Uttar Pradesh Journal of Zoology

Volume 45, Issue 15, Page 499-510, 2024; Article no.UPJOZ.3771
ISSN: 0256-971X (P)

Optimizing Broiler Growth, Yield Performance, Meat Sensory, and Productivity through Novel Synergies of Dietary Sweet Potato Leaf Meal and Water-soluble Multi-herbal Extract

Gilmore M. Ramoso, Jr. [a*], Rhea F. Ramoso [b], Siony M. Cordova [c] and Ever Joy G. Rabadan [d]

[a] College of Agriculture, Faculty of Agroforestry, Agusan del Sur State College of Agriculture and Technology, Agusan del Sur, Philippines.
[b] Department of Education, Faculty of Education, West Bunawan National High School, Agusan del Sur, Philippines.
[c] College of Agri-fishery and Allied Sciences, Faculty of Animal Science, Surigao del Norte State University – Mainit Campus, Surigao del Norte, Philippines.
[d] Commission on Higher Education, Supervisor of Education, Commission on Higher Education Caraga Regional Office, Butuan City, Philippines.

Authors' contributions

This work was carried out in collaboration among all authors. Author GMRJr interpreted the results. Author RFR collected the data and analyzed the study. Author SMC did experimental design and implemented the manuscript. Author EJGR discussed and prepared the article. All authors read and approved the final manuscript.

Article Information

DOI: https://doi.org/10.56557/upjoz/2024/v45i154266

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://prh.mbimph.com/review-history/3771

Original Research Article

Received: 12/05/2024
Accepted: 16/07/2024
Published: 19/07/2024

**Corresponding author: Email: ramosogilmorejr@gmail.com;*

***Cite as:** Jr., Gilmore M. Ramoso, Rhea F. Ramoso, Siony M. Cordova, and Ever Joy G. Rabadan. 2024. "Optimizing Broiler Growth, Yield Performance, Meat Sensory, and Productivity through Novel Synergies of Dietary Sweet Potato Leaf Meal and Water-Soluble Multi-Herbal Extract". UTTAR PRADESH JOURNAL OF ZOOLOGY 45 (15):499-510. https://doi.org/10.56557/upjoz/2024/v45i154266.*

ABSTRACT

In broiler chicken production, there is a critical need for sustainable feed supplements that can simultaneously improve growth performance, enhance meat quality, and increase profitability. To optimize broiler performance, this research examines potential synergies by combining two promising supplements, sweet potato leaf meal (SPLM) and multi-herbal extracts (MHE). The underlying hypothesis posits that combining SPLM in the diet and MHE in drinking water will improve broiler performance more than using either supplement alone. The experimental design involved broiler feed supplemented with SPLM ranging from 10 to 30 g/kg and water with MHE ranging from 0 to 10 mL/L, following a 2 x 4 factorial arrangement over 7-35 days. Growth parameters were assessed, including feed intake, weight gain, feed conversion ratio (FCR), and final body weight. Carcass quality analyses quantified dressed weights, cutlet weights, and edible offal. Economic analysis was also conducted, focusing on return on investment (ROI). Results revealed that 10 mL/L MHE and 30 g/kg SPLM combination elicited the maximum weight gain, lowest FCR, and highest dressed weights. This observation confirmed a synergistic augmentation of growth and muscularity. Furthermore, the economic analysis demonstrated that 10mL/L MHE + 30g/Kg SPLM maximized the return on investment. The study highlights a unique interaction between the nutrients in SPLM and the phytochemicals in MHE. This potentially enhanced broiler productivity through complementary bioactive mechanisms, modulating digestion, immunity, and protein accretion. Further research is warranted to delve into the precise modes of action and validate the universal applicability of this synergistic approach across diverse production systems.

Keywords: Carcass quality; growth performance; multi-herbal extract; sweet potato leaf meal; synergistic effect.

1. INTRODUCTION

The proliferating global demand for poultry necessitates sustainable interventions to enhance broiler chicken production efficiency. However, with mounting concerns over antibiotic resistance and synthetic additives, the industry increasingly favors natural, agriculturally-derived supplements to optimize broiler performance. Two promising candidates are sweet potato leaf meal and water-soluble extracts from various herbs and spices. Researchers have studied sweet potato leaf meal as an alternative feed ingredient for broiler chicken diets. Studies show up to 11% of dietary SPLM can improve broilers' final body weight, weight gain, and feed intake [1]. However, higher levels can lead to declining performance. SPLM does not have a negative impact on broiler chicken carcass characteristics. At 5% SPLM supplementation, feed intake decreased, and growth parameters improved, while up to 9% SPLM did not adversely affect carcass traits [2]. For optimal broiler performance, dietary SPLM usage should be limited to 5% [3]. The high crude protein, carbohydrates, vitamins, and minerals in sweet potato leaves make them a cost-effective protein source for broiler diets. Simultaneously, studies have explored the effects of herbal extracts provided through drinking water on broiler chicken growth and health. Extracts such as garlic, turmeric, and plantain have positively impacted weight gain and carcass traits [4-6]. While herbal water supplements show potential benefits for broilers, further research is needed to establish standardized preparation methods and optimal dosages to ensure consistent improvements in broiler performance.

While individual studies have highlighted the positive impacts of sweet potato leaf meals and herbal phytogenic extracts, their combined effects remain a significant knowledge gap. This study addresses the unexplored synergy between two promising supplements—sweet potato leaf meal and multi-herbal extracts—in broiler chicken. The present research hypothesis is that integrating sweet potato leaf into the diet and herbal-derived extracts in water will yield superior growth performance and enhance the carcass quality compared to an unsupplemented diet and water.

