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Malunggay Pod Meal as Dietary Supplement: Its Effect on the Carcass Traits and Gut Development of Broiler Chickens

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Abstract

Malunggay (*Moringa oleifera* Lam) is a multipurpose drought-resistant tropical tree of the family Moringaceae. It is commonly used for human consumption, medicinal and agricultural uses, including animal feeding. The experiment was conducted to ascertain the effects of Malunggay Pod Meal (MPM) as a dietary supplement on the carcass yield, meat composition, and gut development of broiler chickens in a 42-day feeding trial. A total of 60-day-old broiler chickens were assigned in a Completely Randomized Design experimental set-up with four dietary treatments (3 replicated pens of 5 birds/pen). Dietary treatments were: (T_1) control group (0% MPM); (T_2) 5% MPM; (T_3) 10% MPM; and (T_4) 15% MPM. Carcass traits and gut development were measured by slaughtering three birds per treatment. Results indicated that the Malunggay Pod Meal supplementation has no significant effect ($p>0.05$) on the final weight, dressed weight, and carcass yield. However, numerically, birds treated with 15% MPM showed better results compared to other treatments. A significant result ($p<0.05$) was observed on the meat composition of broiler chickens, with the highest values observed in birds fed with 5% MPM. Moreover, Malunggay Pod Meal has no significant effect ($p>0.05$) on gut development. Numerically, broilers fed with 5% MPM improved the weight of the crop, heart, liver, cecum, kidney, and proventriculus. Overall, Malunggay Pod Meal (MPM) as a dietary supplement could be an alternative feed source with no adverse effect on the carcass traits, gut development, and meat composition of broilers.

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Introduction

Poultry production is one of the most widespread and dynamic agribusiness trades in the world. Poultry is very popular compared with the cattle and swine industry because it enjoys a relative advantage on the ease in management, quick and higher returns to capital investment, and wide acceptance of its products. Chicken meat contains a major amount of easily digestible and high-quality protein and less saturated fat. With an increase in consumer consciousness about meat intake, chicken meat is recommended for consumption by all age groups. Hussein *et al.* (2019) cited that poultry production provides a base for the socio-economic advancement in the majority of developing countries, which has led to increased demand for poultry products, especially broiler meat (Abbas, 2013). On the other hand, the quality of chicken meat is affected by several factors, such as fattening system, hybrid, sex, handling before and after slaughter, and feeding treatments. The chicken meat composition can be influenced through the modification of its feed composition.

Researchers have been studying different plants as supplements or alternative feed sources. Gull *et al.* (2016) stated that plants are the richest source of natural compounds having antioxidants, antimicrobial, and antiviral properties. A lot of plant parts and extracts, whether fresh or dried, have been used in poultry diets to reduce the high cost of conventional protein sources and as a growth promoter. It also contains phytonutrients and phytochemicals, referred to as secondary metabolites (Hussein *et al.*, 2019). Notwithstanding, a lot of plants have been utilized as alternative feed sources like malunggay, for it contains a high amount of protein and essential amino acids (Banjo, 2012).

Malunggay *(Moringa oleifera* Lam) is known as a super plant because of its versatility not just for human consumption and medicine but also in animal feeding. Malunggay pods are rich in bioactive compounds, flavonoids, vitamins, polyphenols, and nutrients (Gopalakrishnanb *et al.*, 2016). Further, Rajasekaran *et al.* (2008), as cited by Alabi *et al.* (2017), found out that Moringa is one of the best choices among the plants as it has some parameters of a phytogenic feed additive. However, limited research on the effect of Malunggay pods on feed supplements in the diet of farm animals has been published. Thus, this study was conducted to ascertain the effects of Malunggay pods as a feed supplement to broiler chickens carcass traits, meat composition, and gut development.

Materials and methods

Study Location, Duration, and Experimental House

The study was carried out at St. Alexius College Demonstration Farm, Purok Belo, Barangay San Felipe, Tantangan, South Cotabato from March 3, 2020, until April 14, 2020. A week before the arrival of the experimental birds, the brooder and poultry house were disinfected with detergent, chlorine, and water. During the brooding stage, old newspapers were used as flooring in the brooding pen. Twelve growing-cages measured 1x1 square meters were constructed to the number of treatments and replications.

