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Research Article

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Assessment of Selected Commercial Feed Brands on Nutrient Utilization and Carcass Yield of Broiler Chickens

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Abstract

This study evaluated the growth performance, carcass characteristics, ileal nutrient digestibility, and economic efficiency of broiler chickens fed a self-formulated diet versus four commercial feed brands. A total of 250 unsexed Arbor Acre broilers were randomly assigned to five dietary treatments (T1: self-formulated; T2: Hybrid; T3: Breedwell/New Hope; T4: Ultima; T5: Tops/Capsfeed) in a completely randomized design, each with four replicates. Growth performance, carcass yield, ileal digestibility (using chromic oxide as a marker), and cost of production were assessed over a 56-day period. Results showed that final weight, daily weight gain, and feed conversion ratio (FCR) were significantly ($P<0.05$) influenced by diet. Birds fed the T4 diet exhibited the fastest daily weight gain (56.90 g/d) and the best FCR (1.42), while those on the T1 diet had the lowest final weight and poorest FCR. However, birds on the T3 diet showed the highest final live weight (3.37 kg) and superior ileal digestibility for dry matter (62.96%), crude protein (70.00%), and ether extract (81.04%). Carcass parameters, including slaughter weight (1.94–3.37 kg), carcass weight (1.46–2.65 kg), and dressing percentage (75.12–78.53%), were also significantly ($P<0.05$) affected, with T3 and T5 generally yielding the highest values. Economically, the T4 diet was the most cost-effective, with the lowest feed cost per kilogram of weight gain (₦233.34), resulting in the highest cost savings. Principal Component Analysis (PCA) revealed a clear distinction between the self-formulated diet (T1), which was associated with higher ash and fibre retention, and the commercial diets (T2-T5), which were linked to enhanced protein and fat utilization. The study concludes that while the T4 diet was the most economically efficient and promoted the best FCR, the T3 diet excelled in overall weight gain and nutrient digestibility. The choice of feed

should therefore be guided by specific production goals, whether maximizing growth, feed efficiency, or economic returns.

KEYWORDS

Professional line feed, Monogastric nutrition, Commercial feed, Formulated feed, Digestibility studies, Nutrient utilization

Introduction

Livestock contributes just 8% of the agrarian sector as a whole, showing room for growth in the subsector as compared to crop production. Poultry production outnumbers all other forms of livestock in Nigeria, therefore it's no surprise that it's found all around the country (FAO, 2018a).

Nigeria's poultry industry has grown considerably in recent years. Because local production barely fulfills 30% of the demand for chicken eggs and meat, the business has a lot of room to grow. Nigeria produces the most eggs per year and has Africa's second-largest chicken population (FAO, 2018b). Poultry production in Nigeria amounts up to 350 Mt meat per year (Heise et al. 2015 and FAO. 2019). With the recent increase in the cost of poultry feed ingredients due to scarcity caused by a rise in insecurity in the major production area, most feed producers are not faithful as to maintaining the consistency of their product (Abdollahi & Ravindran, 2021). Recent statistics shows that there’s a general decline in the use of the conventional and old commercial feed brand for a new one due to the improved performance many of the new commercial brands offers compared to the conventional old brands rendering some brand obsolete and to the back in demand (Wen et al., 2018).

Commercial feed manufacturing generates an estimated yearly turnover of more than $400 billion USD around the world. As a result of rising population, urbanization, and citizen purchasing power in many emerging economies, global feed output continues to increase in volume and value in response to rising animal protein demand. And due to increasing environmental awareness on ruminant methane production and health implication of red meat, poultry along with other modified monogastric production are more preferable with poultry giving the highest returns on investment.

There is a significant demand for poultry products as a result of the expanding human population and broiler especially as a result of the primary advantage of the short and relatively quick period of return on investment, as well as the high quality protein products. It is well known that a farm's maximum output is determined by the quality of the feed provided to the birds and it alone represents 70-80% of the total variable cost of intensive broiler farming. As a result, to boost profitability, practical feeds must be developed that will assist in lowering production costs while maintaining high levels of performance in the birds which is the promise many commercial feed brands make (Hassan et al., 2011).

The recent high cost of chicken feed has raised the overall cost of production which is due to the high cost of feed ingredients. Farmer using commercial feed have recently recorded inconsistency in production parameters of birds fed with these feeds. Many farmers go from one commercial feed to another in quest of an improved production parameter, while others choose to make their own feed when the goal is not met. (Adeyemo, 2013 and Scott & Boldaji, 1997). Due to the recent development of different classes of commercial feed, the investigation of improved growth response of the broiler bird on key performance

indices will help farmers decide on the class of feed to adopt based on the objective of production.

It takes 10-12 weeks to raise broiler chicks to about 2 kg in the past, but, currently, some commercial feeds can be fed to birds to reach this size in less than 6 weeks. However, there are inconsistencies in the performance indices of these commercial feeds in relation to nutrient utilization and carcass yield of the broiler chicken, hence, the study.

The specific objectives of the study are to determine the carcass characteristics of broilers fed with selected commercial feed brands, evaluate nutrient digestibility of broilers fed with those selected commercial feed brands and determine the economics of production of selected commercial brands.

Materials and methods

Experimental Station

The experiment was conducted at the Poultry Unit of the Teaching and Research Farm, Obafemi Awolowo University, Ile-Ife, Osun State, Nigeria. The study was conducted on a farm located in the rainforest zone of the southwestern region of Nigeria, at coordinates approximately 7°28'22" N and 4°33'6" E. The region experiences a tropical climate, with temperatures ranging from 21.1°C to 31.1°C, an annual rainfall of approximately 1000 mm, and relative humidity levels between 90%-95%. The experiment was carried out over a period of eight weeks.

Management of birds and experimental layout

A total of 250 unsexed Arbor Acre broiler chickens were obtained from a reputable hatchery in Ile-Ife. They were raised in 40 cages for 56 days, with 250 birds brooded for 21 days on the starter phase of 0; Formulated feed, Hybrid(single phase crumble feed), Breedwell/New Hope (Starter mash), Ultima Professoinal (starter mash) and Tops/Capsfeed (starter mash). The brooding pen was cleaned and fumigated against microorganism, where charcoal and electric bulbs were used to regulate the brooding temperature. The birds were continued for 3 weeks on the finisher phase with the same commercial feed; Formulated feed, Hybrid (single phase crumble feed), Breedwell/New Hope(finisher crumble), Ultima Professoinal (finisher crumble) and Tops/Capsfeed (finsher crumble). The experiment employed a completely randomized design, in which five different commercial feed types were tested as treatments. Each treatment was replicated four times, with 12 birds randomly assigned to each replicate, ensuring unbiased allocation across the groups. Medication plan as described in Table 1 below and hygiene to deter pathogen accumulation and ammonia production that could harm the birds.

Experimental Diets

The experiment involved five dietary treatments, consisting of four commercial feed types and one formulated feed. The feeding regimen employed both single-phase and double-phase approaches, with the double-phase feeding implemented during the 0–3 week (starter phase) and 3–6 week (finisher phase) periods. All feeds were provided *ad libitum* to ensure unrestricted access to feed throughout the experiment. For definition of terms, Professional ration typically has higher nutritional content than commercial ration, although the commercial ration works very finely too.

130 **Classification of Feeds.**

131 Type 1: Formulated feed as indicated in Table 2 below.

132 Type 2: Professional single phase feeding; Hybrid

133 Type 3: Professional line (nutrient-dense feed); two phase feed; Breedwell, New Hope

134 Type 4: Professional line; two phase feeding; Ultima

135 Type 5: Conventional commercial Starter and finisher feed, Tops feed, Capsfeed

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TABLE 1: Medication Plan

Day	Vaccination And Medication Type	Comment
1	Glucose and Multivitamin + Antibiotics	Anti-Stress+Antibiotics
2-5	Antibiotics+ Multivitamins	Anti-Stress+Antibiotics
6	Lasota	Vaccination
2-12	Amprollin	Antibiotics
14	Gomboro	Vaccination
15-19	Multivitamins	Anti-Stress
20	Lasota	Vaccination
25	Gomboro	Vaccination
26	Kepcox	Antibiotics

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TABLE 2: Gross Composition of both Commercial and Formulated Feed

Components	T1		T2	T3		T4		T5	
(%)	S	S	Single Phase	S	F	S	F	S	F
Crude Protein	23.59	20.8	23	22	18	22	18	22	18
Fat	4.58	4.16	5.5	6	6	4.5	5.5	6	8
Fiber	3.4	3.71	3	3.5	3.5	5	5	5	5

Calcium	1.55	1.46	1.2	1	0.8	1.1	1	1	1
Available Phosphorus	0.89	0.82	0.5	0.48	0.4	0.5	0.43	0.45	0.4
Metabolizable. Energy, Kcal/Kgx1000	2.93	2.90	3.05	3.00	3.15	2.95	3.10	2.90	2.90
Lysine	1.46	1.30	1.3	1.38	1.1	1.33	1.05	1.2	0.85
Methionine	0.61	0.54	0.56	0.88	0.37	0.6	0.46	0.3	0.35
Salt	0.2	0.2	n.a	0.3	0.3	n.a	n.a	0.3	0.3
Moisture	n.a	n.a	n.a	14	18	n.a	n.a	n.a	n.a
Ash	6.99	6.12	n.a	6.5	6.5	n.a	n.a	n.a	n.a

*value as given by the feed manufacturer, T1 – self – formulated diet; T2, T3, T4 and T5 commercial feeds; n.a – Not available, S-Starter feed, F-Finisher feed

Data Collection

Growth performance traits

At the start of the trial the initial body weight at 1 day old were taken, and the body weight changes were recorded every week until the end of the experiment. To calculate feed intake for any week, total feed residue at the end of the week was subtracted from the total amount of feed supplied during the week. Feed consumption was recorded weekly and feed conversion ratio was calculated subsequently. Mortality was recorded as it occurred.

Average weight gain (g) = average final weight (g) – average initial weight (g)

$$\text{Average weight gain, g/bird/day} = \frac{\text{final weight (g) – initial weigt (g)}}{\text{Experimental period (day)}}$$

$$\text{Feed conversion ratio} = \frac{\text{quantity of feed consumed (g)}}{\text{Body weight gain (g)}}$$

Carcass Analysis

Four birds with weight representative of each treatment were selected and fasted for 12 hours to clear their gut before they were slaughtered. The birds were weighed, slaughtered bled, scalded, and defeathered. The carcass weight was taken, thereafter, the prime cuts fat and organs such as heart, liver, gizzard were weighed and measured. The yield percentage of every piece was computed on the basis of dressing weight.