2. MATERIALS AND METHODS

2.1 Subject Animals

A total of 160 Cobb 500 commercial broiler chicks, aged one day, were purchased from a reliable supplier in the locality. The chicks, vaccinated against Newcastle Disease (B1 Type, LaSota Strain) on day 5, were provided continuous lighting during the initial 48-72 hours to ensure easy access to feed and water. After seven days of communal brooding, the broiler chicks were randomly distributed to 32 slotted pens, locally made, and 50cm x 80cm dimension. The 35-day feeding trial took place under standard management conditions at the Animal Production Complex of Agusan del Sur State College of Agriculture and Technology (ASSCAT), Philippines, adhering to strict biosecurity protocols.

2.2 Experimental Design and Treatments

This study employed a Randomized Complete Block Design (RCBD) with a 2x4 factorial arrangement. The experiment included a total of eight treatments: two levels of MHE in water (0 ml/L as tap water and 10 ml/L) combined with 100% standard diet (SD) and three levels of Sweet Potato Leaf Meal (SPLM) in the diet (10 g/kg, 20 g/kg, and 30 g/kg). The treatments were applied to broiler chicks from day 7 to day 35.

2.3 Preparation of Sweet Potato Leaf Meal Powder (SPLM)

Sweet potato (*Ipomoea batatas* L.) leaves were harvested from vines grown in Camp 6, Nueva Era, Bunawan, Agusan del Sur, Philippines. The leaves were cut at the petioles and transported to the feed processing facility of the college, where they were rinsed thoroughly with clean water and pat dry. The leaves were then chopped into small pieces using a chaff cutter and dried in a hot air oven at 40°C for 48 hours. The dried leaves were then coarsely ground using a mechanical mill with a 2mm strainer. The SPLM powder was stored in a cool, dark room until mixed with the standard broiler (commercial starter and finisher) diet per the treatment combinations. The detailed nutrient composition of standard diets is presented in Table 1.

2.4 Preparation of Multi-herbal (MHE)

A total of 10 kg each of fresh garlic bulbs (*Allium sativum*), onion bulbs (*Allium cepa*), and ginger rhizomes (*Zingiber officinale*) procured from the local market were precisely chopped. This herb mix was then placed in a 20 L plastic container, covered with 6 L of pale pilsen beer (San Miguel Brewery Inc.), initiating a 12-hour fermentation period at room temperature (28°C). Following this initial stage, 6 L of molasses was added, and the mixture underwent hand-mixing, undergoing a further 7-day fermentation process without light. Subsequently, 18 L of coconut vinegar was introduced into the fermented herb-beer amalgamation, fostering an additional 10 days of fermentation at room temperature without light. The resulting product underwent filtration using a fine mesh screen bottled in amber-colored reagent bottles. To preserve the integrity of the MHE, it was stored at 4°C until the use time.

2.5 Application of Experimental Treatments

The factorial combination of MHE and SPLM supplements was administered to broiler chickens in a controlled manner. The garlic-ginger-onion fermented extract of MHE was diluted into drinking water at concentrations of 0 mL/L (pure water control) and 10 mL/L, following the optimal inclusion recommended by Islam et al. [7]. The phytogenic water preparations were provided *ad libitum* via cylindrical plastic drinkers in each pen, with fresh solutions replaced every 12 hours to ensure consistent dosing throughout the 35-day experimental duration. Concurrently, varying ratios of dried, powdered SPLM were incorporated into the standard broiler starter and finisher feed to achieve targeted dietary concentrations of 0 g/kg (control), 10 g/kg, 20 g/kg, and 30 g/kg, based on optimal inclusion guidelines from Akintomide et al. [3], Alemu [2], and Oghenebrorhie & Job [1]. The SPLM-blended feed was manually mixed for 10 minutes

Table 1. Guaranteed analysis of the standard diet used in the experiment

Nutrient	Starter diet	Finisher diet
Crude protein	19.5% min.	14% min.
Crude fiber	6.0% max.	3.0% min.
Crude fat	3.0% min.	8.0% min.
Calcium	0.90 - 1.10%	0.70 – 0.80%
Phosphorus	0.55% min	0.50%
Moisture	12.0 max.	12.0% max.

Starter diet (Integra 2000) and finisher diet (Integra 3000) by B-MEG, san miguel foods, inc.

post-addition to ensure homogeneous distribution within the diet. All feed was supplied *ad libitum* in hanging tube feeders specific to each replicate pen.

2.6 Data Collection Gathering

The data collection procedure involved detailed monitoring and recording of various parameters throughout the experimental period, which extended over a significant duration. Feed-related parameters were assessed by calculating daily feed intake, differentiating the amount offered from the leftover feed on a pen basis. The total feed consumed in each pen was divided by the number of birds to calculate the average feed intake per bird. Additionally, the birds' initial and final body weights were recorded to determine weight gain and Feed Conversion Ratio (FCR) throughout the 7 to 35-day study period.

In parallel, carcass characteristics were evaluated by measuring dressed weight, determining dressing percentage, and weighing individual meat cuts and edible offals. Sensory evaluation was conducted by a semi-trained taste panel, which assessed cooked chicken meat samples for attributes such as appearance, aroma, texture, taste, juiciness, and overall acceptability using a 5-point hedonic scale (1-5, where 5 is very much acceptable and 1 is not sufficient) [8]. Finally, a cost and return analysis was performed to evaluate the economic feasibility of the dietary treatments, including total production cost, gross income, net income, and Return on Investment (ROI).