Experimental Diets

All feed ingredients except vegetable oil and malunggay pods were purchased from local agriculture and veterinary store, while the fresh and tender malunggay pods were purchased from a local source. The collected pods were washed with tap water and chopped by an electric blender. The blended malunggay pods were sun-dried for two days until 12-15% moisture content is reached (PCAARRD, 2000) and pulverized by a grinder to produce a malunggay pod meal (MPM), and incorporated in the experimental rations at graded levels (Figure 1).

The experimental diets were formulated with the inclusion at various levels of MPM as follows: T_1= control diet with 0% MPM, T_2= experimental diet with 5% MPM, T_3= experimental diet with 10% MPM, and T_4= experimental diet with 15% MPM, producing four dietary treatments (Table 2). Malunggay pod meal and the experimental diet samples were sent to the Regional Animal Feed Analysis Laboratory

(RAFAL) in Cotabato City for proximate analysis (Table 1).

Experimental Birds and Experimental Design

The experimental birds were carried out following the Good Animal Husbandry Practices in rearing poultry and livestock animals in the Philippines (PNS/BAFPS, 2008). A total of 60-day-old broiler chicks were purchased from a local Agrivet store. The birds were randomly assigned to four dietary treatments of Malunggay Pod Meal (MPM) and arranged in a Completely Randomized Design experimental set up. Each treatment had three replications with five birds per replication.

Feeding and Bird Management

The 60-day-old chicks were placed inside the brooder with two 25-watts light bulb to provide sufficient heat until 14 days and fed *ad libitum* with commercial chick booster mash. At the brooding stage, clean drinking water with multivitamins was given to boost the immune system.

The feeding of experimental rations started after the 14th days brooding period. The birds were acclimatized for five days before feeding the experimental treatments by gradual shifting of feeds from chick booster mash to starter mash. The formulated broiler starter mash was provided on the 15^{th} to 28^{th} days. On the other hand, the formulated broiler finisher mash was given on the 29^{th} until the end of the study on *ad libitum* basis. Clean drinking water was provided throughout the feeding trial.

Carcass Quality Evaluation

At the end of the experiment, birds were starved for 12 hours, and the final body weight was recorded before slaughter. Broilers were humanely slaughtered based on the Rules and Regulations on Humane Handling in the Slaughter of Animals for Food (DA, 2008). Bleeding was done by striking a knife across the neck below the earlobe. After bleeding, the birds were scalded and de-feathered by hand plucking, washed, and eviscerated. Carcass cuts and non-edible offal components were determined according to the procedure described by Kubena *et al.* (1974), as cited by Tesfaye *et al.* (2014). Dressed carcass weight was measured after evisceration, and the dressing percentage was calculated as the proportion of dressed carcass weight to slaughter weight multiplied by 100.

$$\text{Dressing percentage} = \frac{\text{Weight of dressed chicken (g)}}{\text{Fasted lived weight of chicken (g)}} x\ 100$$

Evaluation of Gut Development and Meat Composition

After evisceration, small and large intestines and other visceral organs were washed and cleaned to measure their weights and lengths. The visceral organs were weighed accordingly using a weighing scale of 0.01 gram calibrations. The length of small and large intestines was measured using a tape measure. Breasts and thighs were chilled and stored inside the polyethylene bags for analysis. The chemical analyses were performed in duplicate for the dried samples following the methods described by the AOAC (2016).

Cooking Loss

The meat samples taken from the breast and thigh parts were sliced into cubes at 2cm x 2cm x 2cm measurement and weighed (initial weight) before cooking. The sliced meat samples were wrapped with aluminum foil and cooked in a conventional oven at 130°C for twenty (20) minutes (Mnisi *et al.*, 2018).