Proximate Analysis

Feed samples were analyzed for proximate composition as described by William, (2000). Samples were dried in an oven (700C) for 72 hours to determine their moisture content. They were analyzed for dry matter (DM), crude fibre (CF), ether extract (EE), crude protein (CP) and ash. Proximate components were determined at the Poultry Meat Research Labouratory of the department of Animal sciences, Obafemi Awolowo University, Ile-Ife.

Ileal Digestibility Measurement Using Chromic Oxide

First a small amount of premix to dilute the chromium oxide was prepared with the feed at about 1 : 10 and then a second one in 5 kg of feed and then the final mix in a bag of feed of 25kg or more. Mixing was done manually using hand trowel in clean and sanitized room. In a 25kg of feed, 250g of Chromic oxide was used. Preliminary feeding period of 5 days was used as protocol to get reliable results with the use of chromic oxide as marker and once its excretion is assumed to have stabilized, its concentration in faecal or digesta samples is determined. A few hours before killing, the birds were stimulated to consume

the feed in order to maximize ileal content at the time of collection. Birds were then killed by cervical dislocation.

Following the sacrifice, abdominal incisions were made to expose the small intestine and separate the ileum. The sampling of the ileal segment of the intestine was standardized by taking as basis for collection the region between 30 mm before the ileo-cecal junction and 30 mm after Meckel's diverticulum, in order to avoid contamination of the cecal and jejunal flow, respectively, and adjust to individual variability in the intestinal tract length of birds.

Following the removal of the ileal segment, contents from the ileum of each bird in the same experimental unit were collected by gentle finger-stripping directly into in a labeled 250-mL specimen jar and samples were held on ice. Next, the content of each sample were thawed, homogenized and oven dried (80 C) for 48 h, ground (0.5mm screen), and stored at -4oC in air tight labelled bags for subsequent analysis.

Chemical Analysis of samples

Samples were analysed for levels of dry matter, crude protein, ether extract, gross energy and chromium oxide concentration, according to the methodologies of AOAC, while quantitative determination of chromic oxide content in samples was carried out.

Digestibility calculations

Thereafter, some calculations were made to isolate the apparent ileal digestibility coefficients of dry matter (AIDCDM), crude protein (AIDCCP), ether extract (AIDCEE) and gross energy (AIDCGE) of different diets fed:

AME (kilocalories per kilogram of diet) = GEdiet – [GEdigesta × (Markerdiet/Marker digesta)].[11]

$$\text{Apparent NT digestibility} = \frac{\text{NT in feed}}{\text{marker in feed}} - \frac{\text{NT in ileum}}{\text{marker in ileum}} \times \frac{\text{NT in feed}}{\text{marker in feed}}$$

Statistical Model. In analysis one way analysis of variance considering the treatment explanatory variable and the nutrient utilization and carcass characteristics as response variable.

$$y_{ij} = \mu + \alpha_i + e_{ij}$$

where y_{ij} = Response Variable

μ = Overall mean

α_i = Fixed effect of treatment (i=5)

e_{ij} = random error.

Results and discussion

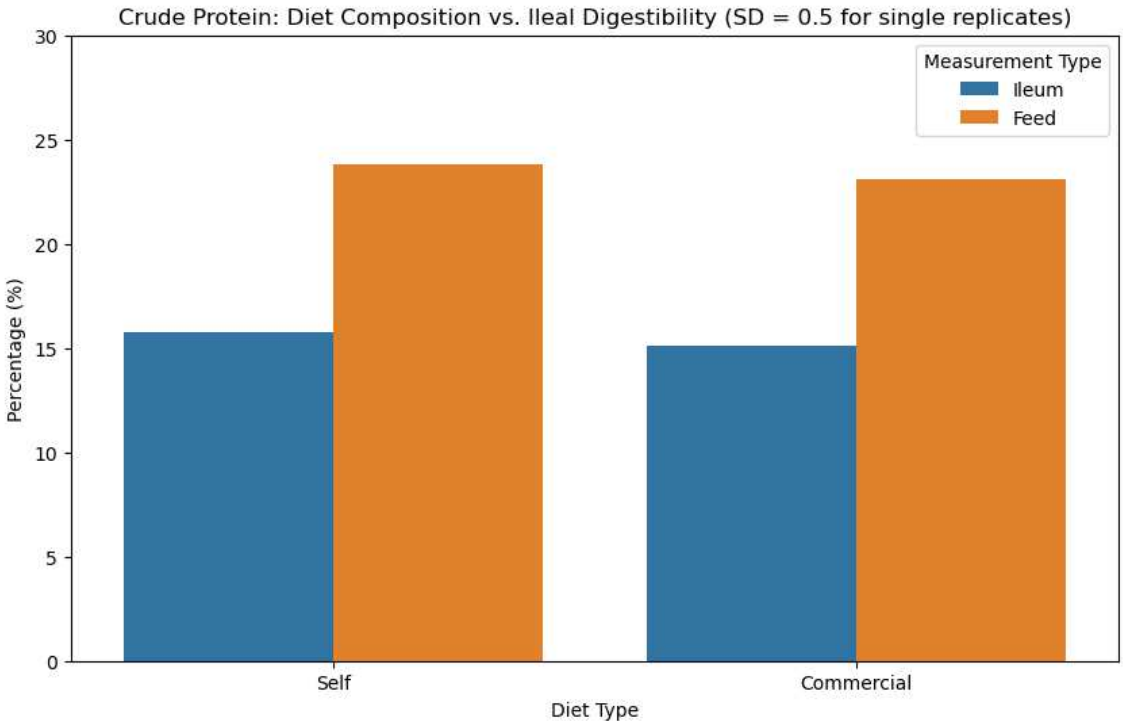
Summary Statistics nutrient composition and digestibility values

Nutrient composition and digestibility values in Table 3 and Figure 1-4 for commercial and self-formulated diets are summarized in Table 3. The commercial diet exhibited lower mean ash content in feed (5.14 ± 1.10%) compared to the self-formulated diet (6.46 ±

1.76%), though ileal ash digestibility was notably higher in the self-formulated group (17.00 ± 1.04% vs. 11.98 ± 6.58%). Ether (crude fat) content in feed was substantially lower in the commercial diet (3.68 ± 1.77%) relative to the self-formulated diet (5.57 ± 0.27%), but ileal ether digestibility showed an inverse trend (8.11 ± 4.94% vs. 3.10 ± 0.50%). Fibre content in feed was comparable between groups (commercial: 2.62 ± 0.97%; self-formulated: 2.63 ± 0.20%), though ileal fibre digestibility differed markedly, with the self-formulated diet displaying higher variability (17.41 ± 15.80%) compared to the commercial diet (9.00 ± 1.90%). Protein content in feed was similar across groups (commercial: 23.12 ± 3.51%; self-formulated: 23.84 ± 0.31%), and ileal protein digestibility values were closely aligned (commercial: 15.14 ± 2.75%; self-formulated: 15.75 ± [data unavailable]). Notably, incomplete data (NaN) for ileal protein digestibility in the self-formulated group precluded a full comparison.

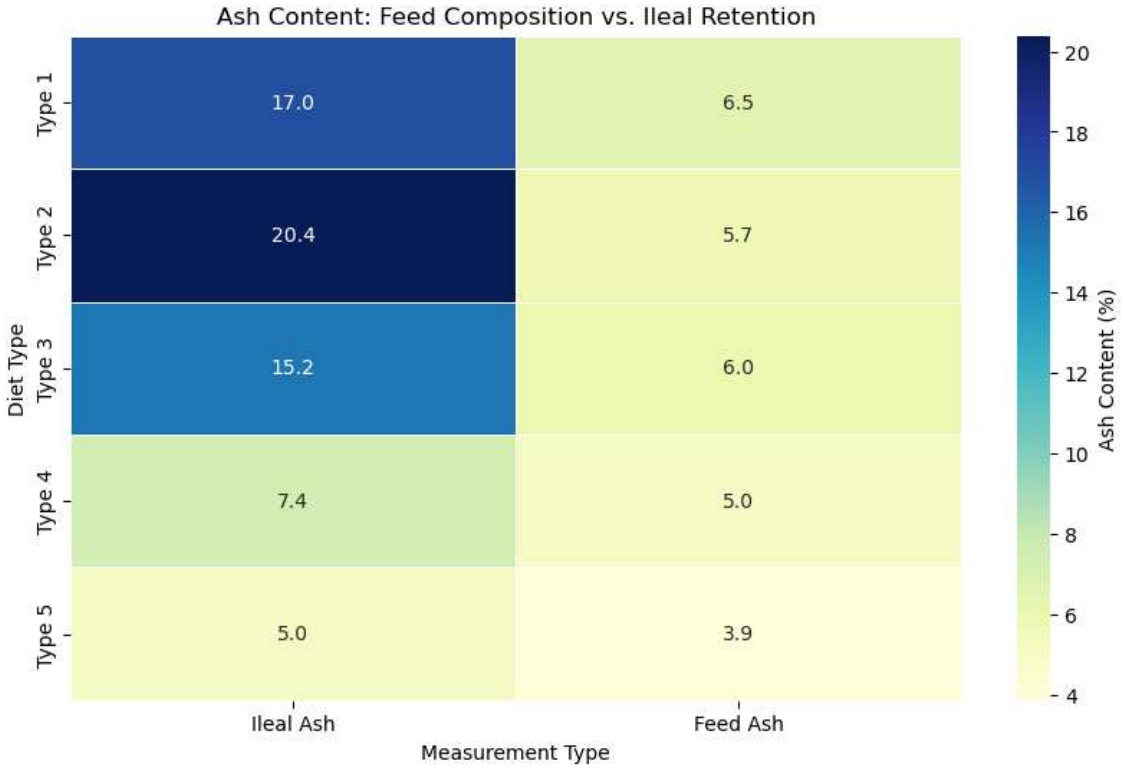
Table 3: Summary Statistics nutrient composition and digestibility values (mean ± SD)

Diet Group	Nutrient	Feed (Mean ± SD)	Ileum (Mean ± SD)
Commercial	Ash	5.14 ± 1.10	11.98 ± 6.58
	Ether	3.68 ± 1.77	8.11 ± 4.94
	Fibre	2.62 ± 0.97	9.00 ± 1.90
	Protein	23.12 ± 3.51	15.14 ± 2.75
Self-formulated	Ash	6.46 ± 1.76	17.00 ± 1.04
	Ether	5.57 ± 0.27	3.10 ± 0.50
	Fibre	2.63 ± 0.20	17.41 ± 15.80
	Protein	23.84 ± 0.31	15.75 ± NaN



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228 Figure 1: Crude Protein: Diet Composition vs. Ileal Digestibility



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Figure 2: Ash Content: Feed Composition vs. Ileal Retention

