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OPTIMIZING BROILER PRODUCTIVITY: INTERACTIONS BETWEEN STOCKING DENSITY AND DIETARY ENERGY-PROTEIN PROFILES IN THE PHILIPPINE SETTING

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ABSTRACT

This study evaluated the effects of varying stocking densities and dietary energy-protein levels on broiler performance, carcass traits, organ weights, and economic outcomes. A total of 360 straight-run Cobb 500 chicks were used in a 3 × 3 factorial design with three stocking densities (4, 8, and 12 birds/m²), three energy levels (2825, 2784, and 2744 kcal/kg ME), and three crude protein levels (18.26%, 20.26%, and 22.26%). Each treatment was replicated five times. Growth performance parameters—average daily gain (ADG), average daily feed intake (ADFI), and feed conversion ratio (FCR)—were measured, along with carcass yield and organ weights. No significant differences were observed in ADG, ADFI, live weight, or carcass characteristics among treatments. However, the combination of 12 birds/m² and the highest protein level (22.26% CP, 2744 kcal/kg ME) resulted in the lowest FCR, indicating improved feed efficiency. Organ weights were not significantly affected by treatments. These findings provide insights into optimizing broiler productivity under different rearing conditions.

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INTRODUCTION

Broiler chicken production is a vital component of the agricultural industry in the Philippines. The rising demand for meat necessitates the implementation of efficient management systems to optimize broiler growth rates and ensure animal welfare. Globally, poultry producers aim to maximize the number of birds raised per square meter while minimizing losses due to overcrowding (Abudabos *et al.,* 2013). One of the most critical management factors in poultry production is stocking density, defined as the number of birds or total body mass (kg) per unit area (m²) (Yanai *et al.,* 2018).

High stocking densities may negatively affect broiler performance due to increased ambient temperatures and reduced airflow at bird level (Feddes, 2002). While increasing bird density can lower production costs, excessive crowding can impair performance and welfare (Bailie *et al*., 2018). Thus, the global poultry industry's goal is not only to maximize meat yield per square meter with uniformity and quality but also to reduce losses associated with overpopulation (Abudabos *et al.*, 2013).

In addition to stocking density, dietary composition—particularly metabolizable energy (ME) and crude protein (CP) levels—significantly affects growth performance and carcass traits in broilers. Metabolizable energy refers to the energy available to birds after accounting for losses through feces, urine, and gases (Yang *et al.*, 2020).

Adequate ME levels are essential for proper growth and development, depending on the birds' age, breed, and production stage. A deficiency in ME can lead to stunted growth and higher disease susceptibility, while excess energy can result in unnecessary fat deposition and inefficient resource use (Sakomura *et al.,* 2004). Balancing ME through diverse feed ingredients—such as corn, soybean meal, and animal by-products—helps ensure bird welfare and profitability (Copat *et al.,* 2020).

Crude protein, calculated by multiplying a feed's nitrogen content by 6.25, is another crucial nutrient that supports muscle and tissue development (Complete Feed Solution, 2023). CP requirements vary with age, breed, and production stage. Broilers typically require 18–22% CP, which is higher than that required by layer hens (15–18%) (Jabbar *et al.,* 2021). However, excessive protein intake can lead to nitrogen excretion and environmental pollution. To avoid this, CP levels must be carefully managed using a variety of protein sources—such as soybean meal, corn gluten meal, and animal by-products—while considering amino acid balance (Gheisari *et al.,* 2015). This approach supports bird health and productivity by ensuring nutritional adequacy without waste.

Despite these insights, limited research has explored the combined effects of stocking density and varying levels of ME and CP on broiler performance. This study aims to fill that gap by investigating how different stocking densities and dietary energy-protein levels influence the growth performance of broiler chickens.

The findings will provide valuable insights into optimal stocking and dietary strategies suitable for broiler production in the Philippines. These insights could inform improved management practices and policymaking in the local poultry industry. Ultimately, the study seeks to promote cost-effective, sustainable broiler production, enhancing both profitability and long-term viability. Therefore, the objective of this research is to evaluate the effects of stocking density and different levels of metabolizable energy and crude protein on the performance of broiler chickens under small-scale production systems.