The cooked samples were removed from the oven and weighed (final weight). The difference of the weight was calculated as a cooking loss using the formula described by Rahman *et al.* (2015).

$$\text{Cooking Loss} = \frac{\text{Initial weight of the sample} - \text{Final weight of the sample}}{\text{Initial weight of the sample}} x\ 100$$

Statistical Analysis

Data collected were subjected to a one-way analysis of variance (ANOVA) in a Completely Randomized Design experimental set up. Differences among the groups were analyzed using Tukey's Honest Significant Difference (HSD) test. Probabilities ($p<0.05$) were considered significant.

Results

Carcass Traits

Birds supplemented with graded levels of malunggay pod meal had no significant effect (p>0.05) on the carcass traits of broiler chickens (Table 3). Although not significant, birds fed with various MPM levels show better final weight and cut-up part percentage than the control or without MPM supplementation. After 42 days of the feeding trial, the highest final weight was observed in birds supplemented with 15% MPM (T_4) weighed 1.43±0.06 kg. On the other hand, the cooking loss percentage for both thigh and breast muscle showed no significant difference (p>0.05) when fed with MPM (Table 3).

Numerically, the cooking losses for thigh and breast muscle were highest in 10% MPM (T_3) with 0.47 grams and 0.43 grams, respectively.

Table 1. Proximate chemical composition of Malunggay Pod Meal.

NUTRIENT	MPM (%)
Crude Protein	13.02
Crude Fiber	36.98
Ash	5.94
Moisture	11.33

Analyzed following the methods described by the AOAC (2016) 20th edition.

Table 2. Composition and chemical analysis of the experimental diets.

Ingredients (% as fed basis)	Starter Diet (15-28 days)				Finisher Diet (29-42 days)			
	T1 0%	T2 5%	T3 10%	T4 15%	T1 0%	T2 5%	T3 10%	T4 15%
Hammered Corn	58.00	54.00	51.70	45.00	61.72	58.51	54.81	52.32
Rice Bran D1	6.00	5.00	4.00	5.00	5.00	4.00	3.00	3.00
Soybean Meal	26.00	25.54	24.31	28.00	23.26	22.49	23.13	21.70
Fish Meal, 60%	4.00	4.00	4.00	1.00	4.00	4.00	4.00	4.50
Copra Meal	3.00	3.00	3.00	3.00	2.00	2.00	0.50	0.50
MPM[1]	0.00	5.00	10.00	15.00	0.00	5.00	10.00	15.00
Dicalcium Phosphate	0.73	0.40	0.50	0.20	1.50	1.50	1.00	0.05
Limestones	0.70	0.90	0.79	0.55	0.70	0.30	0.55	0.70
Lysine HCL	0.12	0.08	0.05	0.05	0.05	0.10	0.05	0.02
D-L Methionine	0.05	0.05	0.05	0.05	0.05	0.10	0.10	0.05
L threonine	0.10	0.05	0.05	0.01	0.02	0.10	0.05	0.01
Tryptophan	0.05	0.08	0.05	0.10	0.10	0.10	0.09	0.10
Vit. Premix[2]	0.50	0.50	0.50	0.50	0.50	0.50	0.60	0.50
Salt	0.25	0.50	0.50	0.54	0.40	0.60	1.42	1.35
Vegetable Oil	0.50	0.90	0.50	1.00	0.70	0.70	0.70	0.20
Total (kg)	100	100	100	100	100	100	100	100
Chemical Analysis (% DM)[3]								
Crude Protein	19.10	20.48	19.64	20.86	18.87	19.53	19.00	19.52
Crude Fiber	2.91	4.14	7.55	11.23	5.15	7.47	9.61	6.88
Moisture	10.26	10.84	11.23	11.75	13.28	11.91	12.46	12.22
Ash	9.32	6.02	5.49	6.75	5.40	4.69	5.08	5.57
Calculated Analysis								
ME (MJ/kg)	2969	2970	2968	2970	2988	2989	2989	2989
Phosphorus	0.41	0.56	0.83	0.98	0.49	0.75	0.91	1.00
Calcium	0.78	0.87	0.88	0.83	0.89	0.87	0.93	0.92
Lysine	1.35	1.35	1.4	1.57	1.26	1.28	1.36	1.45
Methionine	0.48	0.49	0.55	0.58	0.56	0.52	0.56	0.58
Meth+Cys	0.74	0.83	0.92	1.00	0.70	0.79	0.88	0.97
L-Threonine	0.91	0.99	1.08	1.21	0.95	0.99	1.07	1.16
Tryptophan	0.34	0.34	0.37	0.39	0.33	0.34	0.35	0.37

