wheat pollard hard	2.00	2.20	4.10
DL Methionine	0.15	0.30	0.30
L-Lysine HCL	0.35	0.60	0.45
Total	100.00	100.00	100.00
Calculated Analysis			
ME, kcal/kg	2890	2887	2888
C. Protein, %	15.99	15.96	15.96
Crude Fat	4.23	4.21	4.12
Crude Fiber	2.82	3.73	3.78
Ca, %	1.03	1.02	1.06
P, Av.%	0.41	0.42	0.43

Sanitation Practices

Cleaning of the feeding and watering troughs was done regularly. Removal of manure was done every day during the study to avoid foul odor and to maintain proper sanitation.

Statistical Analysis of Data

The data collected were analyzed using Analysis of variance (ANOVA) in Two Factor Factorial in Completely Randomized Design (CRD), and differences in treatment means were compared using Least Significant Design at a 5% level of significance.

Measurement of Production Performance

Initial weight, final weight, gain weight, feed consumption, feed conversion ratio, dressing percentage, carcass and organ weight, and cost and return analysis are data to be gathered to measure the production performance. For initial weight birds were weighed 21 days after brooding and for final weight it was taken when the birds were already 81 days old at the termination of the study.

Gain weight was taken by getting the difference of the final weight and the initial weight of the birds. For feed consumption this was taken by subtracting the feed refusal from the total feed offered. Feed refusal was taken every morning before offering new feeds to experimental ducks. The FCR was taken by dividing the feed consumed by the total gain weight of the ducks.

The weight of carcass and visceral organs such as heart, liver and gizzard was taken and recorded. Dressing percentage was taken by dividing the carcass weight by the live weight multiply by 100. For the cost and return analysis, all expenses that were incurred were recorded in determining the cost of production. Gross income, net income and return on investment were also computed.

Results and Discussion

Initial Weight

As shown in Table 4, the highest initial weight was recorded in T2 (soybean curd residue as 15% replacement for soybean meal in formulated duck starter/grower feeds in Male Mallard duck) at 362.83 g. Initial weight was taken and used to determine the effect of the different experimental treatments in the gain in weight of the animals, which was the first parameter of the study. The two-way ANOVA did not show any significant difference in the combined effects of the levels of substitution and the sex of the mallard ducks. The individual effects also did not show any significant difference at the 5% level of significance. Results indicate that the ducks make up for good test subjects because there are no variations in their initial weight.

Table 4

Initial weight (g) of the mallard ducks

Treatments	Sex of Ducks		Mean
	(Male)	(Female)	
T1 (Control)	349.5	344.5	347.00
T2 (15% SCR)	362.83	325.67	344.25
T3 (20% SCR)	338.5	351.67	345.08
Mean	350.28	340.61	

Gain in Weight

The Analysis of Variance revealed that there were no interactions at the 5% level between levels of substitution and sex of ducks in terms of gain in weight. As shown in Table 5 the heaviest weight gain was observed in T3 with the 20% replacement of SCR in formulated feeds in male mallard ducks at 625.17g. It is also observed that the mean of T3 (20% replacement of SCR) regardless of sex was highest compared to other treatments.

Table 5

Gain in weight (g) of the mallard ducks fed varying levels of soybean curd residue.

Treatments	Sex of Ducks		Mean
	(Male)	(Female)	
T1 (Control)	551.50	555.83	553.66
T2 (15% SCR)	560.50	594.33	577.41
T3 (20% SCR)	625.17	596.33	610.75
Mean	579.06	582.16	

Feed Consumed

For the combined effects of the level of the soybean substitution and the sex of the mallard ducks, two-way ANOVA did not show any significant effect on the feed consumed of the mallard ducks. There was no interaction either shown in the individual effects of the soybean substitution and the sex of the mallard ducks on the feed consumed by the mallard ducks. From this, it can be assumed that all the treatments were the same when the feed consumption was used as the point of comparison. As shown in Table 6, the highest consumption was found in T3 (20% replacement of SCR in Female Mallard duck) at 4592.17 g, and the lowest consumption was found in T1 (Basal feeds in Male Mallard duck) at 4501.67 g.

Table 6

Feed consumption (g) of the mallard ducks fed varying levels of soybean curd residue.