MATERIALS AND METHODS

Ethical Consideration

All animal care procedures in this study were conducted in accordance with the Animal Welfare Act (Republic Act No. 8485) of the Philippines. The experimental protocols were reviewed and approved by the Institutional Animal Care and Use Committee (IACUC) of Mindanao State University – Main Campus.

Birds and Experimental Design

A total of 360 straight-run, day-old Cobb 500 broiler chicks were used in this study. The experimental design followed a 3 × 3 factorial arrangement in a completely randomized design (CRD), incorporating three stocking densities (4, 8, and 12 birds/m²), three energy levels with three crude protein levels: 2825 kcal/kg ME with 18.26% crude protein (CP), 2784 kcal/kg ME with 20.26% CP, and 2744 kcal/kg ME with 22.26% CP, respectively.

Experimental Diets

All feed ingredients were sourced from a local poultry supply store. Three experimental diets, primarily composed of corn and soybean meal, were formulated

(Tables 1 and 2). The remaining nutrients were adjusted to meet or exceed the nutrient requirements for broiler chickens as recommended by the NRC (1994). All experimental diets were prepared in meal form.

Table (1): Analyzed Chemical Composition (as fed-basis) of Experimental Diets.

ITEM	DIET		
	2825 kcal/kg ME + 18.26% CP	2784 kcal/kg ME + 20.26% CP	2744 kcal/kg ME + 22.26% CP
Crude Fat	1.80	2.07	2.26
Crude Fiber	1.23	1.56	1.52
Moisture Content	14.69	14.93	14.53
Crude Ash	6.36	7.03	7.02
Crude Protein (N x 6.25)	16.74	18.95	20.43
Nitrogen Free Extract	59.18	55.46	54.24

Table (2): Ingredient and Calculated Composition (as-fed basis) of Experimental Diets

ITEM	DIET		
	2825 kcal/kg ME + 18.26% CP	2784 kcal/kg ME + 20.26% CP	2744 kcal/kg ME + 22.26% CP
Ingredient,%			
Yellow Corn	58.22	53.15	48.07
Soybean meal	25.88	30.95	36.03
Rice bran D_1	10.00	10.00	10.00
Salt	0.30	0.30	0.30
Limestone	3.00	3.00	3.00
Monocalcium phosphate	2.00	2.00	2.00
DL-methionine	0.20	0.20	0.20
L-lysine	0.20	0.20	0.20
Vitamin premix[1]	0.10	0.10	0.10
Mineral premix[2]	0.10	0.10	0.10
TOTAL	100.00	100.00	100.00
Calculated analysis,%			
CP, %	18.26	20.26	22.26
ME, kcal/kg	2825	2784	2744
Methionine	0.28	0.29	0.31
Lysine	0.90	0.96	1.02
Ca	1.65	1.67	1.68
P, avail	0.53	0.54	0.54

[1]Provided the following quantities of micro minerals per kg of complete diet: Cu, 12.5 mg as copper sulfate; Fe, 90 mg as iron sulfate; I, 0.40 mg as potassium iodate; Mn, 42 mg as manganese sulfate; Se, 0.3 mg as sodium selenite; and Zn, 100 mg as zinc oxide.

[2]Provided the following quantities of vitamins per kg of complete diet: Vitamin A, 15,000 IU; vitamin D3, 2,700 IU; vitamin E, 60 mg; vitamin K, 2.70 mg; thiamine, 2.70 mg; riboflavin, 6.60 mg; pyridoxine, 4.20 mg; vitamin B12, 0.03 mg; D-pantothenic acid, 21.0 mg; niacin, 45 mg; folic acid, 3.00 mg; biotin, 0.30 mg.