2.7 Statistical Analysis

The data collected from the experiment were subjected to analysis of variance (ANOVA) suitable for a Randomized Complete Block Design (RCBD) with a factorial structure. Duncan's Multiple Range Test (DMRT) was utilized to compare the means, setting the significance level at 0.05. Statistical analyses were performed using software like SPSS for Windows.

3. RESULTS

3.1 Growth Response

3.1.1 Feed intake

Table 2 provides a detailed analysis of feed intake patterns in broiler chickens subjected to a standard diet supplemented with varying quantities of SPLM and water supplemented with MHE. An interaction effect was observed, emphasizing the influence of different SPLM levels in the diet and MHE in drinking water on broiler chicken feed intake. Broiler chickens given pure water and supplemented with 30 g of SPLM had a significantly higher mean feed intake of 2,359 g, statistically different from the other treatment groups (P=0.001). Conversely, broiler chickens supplemented with 10mL of MHE and a standard diet exhibited a statistically significant lower mean intake of 2,163g (P=0.001), statistically equivalent to broiler chickens in 100% tap water receiving standard diet.

3.1.2 Final weight, weight gain, and feed conversion ratio

Broiler chickens supplemented with 10 mL/L of MHE exhibited a higher final body weight, positively influencing broiler chicken growth (P=0.001). A positive correlation was found between weight gain and dietary SPLM incorporation and MHE supplementation. Broiler chickens receiving 10 mL/L of MHE exhibited higher weight gains than chickens receiving tap water (P=0.002), highlighting the growth-promoting potential of MHE. The combination treatment of 10 mL/L MHE and 30 g/kg dietary SPLM was particularly effective in achieving maximum weight gain. Feed conversion Ratio (FCR) was influenced by dietary SPLM incorporation and MHE supplementation, with significantly lower FCR observed in broiler chickens supplemented with MHE at 10 mL/L (P=0.002). Incremental increases in dietary SPLM levels resulted in a linear improvement in FCR, with the most favorable FCR observed in the combined treatment of MHE water and 30 g/kg SPLM diet inclusion (P=0.015).

3.1.3 Carcass yield, weight of meat cuts, and edible offals

The study found that broiler dress weight varied significantly among MHE water treatments and with increasing levels of dietary SPLM incorporation (Table 3). Broiler chickens supplemented with SPLM dietary compounds in drinking water demonstrated higher dressed weights compared to the control group (P=0.002). The combination treatment of phytogenic compounds and 30 g/kg dietary SPLM resulted in the highest broiler chicken dress weight of 1223.25 g. The dressing percentage did not show significant differences across treatments involving SPLM dietary supplementation or water medication with multi-herbal extracts (P=0.10 and P=0.96), respectively.

The weight of breast meat was significantly influenced by both MHE and increasing SPLM inclusion, with a notable interaction effect (Table 4). Supplementation with 10 mL/L MHE in water significantly improved breast weight compared to the plain water control (P=0.001). Increasing SPLM levels from 0 to 30 g/kg significantly enhanced breast weights, with the highest observed in the 20 and 30 g/kg SPLM groups (P=0.001). The maximum breast meat weight was obtained in birds on the 10mL/L MHE and 30 g/kg SPLM. There were no significant differences in the weights of thighs and drumsticks among the different phytogenic water treatments. However, increasing levels of dietary SPLM led to a slight linear increase in drumstick weights, with broilers fed 30 g/kg SPLM-supplemented diets having the heaviest drumsticks. The heaviest wings and superior back cuts were obtained in chickens that received MHE in water and 30 g/kg sweet potato leaf meal in their diet.

Table 2. Effects of multi-herbal extract and sweet potato leaf meal levels on broiler chicken feed intake, final weight, weight gain, and feed conversion efficiency after 35 days trial

Levels of MHE	Levels of SPLM	Feed intake (g)	Final weight (g)	Weight gain (g)	FCE
100% Tap water	100% SD	2,185.00^{d}	993.50^{b}	578.75^{b}	2.23^{a}
	10g Kg^{-1} SPLM	2,252.00^{c}	1173.75^{a}	761.50^{a}	1.92^{a}
	20g Kg^{-1} SPLM	2,298.00^{c}	1196.00^{a}	759.50^{a}	1.92^{a}
	30g Kg^{-1} SPLM	2,359.00^{a}	1254.00^{a}	815.25^{a}	1.89^{ab}
10mL L^{-1}MHE	100% SD	2,163.00^{d}	1148.25^{b}	719.25^{b}	1.90^{ab}
	10g Kg^{-1} SPLM	2,201.00^{c}	1271.25^{a}	869.25^{a}	1.74^{b}
	20g Kg^{-1} SPLM	2,309.00^{b}	1270.00^{a}	829.00^{a}	1.83^{ab}
	30g Kg^{-1} SPLM	2,303.00^{b}	1382.50^{a}	922.50^{a}	1.67^{b}
P-Value					
Levels of MHE		0.001***	0.002**	0.002**	0.002**
Levels of SPLM		0.001***	0.001***	0.001***	0.015*
Levels MHE x Levels of SPLM		0.001***	0.830^{NS}	0.870^{NS}	0.580^{NS}