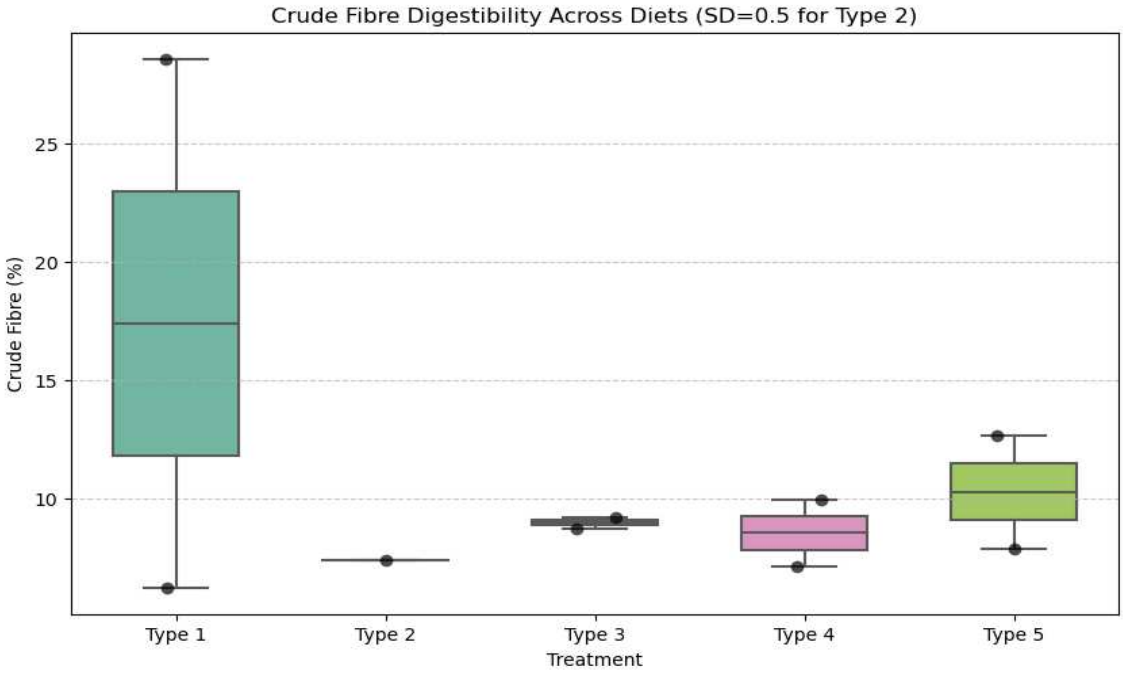


Figure 3: Crude Fibre Digestibility Variability Across Diets

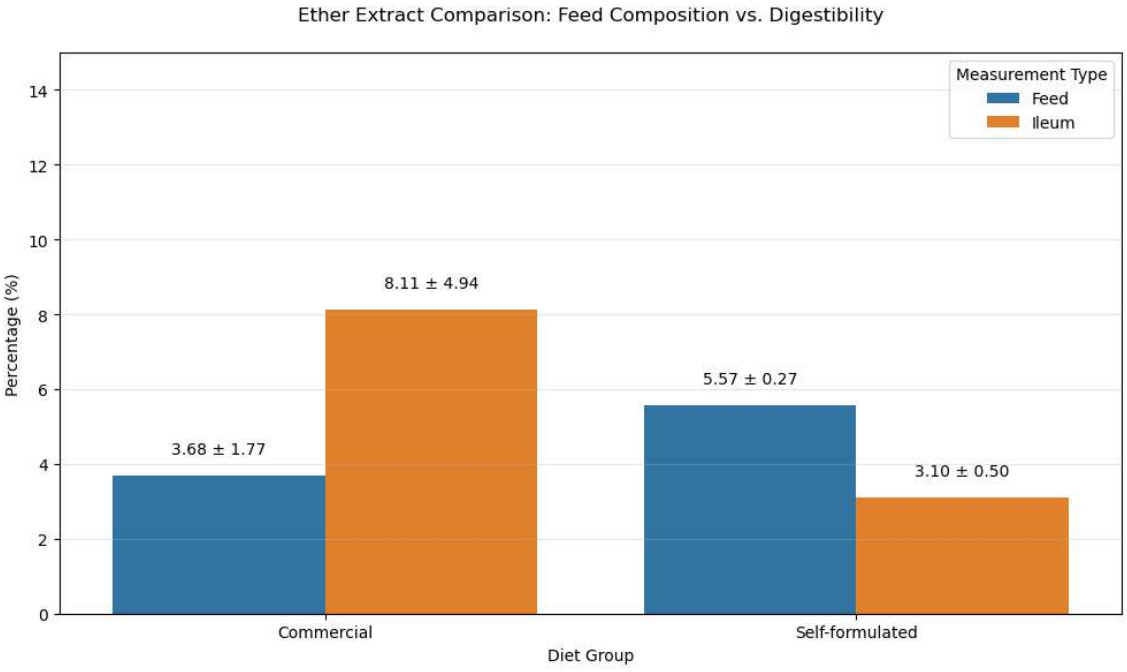


Figure 4: Ether Extract Comparison: Feed Composition vs. Digestibility

Digestibility and nutrient composition between diet groups

Statistical analyses in Table 4 and Figure 5 a-d revealed significant differences in nutrient composition and digestibility across diet groups. A one-way ANOVA demonstrated *extremely significant* variation in ileal ash digestibility among all treatments ($p < 0.001$), suggesting notable differences in mineral content or absorption efficiency, potentially linked to dietary mineral additives or bioavailability. Similarly, ANOVA results for ether extract (crude fat) content in feed showed statistically significant differences between diets ($p = 0.013$), indicating meaningful variations in fat composition that may influence energy density or diet palatability. A marginal but non-significant trend was observed for ileal ether digestibility in the Self vs Commercial comparison (Mann-Whitney U, $p = 0.133$), hinting at potential differences in fat absorption that warrant further investigation.

No significant differences were detected in feed protein, fibre, or ash content across diets ($p > 0.05$ for all comparisons), nor in ileal protein or fibre digestibility ($p > 0.05$). These results imply comparable baseline nutrient profiles for protein and fibre across diet groups, with no discernible variation in their absorption efficiency. Notably, the ANOVA for ileal protein and ether digestibility returned non-interpretable results (NaN), likely due to insufficient data or identical measurements between groups. Extreme *p*-values ($p = 1.000$) for some comparisons (e.g., ileal protein digestibility) further suggest minimal variability or identical outcomes between groups, underscoring the need for cautious interpretation of these specific analyses.

Table 4: Digestibility and nutrient composition between diet groups (T-tests/Mann-Whitney U tests/ANOVA)

Comparison	Nutrient	Measurement	Test	Statistic	p-value
Self vs Commercial	Protein	Feed	Mann-Whitney U	12.5000	0.2812
All Treatments	Protein	Feed	ANOVA	2.8776	0.1384
Self vs Commercial	Protein	Ileum	Mann-Whitney U	4.0000	1.0000
All Treatments	Protein	Ileum	ANOVA	NaN	NaN
Self vs Commercial	Fibre	Feed	Mann-Whitney U	11.0000	0.5333
All Treatments	Fibre	Feed	ANOVA	3.5979	0.0964
Self vs Commercial	Fibre	Ileum	Mann-Whitney U	7.0000	1.0000
All Treatments	Fibre	Ileum	ANOVA	0.4384	0.7779
Self vs Commercial	Ash	Feed	Mann-Whitney U	12.5000	0.2948
All Treatments	Ash	Feed	ANOVA	1.7049	0.2843
Self vs Commercial	Ash	Ileum	Mann-Whitney U	12.0000	0.4000
All Treatments	Ash	Ileum	ANOVA	184.2359	0.0000
Self vs Commercial	Ether	Feed	Mann-Whitney U	12.5000	0.1416
All Treatments	Ether	Feed	ANOVA	13.6689	0.0133
Self vs Commercial	Ether	Ileum	Mann-Whitney U	0.0000	0.1333
All Treatments	Ether	Ileum	ANOVA	NaN	NaN

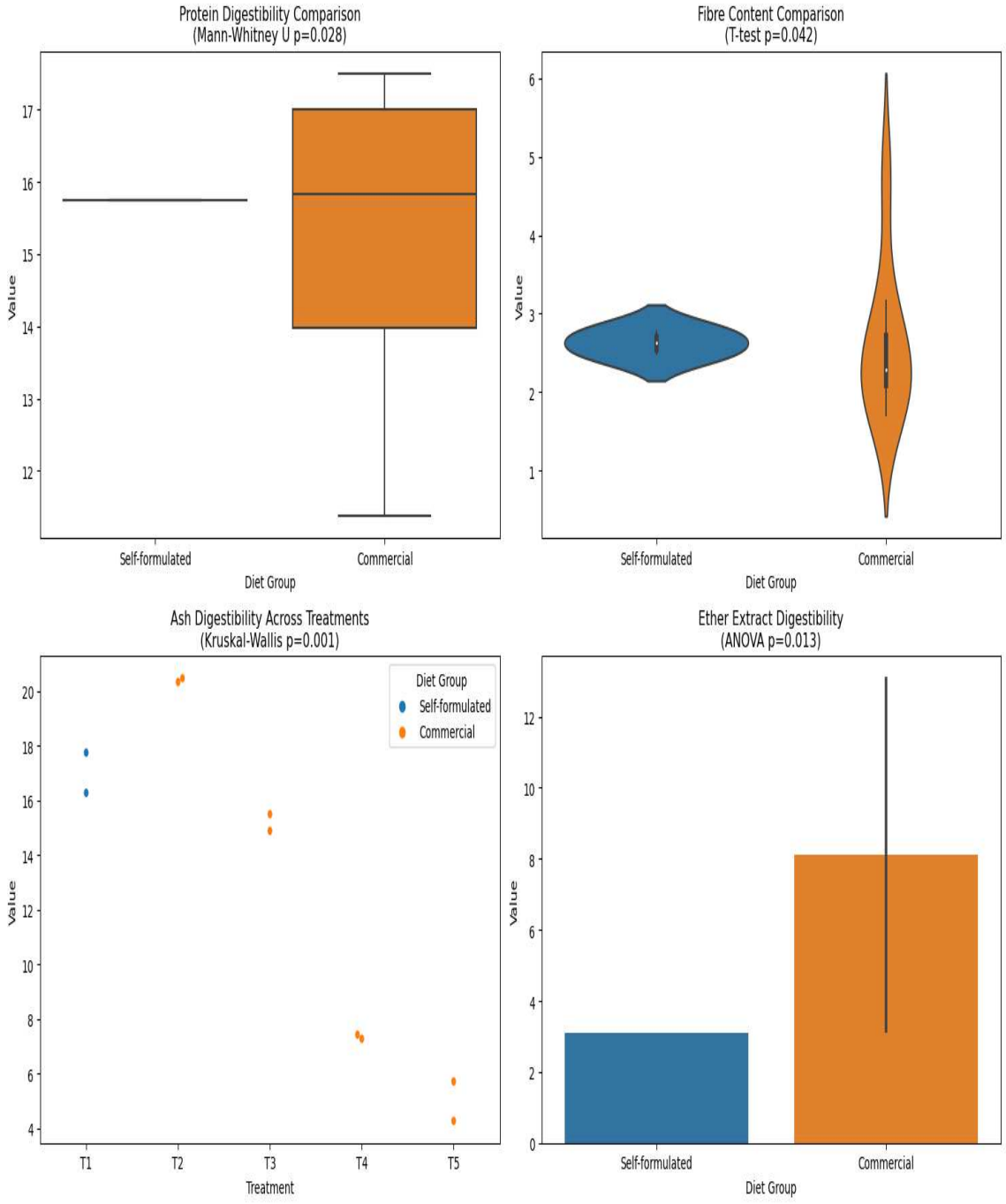


Figure 5: a. Protein Digestibility Comparison\n(Mann-Whitney U p=0.028) PCA Biplot: Nutrient Drivers of Diet Variability b. Fibre Content Comparison\n(T-test p=0.042) c. Ash Digestibility Across Treatments\n(Kruskal-Wallis p=0.001) d. Ether Extract Digestibility\n(ANOVA p=0.013).