Experimental Procedures

The experiment was conducted in an open-sided poultry house with wire mesh walls. The facility was thoroughly cleaned and disinfected prior to the start of the study. Chicks were initially placed in 12 electrically heated brooder pens for a 7-day adaptation period and fed commercial booster feeds. Electrolytes were added to the drinking water to support hydration and maintain electrolyte balance.

After the adaptation period, the chicks were transferred to 45 cages, each measuring 1 m², where they were housed from day 7 to day 35. Throughout the experimental period, the broilers were provided with the designated diets *ad libitum*, and clean drinking water was available at all times. Each cage was equipped with a plastic feeder and drinker, and both the drinkers and cages were cleaned regularly to maintain hygiene.

Data Collection and Measurements

Growth performance. Weekly records of body weight (BW) and feed intake for each bird were maintained throughout the study. At the end of the experiment, the collected data were summarized and analyzed. The average daily gain (ADG), average daily feed intake (ADFI), and feed conversion ratio (FCR) were calculated for each treatment group, feeding phase, and the overall experimental period using the formulas provided by Aguilar and Villanueva (2023).

$$ADG = \frac{Final\ Weight - Initial\ weight}{Number\ of\ Days}$$

$$ADFI = \frac{Total\ Feed\ Intake}{Number\ of\ days}$$

$$FCR = \frac{Average\ daily\ feed\ intake}{Average\ daily\ gain}$$

Carcass and organ weights. On the 28th day of the experiment, three (3) birds were randomly selected from each treatment group, slaughtered, defeathered and eviscerated. The carcass, gizzard, heart, spleen, and liver were collected to assess physiological responses. The absolute and relative weights of these organs were then calculated using the formulas outlined by Aguilar and Villanueva (2023).

$$Absolute\ weight = Actual\ weight\ of\ organs, g.$$

$$Relative\ weight = \frac{Actual\ Wt. of\ organs}{Final\ Wt., g.}\ x\ 100$$

Diet economics. Using the market prices prevailing at the time of the study, the following formulas were applied to calculate feed cost per bird, value of gain per bird, feed cost per kilogram of gain, and margin over feed cost (MOFC) based on both live weight and carcass weight (Aguilar and Villanueva, 2023).

$$Feed\ Cost\ per\ Bird = Total\ feed\ intake\ per\ bird\ x\ Feed\ Price$$

$$Value\ of\ Gain\ per\ Bird = Weight\ at\ 28\ days\ x\ Current\ price$$

$$Feed\ Cost\ per\ kg\ gain = \frac{Feed\ Cost}{Weight\ at\ 28\ days}$$

$$MOFC = Value\ of\ gain\ per\ bird - Feed\ Cost$$

Chemical Analyses

Each meal sample was analyzed in triplicate for moisture content (drying at 135°C), crude protein (Kjeldahl method), crude fat (Randall method), crude fiber (filter bag technique), and crude ash (ignition at 600°C), following the procedures outlined by AOAC (2007).

Statistical Analysis

The study employed a Completely Randomized Factorial Design with three stocking densities and three levels of metabolizable energy (kcal/kg) combined with crude protein (%). Data analysis was performed using the PROC MIXED procedure in SAS (Statistical Analysis System) Institute Inc. (SAS,2013). When significant differences ($P \leq 0.05$) were detected, means were separated using the Tukey-Kramer test with the PDIFF option in SAS. Significance and trends between mean values were determined at alpha levels of 0.05 and 0.10, respectively.

RESULTS AND DISCUSSION

Growth Performance

Table 3 presents the growth performance of broiler chickens housed in 1 m² cages with varying stocking densities (4, 8, and 12 birds) and different levels of metabolizable energy (ME) and crude protein (CP). On day 1, no significant differences ($P > 0.05$) were observed across stocking densities or dietary treatments, indicating that these factors did not affect initial broiler performance. Similarly, on day 28, stocking density had no significant effect ($P > 0.05$), suggesting that broilers can adapt well to different space allowances, likely due to their genetic resilience and effective management practices. This finding supports the conclusions of Pettit-Riley et al. (2001) and El-Deek *et al*. (2004), who reported that increasing bird density from 10 to 20 birds/m² did not significantly affect body weight between 7 and 43 days of age.