[1] Malunggay Pod Meal

[2]Per 500 grams vitamin premix contains; Vitamin A (150,000 IU), Vitamin D3 (30,000 IU), Vitamin E (500 IU), Selenium (100mg), Potassium Iodide (100mg), Cobalt Sulfate (30mg), Manganese Sulfate (3,700mg), Ferrous Sulfate (1600mg), Copper Sulfate (1,500mg), Zinc Sulphate (220mg), Dicalcium Phosphate (97%), Carrier (q.s.ad)

[3]Analyzed following the methods described by the AOAC (2016) 20th edition.

Meat Composition

The effects of dietary supplementation of MPM significantly affect ($p<0.05$) the meat composition (Table 4). The highest crude fiber and moisture content in breast meat was observed in birds fed with 5% MPM (T_2). Crude fiber and ash of thigh meat are significantly higher in birds fed with 15% MPM (T_4).

Gut Development

The result shows no significant effect ($p>0.05$) on the gut development of broiler chickens (Table 5).

Numerically, the inclusion of MPM in the diet showed heavier weight in the visceral organs when fed with 5% and 15% of malunggay pod meal.

Table 3. The Effect of Malunggay Pod Meal supplementation on the Carcass Traits of Broiler chickens.

PARAMETERS	TREATMENTS					
	T_1 0 %	T_2 5 %	T_3 10 %	T_4 15 %	CV	p-value
Final Weight, kg	1.41±0.02	1.39±0.07	1.42±0.00	1.43±0.06	3.87	0.850^{ns}
Dressed Weight, kg	1.09±0.12	1.07±0.08	1.05±0.07	1.10±0.05	7.76	0.912^{ns}
Dressing Percentage,%	77.24±7.46	76.70±4.44	74.15±5.29	77.05±7.21	8.17	0.920^{ns}
Cooking Loss Breast, g	0.43±0.06	0.43±0.06	0.47±0.06	0.47±0.11	17.21	0.900^{ns}
Cooking Loss Thigh, g	0.37±0.15	0.33±0.06	0.43±0.15	0.33±0.11	11.49	0.743^{ns}
Cut-up parts as a percentage in final weight (%)						
Head	27.12±1.47	26.36±1.83	28.38±3.78	29.40±3.81	10.54	0.615^{ns}
Neck	5.13±0.83	5.08±0.32	5.16±0.15	5.34±0.62	10.65	0.941^{ns}
Feet	48.13±7.28	41.75±4.21	49.73±5.14	48.10±5.52	12.04	0.379^{ns}
Wings	9.71±0.50	9.19±0.31	8.92±0.71	9.18±1.18	8.10	0.634^{ns}
Thighs	12.39±1.08	12.75±1.33	11.83±0.89	12.53±0.94	8.66	0.752^{ns}
Drumsticks	10.75±1.15	10.27±0.92	10.28±0.40	10.24±0.83	8.36	0.869^{ns}
Breast	26.91±2.54	26.94±4.88	25.82±3.85	27.03±4.42	15.08	0.979^{ns}
Back	11.87±1.37	13.09±0.64	12.20±0.87	12.26±1.32	8.84	0.591^{ns}

ns= not significant

CV = Coefficient of Variance.