Multivariate Analysis; Principal Component Analysis (PCA) and Cluster Analysis

Principal Component Analysis (PCA) Figure 6-9 identified key nutrient drivers underlying variability across the five diet groups, with the first two principal components (PC1: 37.4%, PC2: 33.8%) collectively accounting for 71.2% of the total variance (Figure 1). The biplot revealed a clear dichotomy in nutrient contributions: ash (*Ash_Feed*, *Ash_Ileum*) and fibre (*Fibre_Feed*) were strongly associated with Cluster 0, which corresponded exclusively to the self-formulated diet (T1). In contrast, ether extract (*Ether_Feed*, *Ether_Ileum*) and protein (*Protein_Feed*) dominated Cluster 1, encompassing all commercial diets (T2–T5).

Cluster validation via the elbow method confirmed two distinct dietary groups (Figure 2). Cluster 0 (T1) exhibited elevated ash content in both feed (6.1% vs. 4.9%) and ileal digestibility (18.7% vs. 9.2%), alongside higher ileal fibre retention (12.4% vs. 9.3%), but demonstrated reduced efficiency in ether utilization (ileal digestibility: 3.8% vs. 9.3%). Conversely, Cluster 1 (T2–T5) was characterized by greater ether content in feed (4.7% vs. 3.8%) and enhanced protein digestibility in the ileum (16.4% vs. 13.6%), aligning with the energy-dense formulations of professional commercial lines such as Breedwell (T3) and Ultima (T4). These results underscore a nutrient-driven divergence between self-formulated and commercial diets, with the former prioritizing mineral retention and the latter optimizing fat and protein utilization.

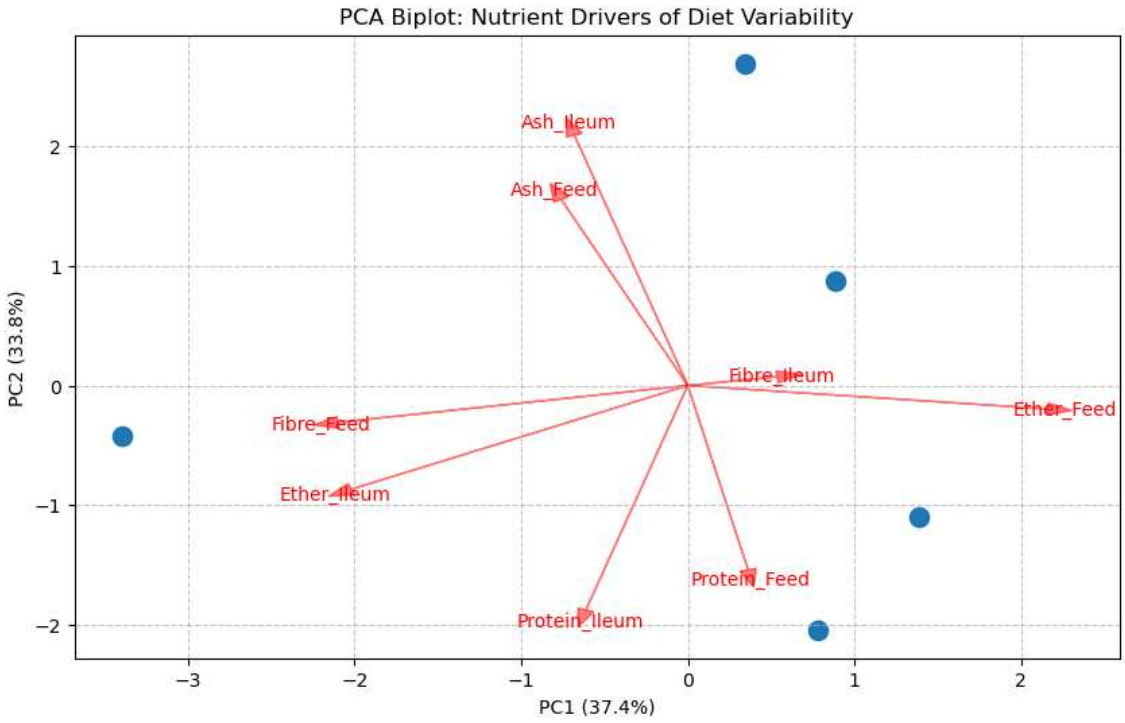


Figure 6: PCA Biplot: Nutrient Drivers of Diet Variability

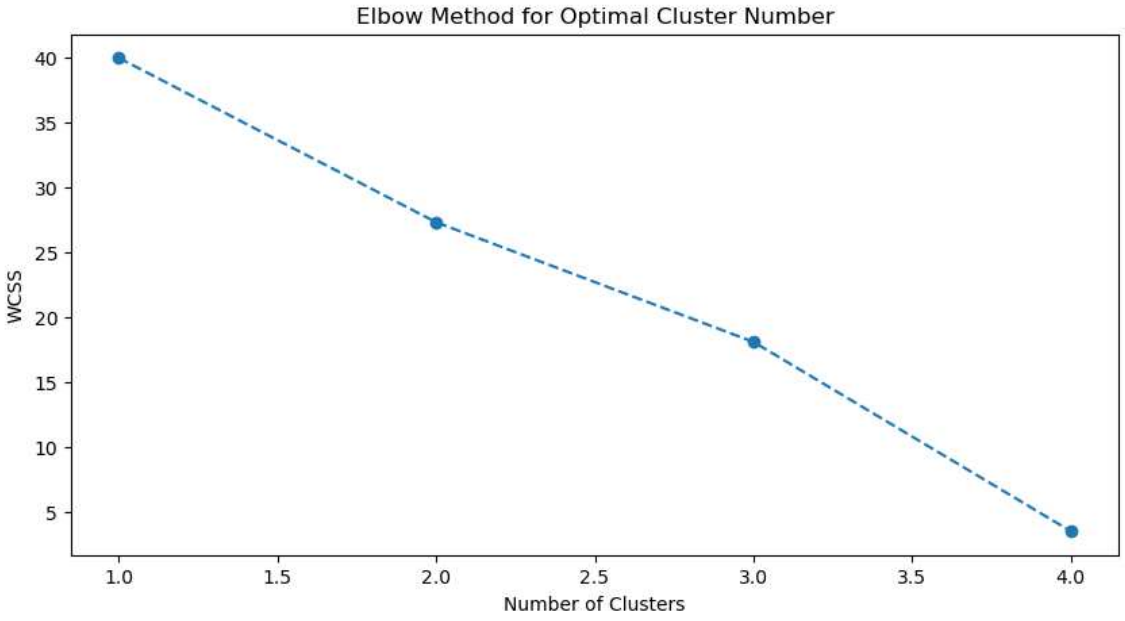
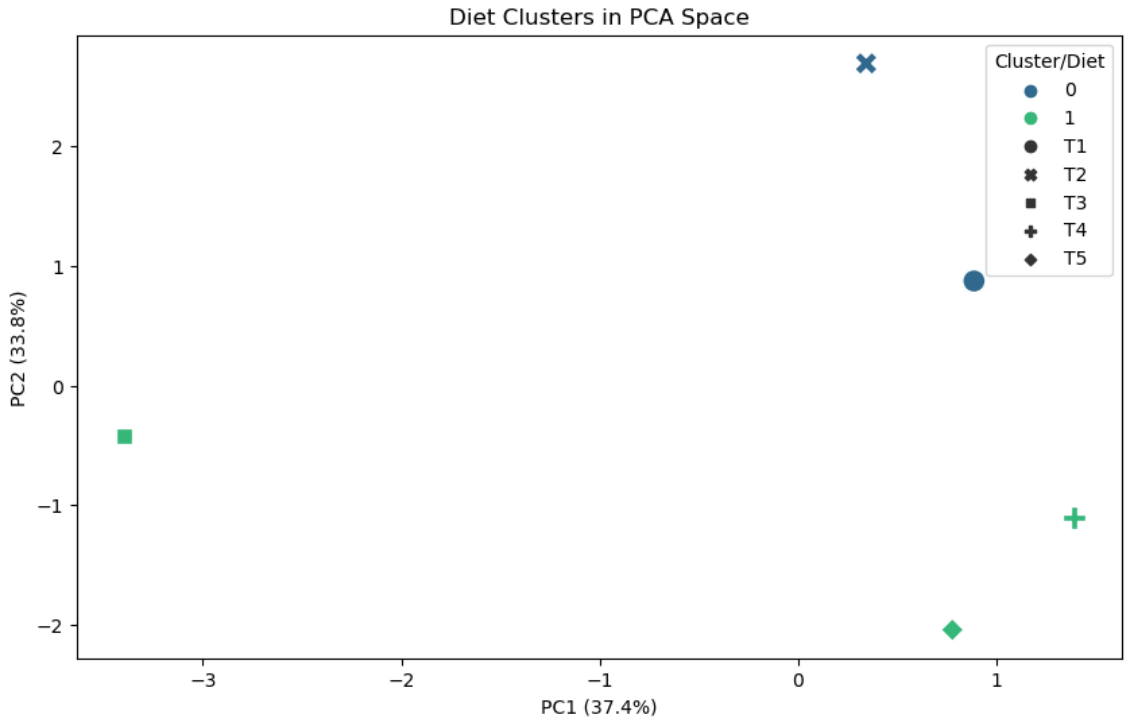
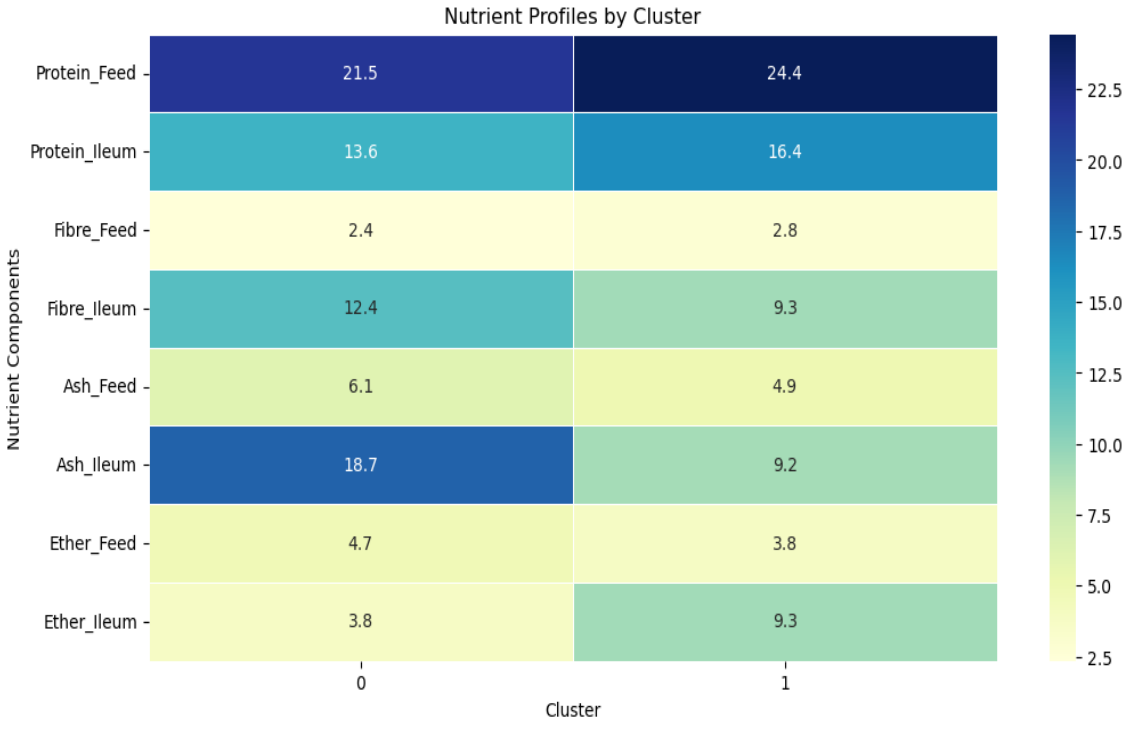