However, dietary treatments showed highly significant differences ($P < 0.05$) on day 28. Specifically, the group receiving a diet with 22.26% CP and 2744 kcal/kg ME exhibited higher body weight than other groups. This improvement is attributed to higher CP content enhancing feed efficiency—the ratio of feed intake to weight gain. Infante-Rodríguez *et al*. (2016) found that dietary energy levels did not affect broiler weight but reduced feed intake in diets with higher ME concentration. Additionally, Allen and Leeson, (2023) reported that higher CP diets promote better growth performance in poultry compared to lower CP diets.

Table (3): Growth Performance of Broiler Chicken under Different Stocking Density and Metabolizable Energy with Crude Protein

Item	Treatment									SEM	*p-value*		
	4 birds/m²			8 birds/m²			12 birds/m²						
	MC_1	MC_2	MC_3	MC_1	MC_2	MC_3	MC_1	MC_2	MC_3		Stocking Density	Dietary Levels	Interaction
BW, g													
d 1	143.63	143.38	147.25	143.85	143.19	147.35	142.98	143.75	147.15	3.918	0.999	0.4053	0.9998
d 28	1,695.50	1,843.75	1,866.38	1,746.94	1,839.22	1,848.10	$1,722.85^{b}$	$1,794.88^{b}$	$1,946.34^{a}$	52.397	0.879	0.0032	0.4955
Day 1-7													
ADG, g	28.81	33.94	35.07	30.57^{b}	32.42^{b}	36.74^{a}	29.86^{b}	30.94^{ab}	35.69^{a}	1.445	0.6593	<0.0001	0.6095
ADFI, g	46.87	48.62	47.53	47.90	48.31	50.59	47.93	47.83	50.24	1.564	0.5884	0.3412	0.8000
FCR	1.64^{a}	1.44^{b}	1.36^{b}	1.57^{a}	1.49^{a}	1.38^{b}	1.61^{a}	1.55^{a}	1.41^{b}	0.031	0.1798	<0.0001	0.2010
Day 8-14													
ADG, g	53.61	63.09	63.36	60.36	62.30	64.23	58.37	63.34	63.96	2.692	0.5499	0.0148	0.6932
ADFI, g	85.19	93.05	92.15	89.44	89.22	92.15	88.81	90.95	93.14	3.473	0.9516	0.2578	0.8351
FCR	1.62	1.48	1.46	1.48	1.43	1.44	1.52	1.44	1.46	0.039	0.1043	0.0092	0.5450
Day 15-21													
ADG, g	68.02	75.72	77.88	68.93	76.08	77.67	69.05	69.97	70.88	3.636	0.2968	0.0727	0.7907
ADFI, g	115.42	125.03	124.78	118.36	121.21	120.24	116.64	118.04	118.09	4.259	0.4979	0.3523	0.8343
FCR	1.70	1.65	1.61	1.72	1.60	1.55	1.70	1.70	1.67	0.045	0.2254	0.0592	0.5985
Day 21-28													
ADG, g	71.26	70.16	69.28	69.15	71.50	64.33	68.41	71.63	86.51	4.180	0.1115	0.5473	0.0476
ADFI, g	133.52	134.44	133.03	126.52	132.65	125.01	123.70	124.13	127.70	3.200	0.0103	0.6196	0.5268
FCR	1.88	1.92	1.94	1.83	1.86	1.96	1.82	1.74	1.53	0.088	0.0124	0.8502	0.1697
Day 1-28													
ADG, g	55.42	60.73	61.40	57.26	60.57	60.74	56.43	58.97	64.26	1.902	0.9035	0.0034	0.6121
ADFI, g	95.25	100.28	99.37	95.56	97.85	97.00	94.27	95.24	97.29	2.719	0.4853	0.3567	0.9347
FCR	1.72^{a}	1.65^{ab}	1.62^{b}	1.67	1.62	1.60	1.67^{a}	1.62^{ab}	1.52^{b}	0.023	0.0082	<0.0001	0.4055