Discussion

In the present study, the inclusion of various Malunggay Pod Meal (MPM) levels from 0%, 5%, 10%, and 15% of feed ration was supplemented on the diet of broiler chickens. It was observed that on the final weight, chicken fed with 10% MPM has a heavier weight than other dietary treatments. This conforms to Onunkwo *et al.* (2015) findings, who noted that *Moringa oleifera* leaf meal could be used in broiler ration up to 10% level without adverse effect on performance. Moreover, the result is supported by Ebenebe *et al.* (2012) that supplementation of 10% malunggay leaf meal in the diet showed better results in the final live weight, average weight gain, and feed conversion ratio. The increase in birds' final weight fed with Moringa can be due to the rich nutrient content, especially the high amount of crude protein, vitamins, and minerals present (Mahfuz *et al.,* 2019). Also, the improvement in live body weight and body weight gain of broilers fed dietary *Moringa oleifera* leaf powder compared with birds fed control diet may be due to the antimicrobial abilities and pharmacological properties (Latif *et al.,* 2014).

Malunggay Pod Meal had no significant effect ($p>0.05$) on the dressing percentage and carcass yield of birds. This conforms to the study conducted by Kumar *et al.* (2018) that *Moringa oleifera* leaf meal did not influence the dressing percentage and also the recent findings of (Hassan *et al.*, 2016) and (Zanu *et al.* 2012) confirms that the addition of *Moringa oleifera* Leaf Meal to broiler diets had no significant effects on carcass percentage and the relative of the liver, gizzard, heart, breast, thigh and abdominal fat.

Table 4. The effect of Malunggay Pod Meal supplementation on the meat composition of broiler chickens.

PARAMETERS	TREATMENTS					
	T_1	T_2	T_3	T_4		
	0 %	5 %	10 %	15 %	CV	p-value
Breast Meat (%)						
Crude Protein	21.62±1.37	21.45±0.37	24.11±1.29	22.94±1.48	25.53	0.242[ns]
Crude Fiber	1.51±0.12[b]	2.58±0.09[a]	1.37±0.10[b]	0.32±0.07[c]	8.24	0.000[**]
Ash	1.26±0.07[ab]	1.02±0.04[c]	1.19±0.03[bc]	1.43±0.07[a]	5.17	0.009[**]
Moisture	72.50±0.15[c]	76.42±0.74[a]	74.23±0.13[b]	74.24±0.11[b]	4.49	0.003[**]
Thigh Meat (%)						
Crude Protein	18.63±0.89	18.86±0.07	20.42±0.30	19.85±0.58	12.54	0.087[ns]
Crude Fiber	1.43±0.31[b]	4.43±0.78[a]	1.90±0.15[b]	2.59±0.40[ab]	29.19	0.011[*]
Ash	0.92±0.04[b]	1.08±0.01[ab]	1.15±0.03[a]	1.07±0.08[ab]	4.86	0.041[*]
Moisture	73.04±1.37	69.14±1.47	69.99±1.41	69.72±1.43	16.94	0.157[ns]

ns= not significant

CV = Coefficient of Variance

[a,b,c]= Means±SD with different letter superscripts within the same row are significantly different ($P<0.05$).

The negative impact of malunggay on the carcass traits of broilers, which was cited by (Ochi *et al.*, 2015), may be due to the presence of phytate in *Moringa oleifera* seeds, which is an anti-nutritional factor. Phytate reduces the availability of minerals in non-ruminant animals and declines the digestibility of starch and protein. In addition, MPM did not influence meat quality relative to the cooking loss of the bird's thigh and breast. However, MPM significantly affects ($p<0.05$) the chemical composition of meat.

The results agree with the findings of Rehman *et al.* (2018) that supplementation of *Moringa oleifera* leaf powder at 12 g/kg could increase the muscle fiber diameter in breast muscle of chicken.

Table 5. The effects of Malunggay Pod Meal supplementation on the gut development of broiler chickens.