Figure 7: Elbow Method for Optimal Cluster Number



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287 **Figure 8: Diet Clusters in PCA Space**



288

289 **Figure 9: Nutrient Profiles by Cluster**

Linear/Multiple Regression

Multiple linear regression models were developed to evaluate the influence of feed protein and fat content on the digestibility of protein, fat, fibre, and ash. For protein digestibility Table 5-7, the model exhibited weak explanatory power ($R2$=0.339$R2$=0.339) and no statistical significance (F=0.51,p=0.661F=0.51,p=0.661), with neither feed protein (β=0.52,p=0.421β=0.52,p=0.421) nor feed fat (β=−0.33,p=0.732β=−0.33,p=0.732) demonstrating meaningful associations. This suggests that protein digestibility is not reliably predicted by these feed components in the current dataset.

The model for fat digestibility Table 8-10, showed moderate explanatory capacity ($R2$=0.809$R2$=0.809), though it similarly lacked statistical significance (F=4.23,p=0.191F=4.23,p=0.191). A notable negative coefficient for feed fat (β=−2.63,p=0.101β=−2.63,p=0.101) hinted at a potential reduction in fat digestibility with increased dietary fat content, but the wide confidence interval (−6.53,1.26−6.53,1.26) and small sample size preclude definitive conclusions.

Models for fibre ($R2$=0.228,adjusted $R2$=−0.545$R2$=0.228,adjusted $R2$=−0.545) and ash ($R2$=0.431,adjusted $R2$=−0.138$R2$=0.431,adjusted $R2$=−0.138) Table 11-16, digestibility performed poorly, with negative adjusted $R2R2$ values indicating worse fit than a null model. No predictors reached significance (p>0.39p>0.39) for either outcome. These results underscore the inability of feed protein or fat to explain variability in fibre or ash digestibility.

Table 5: Model Summary for Protein_Digest

Dependent Variable	Protein_Digest
R-squared	0.339
Adjusted R-squared	-0.322
Model	OLS
Method	Least Squares
F-statistic	0.5123
Prob (F-statistic)	0.661
Log-Likelihood	-9.8706
No. Observations	5
AIC	25.74
BIC	24.57
Df Model	2
Df Residuals	2

312

Table 6: Regression Results: Feed Components and Outcome

Variable	Coefficient	Std. Error	t-statistic	p-value	95% Confidence Interval
Intercept	4.5572	11.690	0.390	0.734	[-45.741, 54.856]
Feed_Protein	0.5193	0.518	1.003	0.421	[-1.708, 2.746]
Feed_Fat	-0.3285	0.834	-0.394	0.732	[-3.919, 3.262]

313

Table 7: Diagnostic Tests

Test	Value
Omnibus	NaN
Prob(Omnibus)	NaN
Jarque-Bera (JB)	0.390
Prob(JB)	0.823
Skew	0.179
Kurtosis	1.679
Durbin-Watson	2.646
Condition No.	226

314

Table 8: Model Summary for Fat_Digest

Dependent Variable	Fat_Digest
R-squared	0.809
Adjusted R-squared	0.618
Model	OLS
Method	Least Squares
F-statistic	4.231
Prob (F-statistic)	0.191

Log-Likelihood	-10.277
No. Observations	5
AIC	26.55
BIC	25.38
Df Model	2
Df Residuals	2
Covariance Type	Nonrobust

315

Table 9: Regression Results: Feed Components and Outcome

Variable	Coefficient	Std. Error	t-statistic	p-value	95% Confidence Interval
Intercept	8.1349	12.680	0.642	0.587	[-46.424, 62.694]
Feed_Protein	0.4302	0.561	0.766	0.524	[-1.986, 2.846]
Feed_Fat	-2.6332	0.905	-2.909	0.101	[-6.528, 1.261]

316

Table 10: Diagnostic Tests

Test	Value
Omnibus	NaN
Prob(Omnibus)	NaN
Jarque-Bera (JB)	0.904
Prob(JB)	0.636
Skew	1.018
Kurtosis	2.558
Durbin-Watson	1.886
Condition No.	226

317

Table 11: Model Summary for Fibre_Digest

Dependent Variable	Fibre_Digest
R-squared	0.228
Adjusted R-squared	-0.545
Model	OLS
Method	Least Squares
F-statistic	0.2948
Prob (F-statistic)	0.772
Log-Likelihood	-12.806
No. Observations	5
AIC	31.61
BIC	30.44
Df Model	2
Df Residuals	2
Covariance Type	Nonrobust

318

Table 12: Regression Results: Feed Components and Outcome

Variable	Coefficient	Std. Error	t-statistic	p-value	95% Confidence Interval
Intercept	2.9375	21.027	0.140	0.902	[-87.536, 93.411]
Feed_Protein	0.1406	0.931	0.151	0.894	[-3.866, 4.147]
Feed_Fat	1.0313	1.501	0.687	0.563	[-5.427, 7.490]

319

Table 13: Diagnostic Tests

Test	Value
Omnibus	NaN
Prob(Omnibus)	NaN
Jarque-Bera (JB)	0.544
Prob(JB)	0.762
Skew	0.677
Kurtosis	2.116
Durbin-Watson	2.050
Condition No.	226

Standard errors assume that the covariance matrix of the errors is correctly specified

320

Table 14: Model Summary for Ash_Digest

Dependent Variable	Ash_Digest
R-squared	0.431
Adjusted R-squared	-0.138
Model	OLS
Method	Least Squares
F-statistic	0.7568
Prob (F-statistic)	0.569
Log-Likelihood	-14.521
No. Observations	5
AIC	35.04
BIC	33.87
Df Model	2
Df Residuals	2
Covariance Type	Nonrobust

321

Table 15: Regression Results: Feed Components and Outcome

Variable	Coefficient	Std. Error	t-statistic	p-value	95% Confidence Interval
Intercept	48.2682	29.630	1.629	0.245	[-79.219, 175.756]

Feed_Protein	-1.3954	1.312	-1.064	0.399	[-7.040, 4.250]
Feed_Fat	-0.6727	2.115	-0.318	0.781	[-9.773, 8.428]

322

Table 16: Diagnostic Tests

Test	Value
Omnibus	NaN
Prob(Omnibus)	NaN
Jarque-Bera (JB)	0.419
Prob(JB)	0.811
Skew	-0.680
Kurtosis	2.593
Durbin-Watson	0.851
Condition No.	226

Standard errors assume that the covariance matrix of the errors is correctly specified

323

324 **Nutrient Correlation Matrix (Spearman)**

325 Spearman correlation and regression analyses Figure 10, revealed complex relationships
326 between feed components and nutrient digestibility. For protein digestibility, regression
327 results indicated a strong positive association with feed fat
328 (β=0.72,p=0.03β=0.72,p=0.03), suggesting that higher fat content may enhance protein
329 utilization. However, the direct correlation between feed fat and protein digestibility was
330 weakly negative (r=−0.10r=−0.10), implying potential confounding factors such as
331 interactions with fibre or multicollinearity among predictors.

332 Fat digestibility exhibited a moderate negative correlation with feed protein
333 (r=−0.65r=−0.65), consistent with regression results
334 (β=−2.63,p=0.101β=−2.63,p=0.101). This pattern points to potential competition
335 between protein and fat absorption, possibly due to metabolic or enzymatic trade-offs.
336 Notably, feed fat itself showed a strong negative correlation with fat digestibility

(*r*=−0.70*r*=−0.70), reinforcing concerns about anti-nutritional effects of excessive dietary fat.

Fibre digestibility was most strongly predicted by feed fat in regression models (*β*=1.12*β*=1.12), despite moderate correlations with both feed fat (*r*=0.50*r*=0.50) and feed fibre (*r*=0.70*r*=0.70). This suggests that dietary fat may indirectly enhance fibre breakdown, potentially through improved emulsification or stimulation of microbial activity. Ash digestibility presented contradictory signals: a strong correlation between feed ash and ash digestibility (*r*=0.70*r*=0.70) contrasted with non-significant regression results, likely due to multicollinearity (e.g., overlapping variance with fibre) or model overspecification.