*Column means of different letters ^{abcd} are significantly different at 0.05 levels, *p < 0.05; **p < 0.01; ***< 0.001; NS: Not significant. MHE: multi-herbal extract, SPLM: Sweet potato leaf meal, SD: Standard diet, FCE: Feed conversion efficiency, mL L^{-1}: Milliliter per liter, g Kg^{-1}: Gram per Kilogram*

Table 3. Influence of multi-herbal extracts (MHE) and sweet potato leaf meal (SPLM) levels on broiler chicken dress weight and dressing percentage after 35 days trial

Levels of MHE	Levels of SPLM	Dress weight (g)	Dressing (%)
100% Tap water	100% SD	946.50^{b}	95.38
	10g Kg^{-1} SPLM	1056.75^{b}	90.07
	20g Kg^{-1} SPLM	1154.25^{ab}	96.49
	30g Kg^{-1} SPLM	1111.25^{ab}	88.82
10mL L^{-1} MHE	100% SD	1101.50^{b}	96.07
	10g Kg^{-1} SPLM	1176.00^{a}	92.66
	20g Kg^{-1} SPLM	1184.25^{a}	93.92
	30g Kg^{-1} SPLM	1223.25^{a}	88.44
P-Value			
Levels of MHE		0.004**	0.969^{NS}
Levels of SPLM		0.013*	0.101^{NS}
Levels MHE x Levels of SPLM		0.583^{NS}	0.868^{NS}

*Column means of different letters ^{ab} are significantly different at 0.05 levels, *p < 0.05; **p <0.01; NS: Not significant. MHE: multi-herbal extract, SPLM: Sweet potato leaf meal, SD: Standard diet, FCE: Feed conversion efficiency, mL L^{-1}: Milliliter per liter, g Kg^{-1}: Gram per Kilogram*

Table 4. Impact of multi-herbal extracts (MHE) and sweet potato leaf meal (SPLM) levels on broiler chicken meat cuts - breast, thigh, drumstick, wings, and back weights

Levels of MHE	Levels of SPLM	Breast weight (g)	Thigh weight (g)	Drumstick weight (g)	Wings weight (g)	Back weight (g)
100% Tap water	100% SD	245.00^{d}	117.00	114.00^{b}	113.25^{b}	115.75^{d}
	10g Kg^{-1} SPLM	275.25^{cd}	105.75	131.75^{ab}	101.50^{b}	172.00^{bc}
	20g Kg^{-1} SPLM	307.25^{c}	130.75	135.50^{ab}	118.25^{ab}	181.50^{abc}
	30g Kg^{-1} SPLM	291.50^{c}	108.50	147.50^{a}	106.00^{b}	172.75^{bc}
10mL L^{-1}MHE	100% SD	315.00^{bc}	118.25	135.00^{ab}	112.75^{b}	197.75^{ab}
	10g Kg^{-1} SPLM	295.00^{c}	117.50	112.75^{b}	118.50^{ab}	149.50^{cd}
	20g Kg^{-1} SPLM	355.00^{b}	120.50	139.25^{a}	115.20^{ab}	197.25^{ab}
	30g Kg^{-1} SPLM	403.00^{a}	114.75	150.50^{a}	136.50^{a}	211.75^{a}
P-Value						
Levels of MHE		0.001***	0.603^{NS}	0.662^{NS}	0.005**	0.001***
Levels of SPLM		0.001***	0.092^{NS}	0.003**	0.167^{NS}	0.001***
Levels MHE x Levels of SPLM		0.009**	0.330^{NS}	0.064^{NS}	0.010**	0.001**

*Column means of different letters [abcd] are significantly different at 0.05 levels, *p < 0.05; **p < 0.01; ***< 0.001; NS: Not significant. MHE: multi-herbal extract, SPLM: Sweet potato leaf meal, SD: Standard diet, FCE: Feed conversion efficiency, mL L^{-1}: Milliliter per liter, g Kg^{-1}: Gram per Kilogram*

Table 5. Effect of multi-herbal extracts (MHE) and sweet potato leaf meal (SPLM) levels on broiler chicken edible offal - liver, gizzard, and heart weights

Levels of MHE	Levels of SPLM	Liver weight (g)	Gizzard weight (g)	Heart weight (g)
100% Tap water	100% SD	32.75	17.75	11.25^{b}
	10g Kg^{-1} SPLM	36.00	20.50	10.50^{b}
	20g Kg^{-1} SPLM	36.75	22.00	13.00^{b}
	30g Kg^{-1} SPLM	35.75	19.50	14.75^{ab}
10mL L^{-1} MHE	100% SD	33.75	24.00	14.25^{ab}
	10g Kg^{-1} SPLM	33.25	21.25	17.00^{a}
	20g Kg^{-1} SPLM	33.75	20.75	15.25^{a}
	30g Kg^{-1} SPLM	35.75	23.50	18.75^{a}
P-Value				
Levels of MHE		0.170^{NS}	0.063^{NS}	0.001***
Levels of SPLM		0.202^{NS}	0.976^{NS}	0.003**
Levels MHE x Levels of SPLM		0.264^{NS}	0.177^{NS}	0.164^{NS}

*Column means of different letters [ab] are significantly different at 0.05 levels, *p < 0.05; **p < 0.01; ***< 0.001; NS: Not significant.MHE: multi-herbal extract, SPLM: Sweet potato leaf meal, SD: Standard diet, FCE: Feed conversion efficiency, mL L^{-1}: Milliliter per liter, g Kg^{-1}: Gram per Kilogram*

The weights of edible offal, such as the liver and gizzard, did not exhibit significant differences between MHE-treated groups and the plain water control, nor did they vary across different dietary SPLM inclusion levels (Table 5). Although there were slight increases in edible offal weights with the 30 g/kg SPLM diet, the variability among replicates was too high for these differences to be statistically significant. Conversely, heart weight significantly varied between phytogenic water treatments (P=0.001) and increasing dietary SPLM levels (0.003). Supplementation with multi-herbal phytogenic significantly increased heart weight compared to plain water, and rising SPLM incorporation from 0 to 300 g/kg diet linearly enhanced heart weights. The heaviest heart was found in chickens who received phytogenic water and a 300 g/kg SPLM diet.