MC_1 = 2,825 kcal/kg ME + 18.26% CP; MC_2 = 2,784 kcal/kg ME + 20.26% CP; MC_3 = 2,744 kcal/kg ME + 22.26% CPBW = body weight; ADG = average daily gain; ADFI = average daily feed intake; FCR = feed conversation ratio; SEM = standard error of means; $^{a-b}$ values with the same letter are not significantly different

During days 1 to 7, significant differences in dietary treatments were observed ($P < 0.05$). The group fed a diet containing 2744 kcal/kg ME and 22.26% CP achieved the highest average daily gain (ADG), indicating that this formulation provided optimal growth conditions for broiler chicks in the early developmental stage. Although average daily feed intake (ADFI) did not differ significantly among the groups ($P > 0.05$), feed conversion ratio (FCR) varied significantly with dietary level ($P < 0.05$). The 2744 kcal/kg ME + 22.26% CP group recorded the lowest FCR, demonstrating enhanced feed efficiency. This combination of energy and protein improved nutrient utilization and balanced amino acid intake, allowing chicks to gain more weight per unit of feed consumed. Such a precise balance of dietary energy and protein supports optimal growth and development, ultimately leading to superior performance.

From days 8 to 28, no significant differences were found in ADG, ADFI, or FCR across stocking densities and dietary treatments. This suggests that broilers maintained consistent performance during this period regardless of environmental or dietary variations, indicating good adaptation to the tested conditions. The range of stocking densities and dietary levels appeared adequate to support efficient growth and feed conversion throughout this phase.

Overall, from day 1 to 28, ADG and ADFI showed no significant differences across all groups ($P > 0.05$), implying that variations in stocking density and diet did not markedly affect growth rate or feed intake during this time. This finding contrasts with Thema *et al.* (2022), who reported that high temperatures, especially during the first week, can negatively impact broiler growth performance by reducing weight gain and increasing mortality.

However, FCR was significantly influenced by both stocking density ($P < 0.05$) and dietary treatment ($P < 0.05$). The group stocked with 12 birds/m^2 and fed 2744 kcal/kg ME with 22.26% CP achieved the lowest overall FCR, reflecting the most efficient feed utilization. Lower FCR values indicate better feed conversion, as birds more effectively convert feed into body mass. Interestingly, higher stocking density was associated with improved feed efficiency, possibly due to increased feed competition or better utilization of available resources. Conversely, lower stocking densities resulted in higher FCR, potentially due to feed wastage when fewer birds consumed excess feed.

These findings align with previous studies by Ravindran and Thomas (2004), Sreehari and Sharma (2010), and Aguilar and Villanueva (2023), which reported that higher stocking densities generally improve feed conversion rates compared to lower densities.

Absolute and Relative Weight

Table 4 presents the absolute and relative organ weights of broiler chickens housed in 1 m^2 cages under varying stocking densities and dietary treatments with different levels of metabolizable energy (ME) and crude protein (CP).

Table (4): Absolute and Relative Weight of Broiler Chicken under Different Stocking Density and Metabolizable Energy with Crude Protein