Treatments	Sex of Ducks		Mean
	(Male)	(Female)	
T1 (Control)	4501.67	4546.83	4524.25
T2 (15% SCR)	4581.17	4571.33	4576.25
T3 (20% SCR)	4548.83	4592.17	4570.50
Mean	4543.89	4570.11	

Final Weight

As shown in Table 7, the highest final weight was observed in T3 (SCR as 20% replacement for soybean meal in formulated duck starter/grower feeds in Male Mallard duck) at 963.67 g. The lowest final weight was found at T1 (Basal feeds (soybean meal + corn) in formulated duck starter/grower feeds in Female Mallard duck) at 900.33. Like the previous parameter, two-way ANOVA did not show any significant effect on the combined effects of the sex of the mallard duck and the soybean substitution levels. The individual effects of the treatments did not show either any interactions with the final weight of the mallard ducks. On the other hand, it was observed that the mean final weight of male mallard duck was higher than female mallard duck. It was also observed that as the level of substitution increases, the higher the final weight of mallard ducks was recorded regardless of sex. It is an excellent indication that SCR can be used as a substitute for soybean meal.

Table 7

Final weight (g) of the mallard ducks fed varying levels of soybean curd residue.

Treatments	Sex of Ducks		Mean
	(Male)	(Female)	
T1 (Control)	901.00	900.30	900.66
T2 (15% SCR)	923.30	920.00	921.66
T3 (20% SCR)	963.70	948.00	955.83
Mean	929.33	922.78	

Feed Conversion Ratio

The ability to convert feed into the meat of any animal is a very important aspect that greatly affects the profitability of animal production. The lower the numerical value, the better is the feed conversion ratio. The two-way ANOVA, however, did not show any significant difference in the combined effects of the level of the soybean substitution and the sex of the mallard ducks. Like the previous parameter, the individual effects of the soybean substitution and the sex of the mallard ducks did not show any significant effect on the average feed consumed by the mallard ducks either. As shown in Table 8, the lowest feed conversion ratio was found in treatment T3 (soybean curd residue as 20% replacement for soybean meal in formulated duck starter/grower feeds in Male Mallard duck) at 7.29. On the other hand, even though there are no significant differences shown in the different treatments between the main factor and sub-factor, it was observed that the mean of the FCR of the male ducks was lower than the female ducks. Also, as the level of substitution was higher, the FCR mean was lower which is safe to assume that soybean curd residue is reasonable to use as a substitute for soybean meal.

Table 8

Feed conversion ratio of the mallard ducks fed varying levels of soybean curd residue.

Treatments	Sex of Ducks		Mean
	(Male)	(Female)	
T1 (Control)	8.16	8.23	8.19
T2 (15% SCR)	8.19	7.72	7.95
T3 (20% SCR)	7.29	7.81	7.55
Mean	7.88	7.92	

Dressing Percentage

The treatments did not show any significant difference in the combined effects of the level of the soybean substitution and the sex of the mallard ducks. The same case also was observed in both individual effects of the two said factors. On the other hand, as to the sex of ducks, the highest mean of dressing percentage was observed in males at 68.60%. Moreover, as to the level of substitution, it is noticeable that as the level of substitution increases, the mean of dressing percentage also increases. Much like the previous parameters, it could be presumed that SCR is a good protein source that can substitute for soybean meal.

Table 9

Dressing percentage of the mallard ducks fed varying levels of soybean curd residue.

Treatments	Sex of Ducks		Mean
	(Male)	(Female)	
T1 (Control)	64.09	62.47	63.28
T2 (15% SCR)	67.42	62.84	65.13
T3 (20% SCR)	74.28	64.15	69.21
Mean	68.60	63.15	

Carcass Weight

The highest carcass weight was observed in T3 (soybean curd residue as 20% replacement for soybean meal in formulated duck starter/grower feeds in Male Mallard duck) at 650g. The lowest average carcass weight was found in T1 (Basal feeds (soybean meal + corn) in formulated duck starter/grower feeds in Female Mallard duck) at 560g. Like the previous parameter, the treatments did not show any significant difference in the combined effects of the level of the SCR substitution and the sex of the mallard ducks. However, the sex of the mallard ducks had a significant effect on the carcass weight at a 5% level of significance with F = 5.28. This shows that male mallard ducks' carcasses tend to be heavier than female mallard ducks; the result is somewhat similar to the study of Boos et al. (2002), wherein males were, on average of 15% heavier and 18% larger than females.

Table 10

Carcass weight of the mallard ducks fed varying levels of soybean curd residue.

Treatments	Sex of Ducks		Mean
	(Male)	(Female)	
T1 (Control)	563.33	560.00	561.66
T2 (15% SCR)	588.33	563.33	575.83
T3 (20% SCR)	650.00	573.33	611.66
Mean	600.55a	565.55b	

Note: Sex of ducks means having different letters (a-b) are significant at 5% level

Organ Weight

The weight of the liver, gizzard, and heart was relatively close to each other. By using two-way ANOVA, it was observed that the treatments did not show any significant difference in the combined effects of the level of the soybean substitution and the sex of the mallard ducks. The individual effects of the two factors also did not show any significant difference. This shows that there is no negative effect on the visceral organs of the ducks with regard to the substitution of soybean curd residue irrespective of the sex of the ducks.