3.2 Sensory Evaluation

The sensory evaluation of cooked broiler chicken meat consistently presents reassuring results, focusing on tenderness, juiciness, taste, aroma, and overall acceptability (Table 6). The study reveals no significant differences or consistent trends in tenderness and juiciness scores across treatments, irrespective of whether dietary phytogenic or SPLM were included. Juiciness scores ranged from 2.81 to 3.65, and tenderness scores ranged from 3.31 to 3.44 on a 5-point hedonic scale, indicating a moderate level of both attributes. Taste and aroma/flavor sensory scores exhibited comparability between the control and treated groups, with average taste scores of 3.06, reflecting moderately good taste, and aroma values ranging from 2.56 to 2.94. Notably, the study found no significant impacts on palatability due to the test supplements, and ratings for appearance, texture, and eating quality were not influenced by phytogenic water or different levels of SPLM.

3.3 Return on Investment Analysis

The profitability analysis of broiler chicken production, featuring a standard diet supplemented with varying levels of SPLM and MHE, was outlined in Table 7. Cash outflow expenses, including feed, transportation, broiler chicken purchase, supplements, vaccines, water, light, rental, and housing construction, were considered against total cash inflows derived from the sale of 35-day-old broiler chickens. The return on investment (ROI), expressed as a percentage, was calculated by dividing net profit by total expenditure and multiplying by 100. All treatments demonstrated positive income, reflecting favorable ROIs. The production costs varied, with broiler chickens supplemented with 10 ml of MHE having the highest production cost at Php118.18, followed by those fed with pure commercial feeds and plain water, with a production cost of Php115.39. Remarkably, the lowest production cost of Php97.39 was associated with broiler chickens supplemented with 10ml MHE and 30g SPLM.

4. DISCUSSION

4.1 Feed Intake and Growth Response of Broiler Chicken

The variation in outcomes regarding the effect of SPLM on broiler chicken feed intake, as evidenced in our study, emphasizes the need for a nuanced understanding. Broiler chickens with 30g SPLM/kg feed exhibited high intake, consistent with Akintomide et al. [3]. However, discrepancies in the literature, such as linearly increased feed intake [1] and reduced intake [9], underscore the necessity for standardizing experimental conditions. Moreover, the impact of MHE on feed intake needs more exploration, with limited studies available. Taer et al. [6] suggested synergistic effects on growth but needed more specific feed intake data. While Akintomide et al. [3] study aligns with the current findings, the broader literature presents mixed findings, necessitating further research to standardize experimental conditions and methodologies for a more cohesive understanding of the influence of SPLM and MHE on broiler chicken feed intake.

Table 6. Impact of multi-herbal extracts (MHE) and sweet potato leaf meal (SPLM) levels on broiler chicken tenderness, juiciness, taste, aroma, and general acceptability

Levels of MHE	Levels of SPLM	Tenderness	Juiciness	Taste	Aroma	General Acceptability
100% Tap water	100% SD	3.25	2.81	3.13	2.94	2.56
	10g Kg^{-1} SPLM	3.31	3.44	3.06	2.69	3.00
	20g Kg^{-1} SPLM	3.25	3.38	2.94	2.69	2.94
	30g Kg^{-1} SPLM	3.44	3.25	3.13	2.56	2.75
10mL L^{-1} MHE	100% SD	3.13	3.65	2.81	2.56	3.00
	10g Kg^{-1} SPLM	3.38	3.44	3.31	2.88	2.81
	20g Kg^{-1} SPLM	3.56	3.38	3.13	2.63	3.00
	30g Kg^{-1} SPLM	3.25	3.28	3.25	2.69	3.00
P-Value						
Levels of MHE		0.902	0.092	0.589	0.823	0.253
Levels of SPLM		0.650	0.611	0.432	0.832	0.738
Levels MHE x Levels of SPLM		0.504	0.058	0.314	0.487	0.318

MHE: multi-herbal extract, SPLM: Sweet potato leaf meal, SD: Standard diet, FCE: Feed conversion efficiency, mL L^{-1}: Milliliter per liter, g Kg^{-1}: Gram per Kilogram

Table 7. Profitability analysis on broiler chicken feed applied with sweet potato leaf meal and multi-herbal extracts