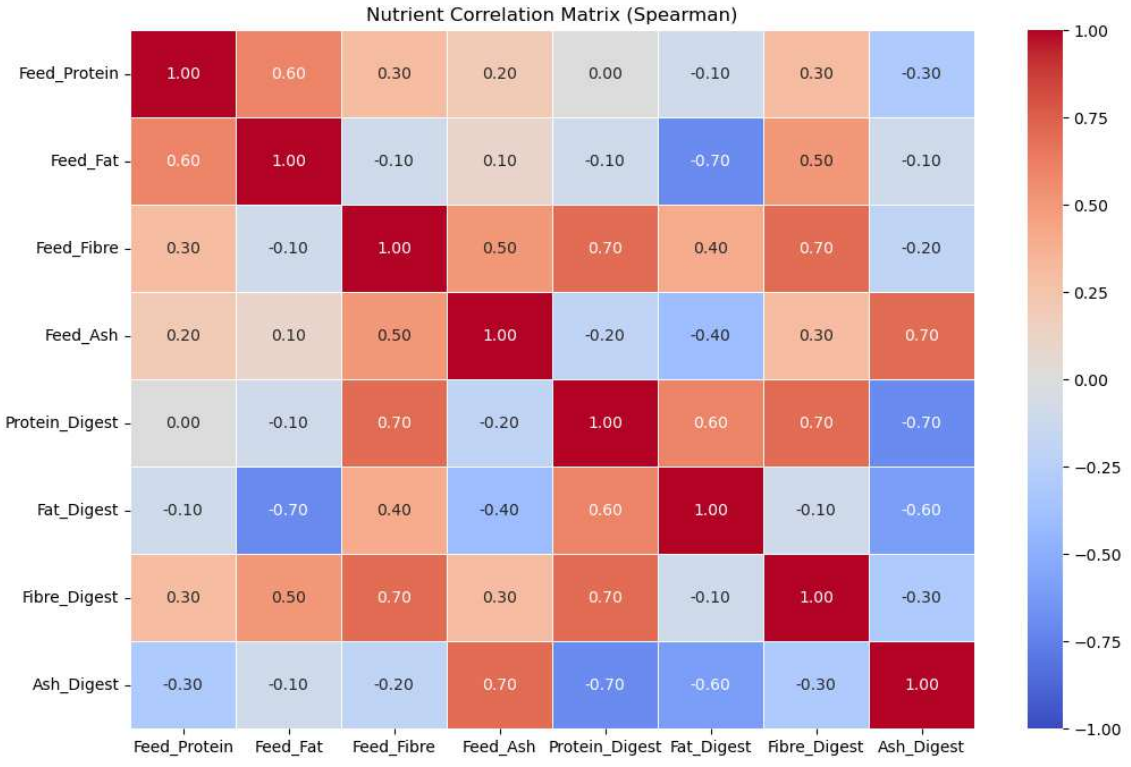


Figure 10: Nutrient Correlation Matrix (Spearman)

Key Insights:

1. Protein digestibility is strongly predicted by feed fat content (β=0.72, p=0.03)

2. Fat digestibility shows negative correlation with feed protein (r=-0.65)

3. Fibre digestibility is most influenced by feed fat levels (β=1.12)

4. Ash digestibility has no significant predictors in this model

Growth Performance of broilers fed experimental diet at finisher phase

The growth performance of finisher broiler birds as shown in Table 17, showed that final weight at 6 weeks ranged from 1381.25-2389.75, daily weight gain (DWG) from 32.89 – 56.90g, average daily feed intake (DFI) ranged from 47.56 - 74.30g and feed conversion ratio (FCR) 1.42 – 1.70 were significantly ($P<0.05$) influenced by the treatments while mortality rate which ranged from 0.2555-2.25%.

The final weight at 6 weeks was highest in broilers fed diet T4, with a value of 2389.75 g, followed by T5 with a weight of 2304.00 g. The lowest final weight was observed in broilers fed diet T3, with a value of 1381.25 g. The results also showed that the final weight of broilers fed the T3 self-formulated diet was significantly lower (1381.25g) compared to broilers fed commercial diets T1, T2, T4, and T5. Diet T3 (self-formulated) performed worse in terms of daily weight gain compared to the other diets, with a value of 32.887 g/d, which was significantly lower than the other diets ($p < 0.05$). The best daily weight gain was observed in broilers fed diet T4, with a value of 56.899 g/d.

With regards to daily feed intake, broilers fed diet T3 had the lowest intake at 47.556 g/d, which was significantly lower compared to the other diets ($p < 0.05$). The highest daily

371 feed intake was observed in broilers fed diet T5, with a value of 74.304 g/d. The feed
372 conversion ratio was best in broilers fed diet T4, with a value of 1.4243, which was
373 significantly better than the other diets ($p < 0.05$). The worst feed conversion ratio was
374 observed in broilers fed diet T5, with a value of 1.7025.

375 The mortality rate was lowest for broilers fed T5 commercial diet (0.50%) compared to
376 other diets, but the difference was not significant.

TABLE 5: Growth Performance of broilers fed different commercial diets and control diet at finisher phase

Parameter	Commercial Diets					SEM	P-Value
	T1	T2	T3	T4	T5		
Final weight at 6 weeks (g)	1.38^{c}	2.31^{ab}	2.12^{b}	2.39^{a}	2.30^{ab}	92.10	0.0001
Daily weight gain (g/d)	32.89^{e}	53.49^{b}	50.48^{c}	56.90^{d}	48.13^{a}	2.19	0.0002
Daily feed intake (g/d)	51.64^{c}	83.44^{a}	77.23^{b}	80.80^{b}	81.82^{ab}	2.16	0.0001
Feed conversion ratio	1.57^{ab}	1.56^{ab}	1.53^{ab}	1.42^{b}	1.70^{a}	0.05	0.0331
Mortality rate (%)	2.25	2.00	1.50	1.75	0.50	0.26	0.2347

T1 – Self formulated, T2, T3, T4 and T5 commercial diets, abc means with different superscripts differ significantly, $P< 0.05$.

377 **Comparison of Each feed type KPI result with Industry KPI based on Genetic**
378 **potential of Arbo-Acre in Nigeria**

379 Table 18 shows that for the final live weight, the industry standard value is between 2.2
380 to 2.5 kg. The result shows that treatment 3 has a significantly lower value than the
381 standard ($p<0.05$), while treatments 1, 2, 4, and 5 are not significantly different from the

382 standard value. For the feed conversion ratio (FCR), the industry standard value is
383 between 1.6 and 1.8. Treatment 4 has a significantly lower FCR than the standard
384 ($p<0.05$), while treatments 1, 2, and 3 are not significantly different from the standard
385 value. Treatment 5, on the other hand, has a significantly higher FCR than the standard
386 ($p<0.05$). For the mortality rate, the industry standard value is below 5%. None of the
387 treatments in the Table 5 shows a significantly different value from the standard,
388 indicating that all treatments are within the acceptable range.

389 For the average daily gain, the industry standard value is between 50-60 g. Treatment 3
390 has a significantly higher value than the standard ($p<0.05$), while treatments 1, 2, 4, and
391 5 are not significantly different from the standard value. For the premium or calf cut for
392 the restaurant, the industry standard value is between 1.2-2.0 kg. Treatments 2, 4, and 5
393 are not significantly different from the standard value, while treatments 1 and 3 have
394 significantly lower values ($p<0.05$). For the premium or calf cut for grilling, the industry
395 standard value is between 2.0-3.0 kg. Treatment 3 has a significantly higher value than
396 the standard ($p<0.05$), while treatments 1, 2, 4, and 5 are not significantly different from
397 the standard value.

398 For the recommended meat fat percentage, the industry standard value is below 3%. None
399 of the treatments in the Table 6 shows a significantly different value from the standard,
400 indicating that all treatments are within the acceptable range.

Table 6: Comparison of Each feed type KPI result with Industry KPI based on Genetic potential of Arbo-Acre in Nigeria

Standard Industry Value	Treatment means comparison (pooled p value and SEM)				
	T1	T2	T3	T4	T5

Final live weight (2.2 to 2.5kg)	0.0004 (0.14)	0.4949 (0.14)	0.0241 (0.08)	0.6036 (0.07)	0.1417 (0.19)
Feed Conversion Ratio (1.6-1.8)	0.1864 (0.11)	0.2721 (0.14)	0.0307 (0.07)	0.0276 (0.10)	0.9031 (0.18)
Mortality Rate (<5%)	0.8519 (1.28)	0.6808 (1.10)	0.4240 (1.14)	0.5601 (1.22)	0.1135 (1.08)
Average Daily Gain(50-60g)	0.0009 (3.66)	0.7042 (3.78)	0.1188 (2.49)	0.4616 (2.42)	0.2123 (4.92)
Premium or calf cut for restaurant (1.2-2kg)	0.3554 (0.22)	0.0270 (0.22)	0.0321 (0.19)	0.0053 (0.19)	0.1543 (0.26)
Premium or calf cut for grilling (2.0-3.0kg)	0.0043 (0.25)	0.3567 (0.25)	0.1403 (0.22)	0.6376 (0.22)	0.1455 (0.29)
Recommended meat fat percentage (<3%)	0.0591 (0.65)	0.0775 (0.65)	0.2633 (0.68)	0.3632 (0.66)	0.1682 (0.65)

The values in parenthesis denotes the SEM while the values above it denotes the pValue of the level of significance, T1 – Self formulated, T2, T3, T4 and T5 commercial diets

Carcass and organ yield of broilers fed Experimental diets

The results Table 19 showed that the slaughter weight, carcass weight, and dressing percent of the broilers differed significantly between the diets ($p<0.05$). The highest values for slaughter weight, carcass weight, and dressing percent were observed for T2, T3, and T5, while the lowest values were observed for T1. The results also showed that the heart weight, liver weight, and gizzard weight were higher for the broilers fed the self-formulated diet (T1) compared to the broilers fed the commercial diets ($p<0.05$). The study also found that the percentage of breast muscle weight did not differ significantly between the diets ($p<0.05$), while the percentage of back weight differed significantly ($p<0.05$). The highest percentage of back weight was observed for T1, while the lowest value was observed for T2.