Table 11

Organ weight of the mallard ducks fed varying levels of soybean curd residue.

	T1 (Control)		T2 (15% SCR)		T3 (20% SCR)	
	(Male)	(Female)	(Male)	(Female)	(Male)	(Female)
Liver Weight	20.00	20.00	20.67	20.00	23.33	20.00
Gizzard Weight	46.67	43.33	46.67	46.67	46.67	40.00
Heart Weight	9.33	9.33	10.00	10.00	9.33	10.00

Cost and Return Analysis

The 20% level of substitution of SCR as a replacement for soybean meal in male mallard ducks resulted in lower cost of production because of lower feed cost for those ducks fed SCR in the diet. However, the highest return on investment (ROI) was recorded in the 20% level of substitution of SCR in female mallard ducks at 21.32% due to the higher selling price/kg live weight of female mallard ducks compared to male mallard ducks, which gives a positive impact to gain a highest net income. On the other hand, as shown in the break-even point calculation in 20% level of substitution of SCR in female mallard ducks, in order to produce profit, the amount of sales required to cover all the variables and fixed costs are greater than 28.44kgs and the cost of producing a kilogram of mallard ducks is P 123.64.

Table 12

Cost and Return Analysis of mallard ducks fed varying levels of soybean curd residue.

	T1-corn + soybean meal		T2- 15% Soybean Curd Residue		T3- 20% Soybean Curd Residue	
	B1- Male	B2- Female	B1- Male	B2- Female	B1- Male	B2- Female
SALES						
Total weight produced (kg)	27.03	27.01	27.7	27.6	28.91	28.44
Sales of Mallard duck	₱3,243.60	₱4,051.50	₱3,324.00	₱4,140.00	₱3,469.20	₱4,266.00
GROSS SALES	**₱3,243.60**	**₱4,051.50**	**₱3,324.00**	**₱4,140.00**	**₱3,469.20**	**₱4,266.00**
EXPENSES/COST						
Stocks -180 heads of mallard duck at P20 (male) and P35 (female)	₱600.00	₱1,050.00	₱600.00	₱1,050.00	₱600.00	₱1,050.00
Feed						
-Starter feeds	₱1,362.56	₱1,379.29	₱1,313.75	₱1,308.51	₱1,307.87	₱1,330.93
-Grower feeds	₱1,114.81	₱1,123.13	₱1,035.38	₱1,035.38	₱1,006.62	₱1,006.62
Labor cost -at P0.04/head/day x 60 days	₱72.00	₱72.00	₱72.00	₱72.00	₱72.00	₱72.00
Housing -Depreciation cost of housing	₱56.80	₱56.80	₱56.80	₱56.80	₱56.80	₱56.80
TOTAL EXPENSES	**₱3,206.17**	**₱3,681.22**	**₱3,077.93**	**₱3,522.69**	**₱3,043.29**	**₱3,516.35**
NET INCOME (₱)	**₱37.43**	**₱370.28**	**₱246.07**	**₱617.31**	**₱425.91**	**₱749.65**
ROI (%)	**1.17**	**10.06**	**7.99**	**17.52**	**13.99**	**21.32**
BREAK EVEN POINT	**27.03 kgs**	**27.01 kgs**	**27.70 kgs**	**27.60 kgs**	**28.91 kgs**	**28.44 kgs**
COST PER UNIT	**118.62**	**136.29**	**111.12**	**127.63**	**105.27**	**123.64**

Note: Selling price/kg live weight of male ₱ 120.00 and female mallard ducks ₱150.00
Starter feed cost/kg: T1-(Control) = P 18.91, T2-(15% SCR) = P 17.76, T3-(20% SCR) = ₱17.74
Grower feed cost/kg: T1-(Control) = P 17.01, T2-(15% SCR) = P 16.32, T3-(20% SCR) = P 16.04

Conclusion

The performance of mallard ducks in terms of final weight, weight gain, average feed consumption, feed conversion ratio, dressing percentage, and visceral organs weight both at 15% and 20% inclusion rates of soybean curd residue (SCR) for starter and grower rations are similar to the animals fed of soybean meal. There is a considerable rise, however, in the carcass weight in terms of the sex of the mallard ducks raised. The use of soybean curd residue (SCR) as substitute to soybean meal (SBM) is more profitable for farmers since it reduces the production cost of raising mallard ducks.

Recommendation

Soybean curd residue as a replacement for soybean meal is strongly recommended to be used by small to medium-scale duck farms and by feed millers at a 20% level of substitution.

Study on higher substitution levels of soybean curd residue at a 30% level of substitution is also encouraged to gain further information about its effects.

Soybean curd residue is also recommended to be tried in other animals, such as swine and ruminants, as an alternative protein source.

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