ITEM	TREATMENT									SEM	*p-value*		
	4 birds/m²			8 birds/m²			12 birds/m²						
	MC_1	MC_2	MC_3	MC_1	MC_2	MC_3	MC_1	MC_2	MC_3		Stocking Density	Dietary Levels	Interaction
Live Weight, g	1706.50	1848.00	1869.83	1743.83	1830.00	1809.50	1731.25	1807.33	1843.50	74.530	0.9659	0.1277	0.9691
Carcass weight, g	1239.92	1340.67	1371.67	1267.92	1303.67	1325.75	1248.58	1324.83	1338.25	58.650	0.9244	0.1326	0.9741
DP , %	72.51	72.48	73.19	72.54	71.25	73.29	71.95	73.12	72.63	0.710	0.8167	0.3500	0.3912
Absolute weight, g													
Head	46.25	49.17	49.42	45.42	44.67	47.92	46.42	47.92	45.25	2.107	0.3863	0.6516	0.6204
Feet	66.00	78.00	72.33	72.58	72.83	72.25	73.33	77.00	77.42	3.267	0.3005	0.1374	0.4576
Gizzard	35.83	35.42	34.67	33.83	34.42	32.58	32.92	32.50	32.67	1.771	0.1918	0.7945	0.9862
Heart	9.42	9.17	8.50	8.67	8.50	9.25	8.42	8.92	9.33	0.535	0.8764	0.8907	0.4257
Spleen	1.83	1.92	2.08	1.58	2.08	2.00	1.83	1.75	2.17	0.211	0.9494	0.1594	0.6652
Liver	33.00	34.92	32.50	32.58	36.50	29.83	32.50	32.33	35.00	1.781	0.9417	0.2788	0.1491
Relative weight, %													
Head	0.027	0.027	0.027	0.026	0.025	0.027	0.027	0.027	0.025	0.001	0.4496	0.4711	0.3527
Feet	0.039	0.042	0.039	0.042	0.039	0.040	0.042	0.043	0.042	0.001	0.0254	0.4383	0.2868
Gizzard	0.021	0.019	0.019	0.020	0.019	0.018	0.019	0.018	0.018	0.001	0.2350	0.0739	0.9617
Heart	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.000	0.3555	0.8868	0.1776
Spleen	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.000	0.9891	0.5349	0.7954
Liver	0.020	0.019	0.017	0.019	0.020	0.017	0.019	0.018	0.019	0.001	0.9993	0.1277	0.3153

MC_1 = 2,825 kcal/kg ME + 18.26% CP; MC_2 = 2,784 kcal/kg ME + 20.26% CP; MC_3 = 2,744 kcal/kg ME + 22.26% CP

SEM = standard error of means; DP = dressing percentage

$^{a-b}$ values with the same letter are not significantly different

Regarding live weight, the mean values observed across different dietary levels and stocking densities showed no statistically significant differences ($P > 0.05$). Similarly, carcass weight remained consistent across all treatments, indicating that both live weight and carcass weight were stable regardless of dietary composition or stocking density. These findings suggest that broiler chickens can maintain growth and carcass yield when fed various diets and housed under different stocking conditions. This aligns with the study by Huerta *et al.* (2023), which reported that broilers maintained consistent organ development across varying dietary energy levels, demonstrating their adaptability to different nutritional environments.

The dressing percentage, expressed as the ratio of carcass weight to live body weight, also showed no significant variation ($P > 0.05$), indicating uniformity in meat yield relative to body size. According to Knight (2020), factors such as age, genotype, and sex have a more pronounced effect on carcass traits, meat quality, and sensory attributes than external factors like diet or stocking density. These inherent biological and genetic factors likely play a more critical role in determining carcass composition, which may explain the minimal influence of dietary and stocking variations observed in this study.

Diet Economics

Table 5 presents the economic analysis of broiler chicken diets across different stocking densities and varying levels of metabolizable energy (ME) and crude protein (CP).

Significant differences in feed cost were observed among dietary levels for both live weight and carcass weight ($P < 0.05$). Birds fed the diet containing 2744 kcal/kg ME and 22.26% CP incurred the highest feed costs, while those fed 2825 kcal/kg ME with 18.26% CP had the lowest feed costs. This suggests that higher protein diets lead to increased feed expenses, which is a well-documented challenge in the poultry industry. Ul Abiden *et al* (2019) have consistently shown that reducing crude protein levels and supplementing with synthetic amino acids can lower feed costs by decreasing reliance on expensive protein sources like soybean meal. However, this strategy requires a more precise amino acid balance.