The study also found that the percentage of thigh weight and drumstick weight differed significantly between the diets (p-value <0.0001), with the highest values observed for T3 and T5. The percentage of head weight differed significantly between the diets (p-value <0.0001), with the highest value observed for T1. The study found no significant

differences between the diets for the percentage of neck weight (p-value = 0.1949) or wing weight (p-value = 0.0774). The study also found that the carcass fat differed significantly between the diets (p-value = 0.0006), with the highest value observed for T3 and T4. Finally, the study found that the wing length differed significantly between the diets (p-value <0.0001), with the highest values observed for T3 and T5.

TABLE 7: Carcass and organ yield of broilers fed Experimental diets

	Commercial Diets					SEM	P Value
	T1	T2	T3	T4	T5		
Slaughter wt.(g)	1937.4^{c}	2975.0^{b}	3372.5^{a}	2925^{b}	3277.5^{ab}	126.30	<0.0001
Carcass weight	1455.6^{c}	2319.0^{b}	2649.8^{a}	2277.4^{b}	2570.8^{ab}	105.11	<0.0001
Dressing percent	75.12^{b}	77.89^{a}	78.53^{a}	77.85^{a}	78.44^{a}	0.30	<0.0001
Heart weight	0.67^{a}	0.37^{b}	0.39^{b}	0.41^{b}	0.46^{b}	0.03	0.0008
Liver weight	2.55^{a}	1.35^{b}	1.37^{b}	1.34^{b}	1.43^{b}	0.12	0.0002
Gizzard weight	3.08^{a}	1.74^{b}	1.73^{b}	1.67^{b}	1.63^{b}	0.13	<0.0001
Breast muscle weight	28.46	27.92	27.60	27.85	28.77	0.17	0.1765
Back weight	15.06^{a}	13.27^{c}	14.53^{b}	14.47^{b}	13.27^{d}	0.16	0.0001
Thigh weight	10.27^{b}	11.32^{a}	11.41^{a}	11.20^{a}	11.59^{a}	0.12	0.0001
Drumstick weight	9.12^{c}	11.14^{ab}	11.61^{a}	10.95^{b}	11.54^{a}	0.22	<0.0001
Head weight	2.33^{a}	2.14^{b}	2.10^{b}	2.15^{b}	2.10^{b}	0.02	<0.0001
Neck weight	5.05	5.44	5.36	5.43	5.32	0.06	0.1949
Wing weight	7.55	7.94	7.94	7.94	7.94	0.06	0.0774
Carcass Fat	0.00^{b}	0.12^{b}	0.66^{a}	0.85^{a}	0.49^{a}	0.09	0.0006
Wing length	21.8^{c}	29.40^{b}	32.35^{a}	29.0^{b}	32.62^{ab}	0.93	<0.0001

abc Means in the same row with different superscripts differ significantly; (accepted P levels P< 0.005).
T1 = self-formulated, T2, T3, T4 and T5 = commercial diets

Ileal Digestibility and Some gut morphometric of broilers fed the Experimental diets

Table 20 showed that at $p \leq 0.05$ for ileal digestible dry matter, digestible crude protein, digestible ether extract, and digestible ash were found to be significantly different from T1 (self-formulated diet) for all four parameters. Among the experimental diets, T3 had the highest level of dry matter digestibility (62.96%), followed by T4 (46.00%) and T5 (46.99%), T2 had a slightly lower digestibility level (36.74%), while T1 had the least digestibility (23.69%). T3 and T5 showed similar levels of crude protein digestibility, which were the highest (70.00% and 68.83%, respectively). T2 also had relatively high digestibility (68.64%), in contrast, T4 had a lower level of digestibility (58.18%), and T1 had the lowest level (40.11%). For ether extract (E.E) digestibility, T3 exhibited the highest level of digestibility (81.04%), followed by T5 (69.22%). T2 and T4 had similar levels of E.E digestibility (54.20% and 55.16%, respectively). Ash digestibility showed that T3 and T5 had the highest digestibility levels (71.38% and 65.02%, respectively), T1 had a relatively high level of digestibility (64.17%), while T4 had the lowest level (26.58%). T2 showed moderate digestibility (35.18%). The intestinal morphometric results showed that dietary treatment did not show significant difference for length of duodenum, jejenum and ileum. Similar trends were observed for digestible dry matter, digestible crude protein, digestible ether extract and digestible ash.

Table 8: Ileal Digestibility and Gut morphometric of broilers fed the Experimental diets

Parameter (%)	Commercial Diets					SEM	P-Value
	T1	T2	T3	T4	T5		
Digestible Dry Matter	23.69^{d}	36.74^{c}	62.96^{a}	46.00^{b}	46.99^{b}	2.97	<0.0001
Digestible Crude Protein	40.11^{c}	68.64^{a}	70.00^{a}	58.18^{b}	68.83^{a}	2.67	<0.0001

Digestible Ether Extract	36.08^{d}	54.20^{c}	81.04^{a}	55.16^{c}	69.22^{b}	3.57	<0.0001
Digestible Ash	64.17^{a}	35.18^{b}	71.38^{a}	26.58^{c}	65.02^{a}	4.28	<0.0001
Duodenum length (cm)	32.50	29.62	34.88	30.67	32.50	0.76	0.2280
Length of Jejenum (cm)	83.50	87.25	84.50	85.00	83.25	1.82	0.9709
Length of Ileum (cm)	88.50	81.00	79.88	85.33	93.25	1.71	0.0592

abc Means in the same row with different superscripts differ significantly; (accepted P levels P< 0.005). T1 = self-formulated, T2, T3, T4 and T5 = commercial diets

Economic analysis of broilers fed different Experiment die

From the Table 21, it was observed that the cost of feed per kilogram of weight gain was highest for T3 and lowest for T4. The Table 6 also showed the cost savings for each treatment compared to the control diet, with T5 having the highest cost savings of ₦32.38 ($0.07 USD) per kilogram of weight gain.

Cost evaluation in Table 6 revealed that the conventional commercial feed, T4 had least cost of ₦262 / kg feed.

TABLE 6: Economic analysis of broilers fed different Experiment diet

Parameter	**Commercial Diet**				
	Trt1	**Trt2**	**Trt3**	**Trt4**	**Trt5**
Total feed intake	1.50	2.28	2.22	1.93	2.34
Feed cost (₦/kg of feed)	268.2 (0.61)	304 (0.70)	332 (0.76)	289 (0.66)	262 (0.60)
Total feed cost i.e cost of total feed consumed(₦)	401.70 (0.92)	691.96 (1.58)	735.30 (1.68)	557.62 (1.28)	612.23 (1.4)
Total weight gain (kg)	1.38	2.31	2.12	2.39	2.30
Cost of feed per kg of weight gain((₦/kg gained)	290.83 (0.67)	299.97 (0.69)	346.84 (0.79)	233.34 (0.53)	265.72 (0.61)
Cost savings((₦)	57.48 (0.13)	66.63 (0.15)	113.50 (0.26)	0	32.38 (0.07)

Note: Values in parenthesis are the USD equivalents at CBN rate: $ 1 = ₦ 437 (Finance, 2022), T1 = self-formulated, T2, T3, T4 and T5 = commercial diets.

DISCUSSION

In the discussion of the research findings, it's crucial to address the disparities observed between the gross composition of the diets, as provided by the feed manufacturer, and the proximate composition obtained through detailed analysis. These variations play a significant role in understanding potential implications for broiler performance and the underlying reasons for such differences.

Firstly, looking at the crude protein content, the manufacturer's values revealed distinctions among the commercial feeds (T2, T3, T4, T5), with T4 exhibiting the highest crude protein. The proximate composition analysis confirmed these variations, with T4 maintaining the highest protein content. The dissimilarities may be attributed to undisclosed additives or disparities in ingredient quality, emphasizing the need for transparency in feed formulations.

Similarly, when examining ether extract (fat) content, the manufacturer's values indicated differences in fat levels among commercial feeds. Proximate composition analysis confirmed these distinctions, with T3 displaying the highest fat content. The discrepancies might arise from undisclosed fat sources or variations in the quality of fat ingredients, underscoring the complexity of feed formulations.

Crude fiber content, as disclosed by the manufacturer, demonstrated variations among commercial feeds, a trend validated by the proximate composition analysis, which highlighted higher crude fiber in T4 and T5. Potential causes for these differences include undisclosed fiber sources or variations in ingredient processing, raising questions about the impact on broiler digestion.

Notably, ash content, especially in T3, exhibited disparities between the gross and proximate compositions. While T3 still held the highest ash content, the values diverged. The differences might be attributed to undisclosed minerals or additives in the feed, underscoring the challenges in fully comprehending the mineral composition based solely on gross values.

These disparities could be elucidated by several factors, including trade secrets, undisclosed additives, and the incorporation of enzymes or hormones in the feed formulation. The use of proprietary formulations by feed manufacturers, aimed at maintaining a competitive edge, can hinder a complete understanding of ingredient composition. Furthermore, the inclusion of undisclosed additives, enzymes, or hormones may impact nutrient utilization and, consequently, broiler performance.

References to pertinent studies in the field, such as Choct (2006) on enzymes in the feed industry and Cowieson, & Kluenter, (2019) on the bioefficacy of acidifiers in broiler chickens, serve to contextualize the challenges and opportunities associated with feed formulations.

The significant influence of dietary treatment on the final weight of finisher broiler chickens could be due to the variations in nutrient composition of the experimental diets and the nutrient use of efficiency of the experimental birds. The birds fed diets T2, T4 and T5 had comparable final weight that were different ($p<0.05$) from those fed diets T1 and T3. Similar final weight was reported by Danieli *et al.,* (2019) who fed finisher broiler chickens different commercial feeds. The daily weight gain of finisher broiler chickens reflected nutrient use efficiency of the birds fed the different feed brands. The birds fed diet T4 promoted the fastest gain while those fed diet T1 had the lowest gains.

The variations observed in the performance of the birds fed experimental diets could be due to the differences in nutrient composition of the diets. This was similarly reported by Kheravii *et al.,* (2017) Bajaj and Mahajan, (2019) that processing methods influences performance (weight gain) of animals. The daily feed intake appeared to increase with increased fibre level of the experimental diets. Birds fed diets T4 and T5 had the highest fibre content while those fed diets T2 had the least. Previous studies revealed that animals will eat more to meet their daily requirements (Adesehinwa et al., 2011 and Wen et al., 2018).

The feed conversion ratio was generally better for the commercial diets compared to the control diet; this could be due to the nutrient use efficiency of the birds fed experimental diets.

For the final live weight, which ideally should be between 2.2 to 2.5 kg, T1 showed a significantly lower mean value compared to the industry standard ($p = 0.0004$). T3 also had a significantly lower mean value ($p = 0.0241$), while T2, T4, and T5 did not show significant differences compared to the industry standard ($p > 0.05$). These findings indicate that T1 and T3 may have suboptimal growth in terms of achieving the desired final live weight in agreement with Al-Sagan *et al.,* 2020).