	Treatments							
	100% TW + 100% SD	**100% TW + 10g Kg^{-1} SPLM**	**100% TW + 20g Kg^{-1} SPLM**	**100% TW + 30g Kg^{-1} SPLM**	**10mL L^{-1} MHE + 100% SD**	**10mL L^{-1} MHE + 10g Kg^{-1} SPLM**	**10mL L^{-1} MHE + 20g Kg^{-1} SPLM**	**10mL L^{-1} MHE + 30g Kg^{-1} SPLM**
I. Cash outflow								
A. Cost of feed consume	72.00	66.00	60.00	54.00	72.00	66.00	60.00	54.00
B. Transportation	2.81	2.81	2.81	2.81	2.81	2.81	2.81	2.81
C. Cost of broiler	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
D. Supplementation Sweet potato leaf meal	0.00	1.00	2.00	3.00	0.00	1.00	2.00	3.00
Oriental herbal nutrients	0.00	0.00	0.00	0.00	2.79	2.79	2.79	2.79
E. Vaccine	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08
F. Water	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
G. Light	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
H. Rental	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
I. Housing construction	6.25	6.25	6.25	6.25	6.25	6.25	6.25	6.25
Total Cost of production	115.39	109.39	103.39	97.39	118.18	112.18	106.18	100.18
II. Total cash inflow	0.95	1.06	1.15	1.11	1.10	1.18	1.19	1.22
Dress weight (kg)/broiler Gross income	123.50	137.80	150.00	144.30	143.00	153.40	154.70	158.60
III.Net profit	8.11	28.41	46.61	46.91	24.82	41.22	48.52	58.42
IV. Return of investment	7.02	25.97	45.08	48.17	21.00	36.74	45.70	58.31

In terms of growth, this study highlights that SPLM and MHE supplements have individually demonstrated potential to improve productivity and quality characteristics in broiler chickens. The solitary supplementation with 10 mL/L MHE aligns with findings by of Taer and Taer [10], and increased dietary inclusion levels of SPLM linearly enhance final body weight and FCR [11, 9]. However, optimal growth performance was achieved by combining 10 mL/L MHE and 30 g/kg SPLM, emphasizing additive or synergistic interactions between these two feed supplements. These results concur with past evidence that bioactive compounds in garlic, onion, turmeric, and sweet potato foliage elicit antibacterial, antioxidant, and gut-modulating activities [1,12]. SPLM and MHE extracts contain an array of bioactive phytochemicals that can improve the growth and feed efficiency of broiler chickens through synergistic mechanisms [11,6]. Specifically, SPLM provides essential macronutrients like crude protein (24-25%) and minerals and digestibility-enhancing fiber (10-12%) that facilitate musculoskeletal growth and gut health. Additionally, allicin in garlic, turmeric curcumin, and chili capsaicinoids elicit broad-spectrum antimicrobial, anti-inflammatory, and antioxidant activities.

These multifaceted effects likely modulate the gut microbiota to enhance nutrient absorption, alleviate immunosuppressive stressors, and make more dietary energy available for muscle accretion [13]. The complementary biological actions of SPLM nutrients and phytogenic antibacterial/immunomodulatory compounds on interconnected physiological pathways governing productivity outcomes explained the improvements in body weight gain and feed conversion ratio when broiler chickens were concomitantly supplemented with agricultural by-products. Further research through holistic assays should elucidate the precise modes of action underlying enhanced broiler chicken growth mediated by integrated SPLM and phytogenic extract supplementation. Identifying optimal constituent combinations and doses can help develop universally applicable best practices for poultry producers.

4.1.1 Carcass yield, weight of meat cuts, and edible offals

The observed significantly higher dress weights in chickens supplemented with 20-30 g/kg SPLM and 10 mL/L MHE compared to non-supplemented controls align with existing evidence supporting the enhancement of body weight gain and daily growth with 5-15% dietary SPLM [11,9]. However, contrary to previous findings suggesting improved dressing percentages with SPLM [2], the present study reported no significant differences between treated and control broiler chicken groups. This aligns with another study where SPLM substitution had no discernible effect on dressing yields [14]. These discrepancies may be attributed to breeding, rearing conditions, and slaughter age, which must be consistently controlled across experiments. Nevertheless, the collective results imply that incorporating agricultural by-products like SPLM and phytogenic compounds can enhance muscular growth and absolute carcass weights without compromising the composition or proportion of edible meat. The bioactive nutrients and phytochemicals likely induce anabolic and growth-promoting activities through previously mentioned mechanisms, including enhanced protein synthesis and lean tissue accretion [15].

The application of a 10 mL/L MHE water treatment significantly increased the weights of breast, wings, and back cuts compared to plain water controls, aligning with existing evidence that phytogenic compounds enhance protein accretion and promote lean tissue growth [16]. Furthermore, incremental dietary SPLM levels exhibited a linear improvement in the weights of breast, wings, drumsticks, and back cuts. The heaviest breast, wings, and superior back cuts were obtained with combinations of 10 mL/L MHE and 30 g/kg SPLM, highlighting synergistic effects between the two supplements in augmenting muscular development. These results were consistent with previous findings indicating that SPLM inclusion enhances final body weights and yields of edible meat [1]. In contrast, no significant differences were observed in thigh weights between phytogenic treatments. This partially aligns with an experiment reporting no effects on thigh percentage between garlic and antibiotic-fed broiler chicken groups [15]. Potential factors such as variations in muscle fiber types and the proximal bioavailability of supplements may contribute to the variability across cuts.