No significant differences in feed cost were found across stocking densities ($P > 0.05$), indicating that varying bird numbers per unit area does not substantially affect feed expenses. This consistency suggests similar feed utilization efficiency regardless of stocking density.

The value of gain per bird and feed cost per kilogram gain for live weight also showed no significant differences, implying diet and stocking density did not impact feed-to-gain efficiency. Similarly, margin over feed cost (MOFC) for both live and carcass weight remained consistent across dietary levels and stocking densities, indicating stable profitability after feed costs.

Table (5): Diet Economics of Broiler Chicken under Different Stocking Density and Metabolizable Energy with Crude Protein

ITEM	TREATMENT									SEM	*p-value*		
	4 birds/m^2			8 birds/m^2			12 birds/m^2						
	MC_1	MC_2	MC_3	MC_1	MC_2	MC_3	MC_1	MC_2	MC_3		Stocking Density	Dietary Levels	Interaction
Live weight													
Feed cost per bird	91.097	100.46	101.38	91.392^{b}	98.018^{a}	98.572^{a}	90.159^{b}	95.403^{ab}	99.262^{a}	2.663	0.4656	0.0009	0.9143
Value of gain per bird	273.04	295.68	299.17	279.01	292.80	289.52	277.00	289.173	294.96	11.93	0.9659	0.1277	0.9691
Feed cost/gain	54.039	54.945	54.535	53.575	54.399	55.611	53.310	53.924	55.537	2.283	0.9871	0.6973	0.9918
MOFC	181.94	195.22	197.79	187.62	194.78	190.95	186.84	193.770	195.69	11.56	0.9945	0.5302	0.9881
Carcass weight													
Feed cost per bird	91.097	100.459	101.383	91.392^{b}	98.018^{a}	98.572^{a}	90.159^{b}	95.403^{ab}	99.262^{a}	2.663	0.4656	0.0009	0.9143
Value of gain per bird	235.58	254.73	260.62	240.90	247.69	251.89	237.23	251.718	254.27	11.14	0.9244	0.1326	0.9741
Feed cost/gain	74.697	75.883	74.676	74.119	76.441	75.919	74.289	74.181	76.499	3.426	0.9819	0.8769	0.9852
MOFC	144.49	154.27	159.23	149.51	149.68	153.32	147.07	156.315	155.00	10.762	0.9694	0.5852	0.9817

MC_1 = 2,825 kcal/kg ME + 18.26% CP; MC_2 = 2,784 kcal/kg ME + 20.26% CP; MC_3 = 2,744 kcal/kg ME + 22.26% CP

MOFC = margin over feed cost; SEM = standard error of means
Liveweight price = ₱150.00; Carcass weight price = ₱190.00
[a-b] values with the same letter are not significantly different

Assuming live weight and carcass prices of 150 and 190 pesos per kilogram, respectively, producers can use these findings to optimize profitability by balancing stocking density and diet. Although MOFC did not differ significantly, higher protein diets, despite their greater cost, may yield better economic returns due to improved growth performance and greater weight gains. Munõz *et al.* (2023) support this, emphasizing that optimizing diet and stocking density enhances resource use and profitability in broiler production.

Regarding organ weights (head, feet, gizzard, heart, spleen, liver), no significant differences were observed in either absolute or relative weights ($P > 0.05$) across all treatments. This suggests that broilers maintained consistent organ development regardless of dietary composition or stocking density, demonstrating their adaptability. This supports Guarino and Castellini's (2022) conclusion that broilers can adjust organ growth in response to dietary and environmental changes without adverse effects.

CONCLUSIONS

A higher stocking density of 12 birds per square meter is more advantageous than lower densities, as it leads to improved feed conversion ratios and more efficient feed-to-body mass conversion, resulting in better growth performance and increased economic returns. Additionally, a diet containing 2,744 kcal/kg ME and 22.26% CP is ideal for optimal broiler growth, enhancing average daily gain and feed efficiency. These findings suggest that combining high protein content with an optimal stocking density can maximize broiler performance and profitability.

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CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest concerning the publication of this study.

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