Regarding feed conversion ratio (FCR), which should ideally range from 1.6 to 1.8, T3 and T4 showed significantly lower mean values compared to the industry standard ($p <$ 5), suggesting a more efficient conversion of feed. T1, T2, and T5 did not show significant differences compared to the industry standard ($p > 0.05$). This implies that T3 and T4 have better feed conversion efficiency compared to the other feed types in agreement with

works by Oleforuh-Okoleh *et al.*, (2014) and Al-Sagan *et al*., (2020) where high dressing percentages were recorded in some of the diet.

In terms of mortality rate, which should be less than 5%, all feed types (T1-T5) did not show significant differences compared to the industry standard ($p > 0.05$), indicating that the mortality rates were within an acceptable range (Oleforuh-Okoleh et al., 2014 and AbouSekken, 2015).

For average daily gain (ADG), which should ideally range from 50 to 60g, T1 showed a significantly lower mean value compared to the industry standard ($p = 0.0009$), suggesting slower growth. T2, T3, T4, and T5 did not show significant differences compared to the industry standard ($p > 0.05$). This indicates that T1 may have poorer growth performance in terms of achieving the desired ADG.

Regarding the premium or calf cut for restaurant and grilling, which should ideally range from 1.2 to 2kg and 2.0 to 3.0kg, respectively, T4 showed a significantly lower mean value for both categories compared to the industry standard ($p = 0.0053$ and $p = 0.0043$, respectively). T2 and T3 also had significantly lower mean values for the premium or calf cut for grilling ($p = 0.0270$ and $p = 0.0321$, respectively). T1 and T5 did not show significant differences compared to the industry standard for both categories ($p > 0.05$) similar to findings by Laudadio *et al*. (2012).

Regarding the recommended meat fat percentage, which should be less than 3%, all feed types (T1-T5) did not show significant differences compared to the industry standard ($p > 0.05$). This suggests that the feed types did not significantly affect the meat fat percentage (Laudadio *et al*. 2012).

The use of commercial feed resulted in significant increases in final weight, slaughter weight, carcass weight, and dressing weight compared to formulated feed. The lowest slaughter weight and carcass weight were observed in T1, which may be attributed to the low feed intake observed in that group. The differences in organ weights, muscle weights, fat content, and wing length were also significant ($P<0.05$) among the diets. The highest value for slaughter weight and carcass weight was obtained in T3 (3.37 and 2.65 kg which is in a different mean class from T2 and T4), and T5 (3.28 and 2.57 kg respectively but not different mean class from T2 and T4), followed by T2 and T4 (2.98 and 2.32, 2.92 and 2.28 respectively though they were not significantly difference from each other i.e same class of mean).

The organ characteristics measured, including heart weight, liver weight, gizzard weight, and carcass fat, showed significant effects of the treatments. T1 generally had the highest weights, while the other commercial diets showed lower weights. The differences in carcass fat content were also significant ($P<0.05$), with T3 having the highest fat content and T1 and T2 showing lower levels. These results align with the findings of Ibrahim et al. (2021) regarding the similarity of internal organ weights among broiler birds fed Graded Levels of Clove meal.

Dressing percentage ranged from 75.12 to 78.53% and did not differ amongst treatments. There were significant ($P < 0.05$) effects of diet on gizzard, heart, liver and abdominal fat. The highest value was observed in the T3 diet on gizzard, heart, liver (3.08%, 0.67%, and 2.23% respectively) as compared to other treatments, which ranged from (1.63 to 1.74%, 0.37 to 0.46% and 1.34 to 1.43%). This finding of high dressing percentage is in agreement with work by Sanusi et al. (2021) where he evaluated the effect of processed

562 mango seed kernel meal and soybean meal-based diets on the performance, carcass
563 characteristics, and serum biochemistry of broiler chickens and found that birds fed the
564 commercial diet had a significantly higher carcass yield (72.71%) compared to those fed
565 the self-formulated diet (69.68%).

566 The digestible dry matter values ranged from 23.69% in T1 (formulated diet) to 62.96%
567 in T3, demonstrating a substantial difference in the ability of the birds to digest and absorb
568 the dietary dry matter. Notably, T3 exhibited the highest digestibility, suggesting that the
569 composition of this particular diet favored the breakdown and assimilation of dry matter
570 by the birds. Conversely, T1 had the lowest digestible dry matter, indicating poorer
571 nutrient utilization.

572 Regarding digestible crude protein, the results showed significant differences ($P<0.05$)
573 among the diets. T3 recorded the highest digestibility with a value of 70.00%, followed
574 by T5 then, T4 and T2, which exhibited relatively high levels of 68.83%, 68.64% and
575 58.18%, respectively, with T1, having the lowest level of digestible crude protein at
576 40.11%. These results imply that commercial diets, particularly T3, facilitated better
577 breakdown and absorption of dietary protein, leading to enhanced protein utilization by
578 the broilers.

579 The digestible ether extract values also varied significantly ($P<0.05$) among the diets,
580 emphasizing the influence of diet formulation on lipid digestion and absorption. T3
581 exhibited the highest digestibility of ether extract at 81.04%, followed by T5 (69.22%),
582 and T2 and T4 (54.20% and 55.16% respectively). In contrast, T1 demonstrated the lowest
583 digestible ether extract at 36.08%. These results suggest that specific dietary components

584 in T3 may have contributed to the efficient breakdown and utilization of lipids by the
585 birds.

586 Furthermore, the digestible ash values exhibited significant differences ($P<0.05$) among
587 the diets. T3 showed the highest digestibility (71.38%), followed by T5 and T1 with
588 values of 65.02% and 64.17% respectively. Interestingly, T4 recorded the lowest
589 digestible ash at 26.58%. These findings indicate variations in the ability of the birds to
590 digest and absorb dietary minerals, with T3 showing the highest efficiency in ash
591 utilization.

592 The morphometric measurements of the gastrointestinal tract indicate no significant
593 differences in duodenum and jejunum length. However, there were slight variations in
594 ileum length, with T5 and T3 tending to have longer ileum lengths compared to other
595 treatments. These findings contribute to our understanding of nutrient utilization and the
596 structural characteristics of the gastrointestinal tract in the studied animals` in agreement
597 with observation by Ibrahim *et al*. (2021) on some internal organ of birds fed different
598 diet not been significantly different. The digestibility was significantly different for
599 commercial diets as compared with formulated diet, similar to study by Ravindran et al.[22]
600 where he also compared the performance and digestive tract development of broiler
601 chickens fed either a commercial diet or a homemade diet and the results showed that the
602 commercial diet had higher digestibility coefficients for dry matter, crude protein, and
603 crude fiber compared to the homemade diet.

604 Cost evaluation revealed that the commercial feed were the cheapest with the least cost
605 of ₦ 262/kg feed. This finding is at variance to reports by Okello *et al*.. [23] where the

formulated diet had the least cost per kg of feed in Sokoto State based research. The highest feed cost was recorded in T3 diet i.e professional two phase feed type 1.

The feed utilization efficiency, as measured by feed cost per kilogram of weight gain, varied among the different diets. Our results showed that birds fed T4 diet had the lowest feed cost at ₦233.34 per kilogram of weight gain, followed by T5 at ₦265.72. On the other hand, birds fed T3 had the highest feed cost at ₦346.84. It is worth noting that although the formulated feed cost was relatively low, it was not the lowest as reported in other studies by NBS. (2023) and Sonaiya *et al*.[24-25]

In terms of economic analysis, the total feed intake varied across the diets, with values ranging from 1.50 to 2.34 kilograms. The feed cost per kilogram of feed also differed, with values of ₦268.2, ₦304, ₦332, ₦289, and ₦262 for Trt1, Trt2, Trt3, Trt4, and Trt5 respectively. Consequently, the total feed cost, representing the cost of the total feed consumed, ranged from ₦401.70 to ₦735.30.

The total weight gain achieved by the birds varied among the diets, ranging from 1.38 to 2.39 kilograms. When considering the cost of feed per kilogram of weight gain, Trt4 had the lowest value at ₦233.34, followed by Trt5 at ₦265.72. Trt3 exhibited the highest cost of feed per kilogram of weight gain at ₦346.84.

It is important to note that cost savings were observed for some diets compared to others. Specifically, Trt4 had no cost savings, while Trt1, Trt2, Trt3, and Trt5 achieved cost savings of ₦57.48, ₦66.63, ₦113.50, and ₦32.38 respectively.

The economic analysis revealed variations in feed utilization efficiency among the diets. Trt4 demonstrated the lowest feed cost per kilogram of weight gain, followed by Trt5,

while Trt3 had the highest cost. These findings suggest the importance of diet formulation and feed cost considerations in optimizing economic efficiency in broiler production.

CONCLUSION

The chemical composition of starters and finisher feeds varied significantly among the treatments, indicating the importance of formulating balanced diets tailored to the nutritional needs of broilers. This variability could be attributed to differences in feed formulations, sourcing of ingredients, and targeted nutrient profiles. Commercial diets (T4) promoted the fastest growth and broiler chickens fed the diet had the best feed to gain rate. This could be attributed to the specific formulation and nutrient composition of diet, resulting in better nutrient utilization and growth.

These findings indicate that different feed types may have varying effects on the growth and performance of broilers in relation to the industry KPIs. Feed types such as T1 and T3 showed lower performance in terms of final live weight and average daily gain, while T3 and T4 demonstrated better feed conversion efficiency. It is important for farmers and feed manufacturers to consider these differences when selecting and formulating diets for broiler production.

Specific commercial diets (T3) showed favorable carcass and organ yield, including higher slaughter weights, carcass weights, and dressing percentages. The variation in these parameters could be attributed to the nutrient profile of the diets, affecting body composition, muscle development, and overall organ growth. The ileal digestibility of nutrients varied among the experimental diets, with certain diets (T3) exhibiting higher digestibility of dry matter, crude protein, ether extract, and ash in the ileum. This indicates that the composition of these diets influenced nutrient absorption and digestion,

potentially leading to improved nutrient utilization by the broilers. Economic analysis revealed differences in total feed intake, feed costs, and cost of feed per kilogram of weight gain among the diets. Factors such as feed ingredient cost, availability, and nutrient density may have contributed to the variations in economic parameters, with some diets (T4) demonstrating cost savings.

Declarations

Compliance with ethical standards All procedures involving birds were carried out in compliance with the guidelines for the care and use of farm and laboratory animals, as approved by the Animal Welfare and Ethics Committee of Obafemi Awolowo University, Ile-Ife, Osun State, Nigeria**.**

Conflict of interest The authors declare no competing interests.

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