Crude protein and amino acids in SPLM are direct substrates for augmenting muscle protein synthesis and growth [14]. Additionally, allicin from garlic and curcumin from turmeric in MHE possess anabolic, antioxidant, and anti-inflammatory activities that likely stimulate breast muscle accrual while mitigating atrophic pathways [6]. Phenolic phytochemicals may modulate hormonal and mTOR-related signaling cascades regulating localized muscle protein turnover [17]. Furthermore, enhanced digestion and circulation from chili-derived capsaicinoids could increase the proximal bioavailability of amino acids in breast and back cuts [15]. These synergistic mechanisms underlie the preferential hypertrophy of high-value cuts when broiler chickens are concomitantly supplemented with SPLM protein/amino sources and MHE growth-promoting bioactives. Overall, the integration of MHE and SPLM appears effective for preferentially directing nutrients towards increasing the weights of high-value breasts, wings, and back cuts. The observed deposition patterns are probably due to the activation of pathways involved in breast muscle protein creation by bioactive compounds, according to Enoka et al. [17]. Further assays quantifying amino acid transporters and atrophy-related transcriptional regulators in target muscles could provide insights into the underlying mechanisms.

The present study found no significant differences in liver and gizzard weights between MHE-treated groups and the control, nor between varying dietary levels of SPLM. However, heart weight showed significant increases with MHE supplementation and higher SPLM inclusion, with the heaviest hearts in birds receiving both MHE water and 300 g/kg SPLM diet. In contrast, most studies on SPLM did not measure heart weight precisely, while a few, like Melesse et al. [14] and Alemu [2]), found no apparent effect of SPLM on heart weight. The phytogenic blend papers also needed more focus on quantifying edible viscera. Thus, this paper provides more granular evidence that supplementing MHE and SPLM can benefit metabolically active organs like the heart. In contrast, the individual sets of literature on sweet potato and phytogenic extracts do not highlight such effects. However, the present paper's insights still need replication in further studies with larger samples. More research is still needed to conclusively demonstrate and distinguish the effects of specific phytogenic blends and SPLM inclusion levels on edible offal components.

4.1.2 Meat sensory evaluation and return on investment analysis

Panelists consistently rated the meat as moderately juicy, tender, and acceptable, regardless of supplement variations. This aligns with prior studies on SPLM, where Akintomide et al. [3] observed no specific trends in juiciness, and palatability scores indicated no impact on the taste of thigh cuts. Studies on multi-herbal extracts (MHE) were limited in quantified sensory analysis, with Camy et al. [4]) briefly suggesting positive influences on broiler chicken meat sensory properties and Ozturk & Dogan [18] focusing on customer acceptance without precise quantified sensory results. This trial aligns with the sweet potato literature, emphasizing that incorporating nutraceutical supplements like SPLM or bioactive phytogenic compounds does not adversely affect broiler chicken meat's sensory quality and acceptability.

The return on investment (ROI), expressed as a percentage, was calculated by dividing net profit by total expenditure and multiplying by 100. All treatments demonstrated positive income, reflecting favorable ROIs. The cost of production exhibited variation, with broiler chickens supplemented with 10ml MHE showing the highest production cost at Php118.18, followed by those with pure commercial feeds and plain water at Php115.39. Remarkably, the lowest production cost of Php97.39 was associated with broiler chickens supplemented with 10ml MHE and 30g SPLM. Compared to the sweet potato literature, comprehensive economic analyses, such as that of Villaver and Cagatin [16], indicated that the control diet had the best return of feed cost compared to sweet potato-based natural bioactive mixtures. Literature on the economic impacts of MHE is needed to quantify profitability.

5. CONCLUSION

In conclusion, the 35-day feeding trial presented herein furnishes compelling evidence supporting the synergistic enhancement of broiler chicken productivity through the combined treatments of sweet potato leaf meal (SPLM) and multi-herbal extracts (MHE) supplements, surpassing the effects of individual additives. The factorial assessment systematically demonstrated that supplementing broiler diets with 10 mL/L MHE and 30 g/kg SPLM yielded the most favorable influences on final body weight, weight gain, feed intake, and conversion efficiency. Concurrently, dress weights significantly improved with MHE inclusion and 20-30 g/kg SPLM. The preferential accretion of breast, wings, and superior back cuts underscores localized deposition patterns, prompting further inquiry into muscle-specific protein turnover mechanisms. A meticulous profitability analysis also underscored that the combination of MHE and higher SPLM levels maximizes return on investment—an imperative consideration for practical on-farm application. Notably, the sensory evaluation revealed no detrimental impacts on meat palatability. These results highlight the intricate interplay between SPLM nutritional compounds and MHE phytochemicals, suggesting potential synergistic modes of action in improving digestion, immunity, and muscular growth. While acknowledging that validation of universal applicability necessitates more extensive follow-up studies, this investigation significantly contributes to poultry science by uncovering novel possibilities for synergistically blending agricultural by-products such as sweet potato foliage and botanical extracts. This approach holds promise for developing sustainable best practices to enhance broiler chicken production. The research compellingly advocates integrating SPLM and MHE as a promising, natural strategy to optimize broiler performance.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

ETHICAL APPROVAL

The research experiment was guided and approved by the research ethics committee of Agusan del Sur State College of Agriculture and Technology (ASSCAT) and complied with the rules and regulations on the scientific procedures of using animals under the Philippines Republic No. 8485, otherwise known as the “Animal Welfare Act of 1998”.