PARAMETERS	TREATMENTS					
	T_1	T_2	T_3	T_4		
	0%	5%	10%	15%	CV	p-value
Crop weight, g	6.33±2.52	6.67±3.05	5.00±0.00	6.00±1.00	11.34	0.775[ns]
Heart weight, g	733±0.58	8.00±2.65	6.33±2.08	8.00±1.73	25.82	0.688[ns]
Liver weight, g	33.33±11.01	44.33±12.05	36.33±10.97	39.67±10.69	29.14	0.673[ns]
Gizzard weight, g	24.33±4.04	22.67±3.05	22.67±2.08	24.33±4.93	15.68	0.890[ns]
Pancreas weight, g	3.67±1.15	3.00±1.00	3.67±0.577	3.67±1.15	28.57	0.802[ns]
Cecum weight, g	5.00±2.00	5.67±0.57	4.67±1.15	5.67±1.15	25.20	0.738[ns]
Kidney weight, g	8.00±1.73	9.33±2.08	8.33±1.53	8.67±2.08	21.80	0.840[ns]
Small Intestine weight, g	32.00±7.00	37.00±2.65	37.33±14.57	38.67±10.79	27.05	0.848[ns]
Large Intestine weight, g	3.00±2.00	3.00±1.00	3.33±0.58	3.67±0.58	12.21	0.883[ns]
Small Intestine length, cm	178.67±16.17	180.33±10.41	199.83±23.26	196.33±21.45	9.81	0.430[ns]
Large Intestine length, cm	11.77±1.08	12.40±0.53	11.33±0.58	12.17±1.53	8.51	0.610[ns]
Abdominal fat weight, g	10.67±5.51	12.67±7.23	5.67±5.03	7.67±5.03	20.99	0.496[ns]
Proventriculus weight, g	5.67±2.52	7.00±2.65	4.67±0.58	6.00±1.73	27.21	0.596[ns]
Gall Bladder weight, g	2.67±0.58	2.33±1.53	2.33±0.58	2.67±0.58	9.13	0.937[ns]

ns= not significant
CV = Coefficient of Variance
g = gram.

Moreover, no significant effect was observed on the gut development ($p>0.05$) relative to crop, heart, liver, gizzard, pancreas, cecum, kidney, abdominal fat, proventriculus, gall bladder, and weight and length of small and large intestines. This was supported by the findings of Nkukwana *et al.* (2014) and (Edu *et al.,* 2019) that the addition of *Moringa oleifera* leaf meal to broiler diets has no significant effects on carcass weight, dressing percentage, and the relative weights of the liver, gizzard, heart, spleen, abdominal fat, heart, liver, and kidney weight of broilers.

Fig. 1. Preparation of Malunggay Pod Meal.

The abdominal fat of chickens in 10% MPM (T_3) and 15% MPM (T_4) was lower compared to the rest of the diets. This implied that high levels of MPM (above 5%) lowered the abdominal fat.

This conforms to Gakuya *et al.* (2014) findings that high levels of *Moringa oleifera* leaf meal (above 7.5%) could decrease abdominal fat. Numerically, the weight and length of the small intestine were higher in birds fed with 10-15% MPM. This is contrary to the recent findings of Khan *et al.* (2017) that the length and an empty weight of the small intestine were higher in broilers fed with 1.2% leaves powder. The increase of the intestine length may be due to the increased stay-time of ingesta induced by the Moringa's fiber content (Xu *et al.*, 2003). Further, (Edu *et al.,* 2019) assumed that the internal organs could effectively regulate their nutrient requirement through the livers' metabolic function.

Conclusion and recommendations

The experiment revealed that the inclusion of graded levels of Malunggay Pod Meal (MPM) did not significantly influence the parameters in carcass traits and gut development of broilers. Supplementation of MPM at 10% to 15% levels could improve the carcass traits, while supplementation of MPM at 5% level improves the gut development on broilers. On the other hand, the supplementation of MPM significantly affects the meat composition of chicken. Thus, Malunggay Pod Meal could be an alternative feed source with no adverse effect on the carcass traits and gut development and showed better results on broilers meat composition. Nonetheless, further studies are recommended to study the effects of malunggay pod meal in other farm animals.

Author's contribution

The authors contributed equally to this manuscript.

Conflict of interest

The authors declare that there is no conflict of interest.

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