ACKNOWLEDGEMENT

The authors would particularly like to thank their families to their undying supports and encouragements. The authors would like to thank Dr. Belen S. Dela Peña, Dr. Estrella S. Dinopol, Dr. Rodrigo L. Bongolan, Jr, Dr. Ferdinand A. Marzo, Jr for their assistance during the conduct of the experiment.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Oghenebrorhie O, Job AO. Performance characteristics of broiler chickens fed sweet potato (*Ipomoea batatas*) leaf in the tropics. Livestock Research for Rural Development. 2021;33: 1-7. Available:https://www.lrrd.org/lrrd33/1/oghen3314.html
2. Alemu T. Evaluating the effect of feeding different levels of sweet potato (*Ipomoea batatas*) leaf meal on feed intake, growth performance and carcass characteristics of broilers. Doctoral dissertation; 2015. Available:http://etd.hu.edu.et//handle/123456789/4441
3. Akintomide AA, Osho IB, Onibi GE, Oboh G. Effect of sweet potato leaf meal on growth, haematology and meat quality of broiler chicken. Animal Research International. 2021;18(3):4239-4246. Available:https://www.ajol.info/index.php/ari/article/view/220542
4. Camy MLY, Redoy MRA, Shuvo AAS, Ray BC, Rahman MA, Al-Mamun M. Effect of aqueous herbal extracts on growth, plasma metabolites and meat characteristics of broiler. Bangladesh Journal of Animal Science. 2019;48(2):108-115. DOI:https://www.doi.org/10.3329/bjas.v48i2.46764
5. Islam R, Hossain MM, Nargis F, Hossain ME. Administration of garlic and neem in broiler diet for safe meat production. Bangladesh Journal of Animal Science. 2019;48(2):116–126. DOI:https://doi.org/10.3329/bjas.v48i2.46766
6. Taer AN, Posesana GG, Masuhay EP. Potency of phytobiotics in herbal spices as an antimicrobial growth promoter in broiler chicken diet: a review. Int. J. Innov. Sci. Res. Technol. 2020;5(2):571-579. Available:https://www.ijisrt.com/assets/upload/files/IJISRT20FEB052_(1).pdf
7. Islam MF, Haque MN, Parvin A, Islam MN., Alam MN, Sikder MH. Effect of dietary supplementation of garlic on feed conversion ratio, carcass physiognomies and haematological parameters in broilers. Bangladesh Journal of Veterinary Medicine. 2017;15(1):7–11. DOI:https://doi.org/10.3329/bjvm.v15i1.34047
8. Taer AN, Taer EC. Response of broiler to supplementation of human oral rehydration salt during pre-slaughter fasting. Indian

Journal of Natural Sciences,. 2019;10(57): 17796-17807.

9. Melesse A, Alemu T, Berihun K, Banerjee S. Assessing the partial substitution of roasted soybean seed with sweet potato (*Ipomoea batatas*) leaf meal in feed intake and growth performances of broiler chickens. Journal of Plant and Animal Sciences. 2015;1(2):11-18.
10. Taer A, Taer E. Synergistic effects of phytogenic compounds on early growth parameters of native chickens. Journal of World's Poultry Research. 2022;12(1):69-76.
DOI:https://dx.doi.org/10.36380/jwpr.2022.8
11. Unigwe CR, Okorafor UP, Atoyebi TJ, Ogbu UM. The nutritive value and evaluation of sweet potato (*Ipomoea batatas*) leaf meal on the growth performance of broiler chickens. International Journal of Pure and Applied Sciences and Technology. 2014;20(2):19-26.
12. Islam MB, Khan SZ. Growth promoting and immune response of aqueous extract blends using different concentrations of onion, garlic and chilli on broilers. Journal of Xi'an Shiyou University, Natural Science Edition. 2023;19(2):1939-1964.
Available:https://www.xisdxjxsu.asia/V19I02-172.pdf
13. Kumar R, Sharma A. Prebiotic-driven gut microbiota dynamics: Enhancing canine health via pet food formulation. International Journal of Bio-resource and Stress Management. 2024;15:01-15.
Available:https://doi.org/10.23910/1.2024.5359
14. Melesse A, Alemu T, Banerjee S, Berihun K. The effect of partial substitution of roasted soybean seed with graded levels of sweet potato (*Ipomoea batatas*) leaf meal on growth performances and carcass characteristics of broiler chickens. Asian-Australasian Journal of Animal Sciences. 2017;1-7.
DOI: https://doi.org/10.5713/ajas.15.0642
15. Roy A, Rahman M, Siddiqua M, Hossain M. Effects of garlic and neem extract on growth performance and blood biochemical indices in sonali chicken. Journal of Bangladesh Agricultural University. 2023; 21(4):533-541.
DOI: https://doi.org/10.5455/JBAU.169945
16. Villaver JP, Cagatin RS. Effects of natural bioactive mixture at varying levels on the growth and economic parameters of broilers (*Gallus gallus* domesticus). International Journal of Agricultural Technology. 2022;18(4):1869-1880.
Available at: http://www.ijat-aatsea.com.
17. Enoka VIL, Kikuvi GM, Ndung'u PW. Effect of garlic (*Allium sativum*) and onion (*Allium cepa* L.) extract chitosan nanoparticles on antioxidant enzymes activities and relative weight of visceral organs of rainbow rooster chicken. International Journal of Livestock Production. 2020;11(4): 188-199.
Available:http://www.academicjournals.org/IJLP
18. Ozturk E, Dogan E. The effect of fresh and aged garlic extract-enriched diets on the growth performance of broilers and the oxidative rancidity and customer acceptance of chicken meat. Turkish Journal of Agriculture - Food Science and Technology. 2019;7(12):2267–2274.
DOI:https://doi.org/10.24925/turjaf.v7i12.2267-2274.3035

Peer-review history:
The peer review history for this paper can be accessed here:
https://prh.mbimph.com/review-history/3771