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ORIGINAL RESEARCH ARTICLE

Evaluating the Impact of Dietary Supplements on Chicken Weight Gain through a Crossover Design Approach

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ABSTRACT
The purpose of this study was to determine how dietary supplements, specifically, ginger and turmeric powders, affect the weight increase of hens when fed two distinct diets (groundnut cake and soya bean cake). Using a crossover design, 100 one-day-old broiler chicks were randomly assigned to four groups, each of which had 25 chicks across two distinct time periods. The research collected primary data through experiments conducted at Ahmadu Bello Institute of Agriculture, Zaria, and employed Analysis of Variance (ANOVA) for data analysis. The results of the study showed that there were no significant differences observed between the two diets ($p < 0.05$). Nevertheless, significant differences were noted among the various supplements ($p > 0.05$), and an interaction effect was observed between the combined diet and supplement on the weight gain of the chickens ($p > 0.05$). In conclusion, the use of a combined diet with supplements in broiler chicken diets resulted in improved weight gain.

INTRODUCTION

Data collection for statistical research is essential and is usually accomplished by conducting surveys or experiments. Researchers gather the crucial data needed for further statistical analysis through these surveys or trials. Researchers from various academic fields conduct experiments primarily to compare the influence of multiple elements on a specific phenomenon or to gain insights into certain processes. To ensure the experiment's efficacy, it is vital to adhere to a scientific approach when planning and conducting it. The statistical design of an experiment involves meticulously planning the experiment to facilitate the collection of appropriate data for subsequent analysis and the drawing of inferences. For data analysis, a variety of experimental designs can be employed, including factorial designs, randomized complete block designs (RCBDs), and completely randomized designs (CRDs). In certain scenarios, where the same experimental unit is subjected to multiple treatments or conditions, a crossover design becomes a more suitable choice. A crossover design is a type of repeated-measures approach in which each individual or object under investigation experiences different treatments at distinct time intervals, effectively switching between treatments during the course of the study. In contrast, a parallel design entails randomly assigning individuals or objects to specific treatments, which they receive consistently throughout the entire duration of the study. The concept of crossover designs originated in agricultural experiments and was first documented by Cochran in 1939. Over time, this design has seen significant advancements and has been applied in various fields, including animal feeding trials (as noted by Lucas in 1957 and Patterson in 1952), biological assays (as discussed by Finney in 1956), and pharmaceutical and clinical trials (explored by Senn in 1995).

In a study by Ukim et al. (2018), the growth and carcass traits of grill chickens were evaluated by replacing maize with acha grains. They employed a completely randomized design (CRD) for their experimental setup, utilizing a dietary supplement based on acha that included the phytase enzyme. Enyenihi et al. (2018) examined the effects of full-fat palm fruit meal (FFPFM) on the growth performance of grilled chicken, with and without the addition of Maxi Grain enzyme. They employed a completely randomized design to conduct their investigation. Apata et al. (2020) investigated the effects of two distinct growth enhancers on the performance, meat quality, and carcass quality of grill chickens. The effects of adding coconut oil to chicken feed on the

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growth and meat output of non-crossbred chickens were investigated by Nguyen et al. (2021). In their investigation, they employed a completely randomized design.

MATERIALS AND METHODS

The Model for Cross Over Design

We define the Cross Over Design model as follows;

$$y_{ijkl} = \mu + \alpha_i + \beta_j + \gamma_k + \theta_l + \varepsilon_{ijkl} \quad (1)$$

where y_{ijkl} is the observed response
μ is the overall mean
α_i is the subject effect (factor 1)
β_j is the diet effect (factor 2)
γ_k is the supplement effect (factor 3)
θ_l is the period effect (factor 4)
ε_{ijkl} is the random error
$\varepsilon_{ijkl} \sim N(0, \sigma^2)$
for $i = 1, 2, \ldots, a$
$j = 1,2, \ldots, b$
$k = 1,2, \ldots, c$
$l = 1,2, \ldots, d \quad l = 1, 2, \ldots, d$
where a=4, b=2, c=2 and d=2

From the model, you can derive the following components: the treatment sum of squares (SStreatment), subject sum of squares (SSsubject), period sum of squares (SSperiod), total sum of squares (SStotal), and error sum of squares (SSerror) as outlined below:

$$SS_{treatment} = \frac{\sum_i^a y_{i..}^2}{a-1} - \frac{y_{...}^2}{N} \quad (2)$$

$$SS_{subject} = \frac{\sum_i^a y_{.j.}^2}{b-1} - \frac{y_{...}^2}{N} \quad (3)$$

$$SS_{period} = \frac{\sum_i^c y_{..k}^2}{c-1} - \frac{y_{...}^2}{N} \quad (4)$$

$$SS_{total} = \sum_i^a \sum_j^b \sum_k^c y_{ijk}^2 - \frac{y_{...}^2}{N} \quad (5)$$

$$SS_{error} = SS_{total} - SS_{treatment} - SS_{subject} - SS_{period} \quad (6)$$

Target Population

The target population is one hundred day-old Ross broiler chickens from a local hatchery.

Technique of statistics compilation

The information used for this study is a primary data. The experiment was conducted at the Animal Science Farm, Institute of Agricultural Research (IAR), Ahmadu Bello University, Zaria, for a duration of seven weeks. The 100 1-day-old chicks were randomly divided into four groups, namely Groups 1, 2, 3, and 4. The seven-week period was divided into two periods of three weeks each, with a one-week washout period. In period 1, Group 1 was given the first diet (1) and supplement(G), Group 2 was given the first diet (1) and supplement (T), and Group 3 was given second diet (2) and supplement (G). Group 4 was given the second diet (2) and supplement (T), after which a one-week washout period was given for the treatment to be washed out. In period 2, Group 1 was given second diet (2) and supplement (T), Group 2 was given second diet (2) and supplement (G), Group 3 was given first diet (1) and supplement (T) and Group 4 was given first diet (1) and supplement (G), the average weight was taken and recorded on weekly bases.

Design Architecture

The design architecture is given in Figure 1.

Data Layout

The design was split such that period 1 has AB and D1, period 2 has BA and D1, and period 1 also has AB and D2, while period 2 has BA and D_2. Note that

Table 1: Design Layout of the Experiment

Subject	Feed/Supplement	Period 1	Period 2
I	**D_1G/D_2T**	**D_1G**	**D_2T**
II	**D_1T/D_2G**	**D_1T**	**D_2G**
III	**D_2G/D_1T**	**D_2G**	**D_1T**
IV	**D_2T/D_1G**	**D_2T**	**D_1G**

G – Supplement 1 (Ginger Powder).
T – Supplement 2 (Turmeric Powder).
D1 – First diet (soybean Cake)
D2– Second diet (groundnut cake)

Table 2: Anova table for the Model

Source of variations	Degree of freedom	Sum of squares	Means squares	F_cal
Subject	a-1	$SS_{subject}$	$\frac{SS_{subject}}{a-1}$	$\frac{MS_{subject}}{MS_{error}}$
Diet	b-1	SS_{diet}	$\frac{SS_{diet}}{b-1}$	$\frac{MS_{diet}}{MS_{error}}$
Supplement	c-1	$SS_{supplement}$	$\frac{SS_{supplement}}{c-1}$	$\frac{MS_{supplement}}{MS_{error}}$
Period	d-1	SS_{period}	$\frac{SS_{period}}{d-1}$	$\frac{MS_{period}}{MS_{error}}$
Error	difference	SS_{error}	$\frac{SS_{error}}{\text{difference}}$	
Total	N-1	SS_{total}	$\frac{SS_{Total}}{N-1}$	

:

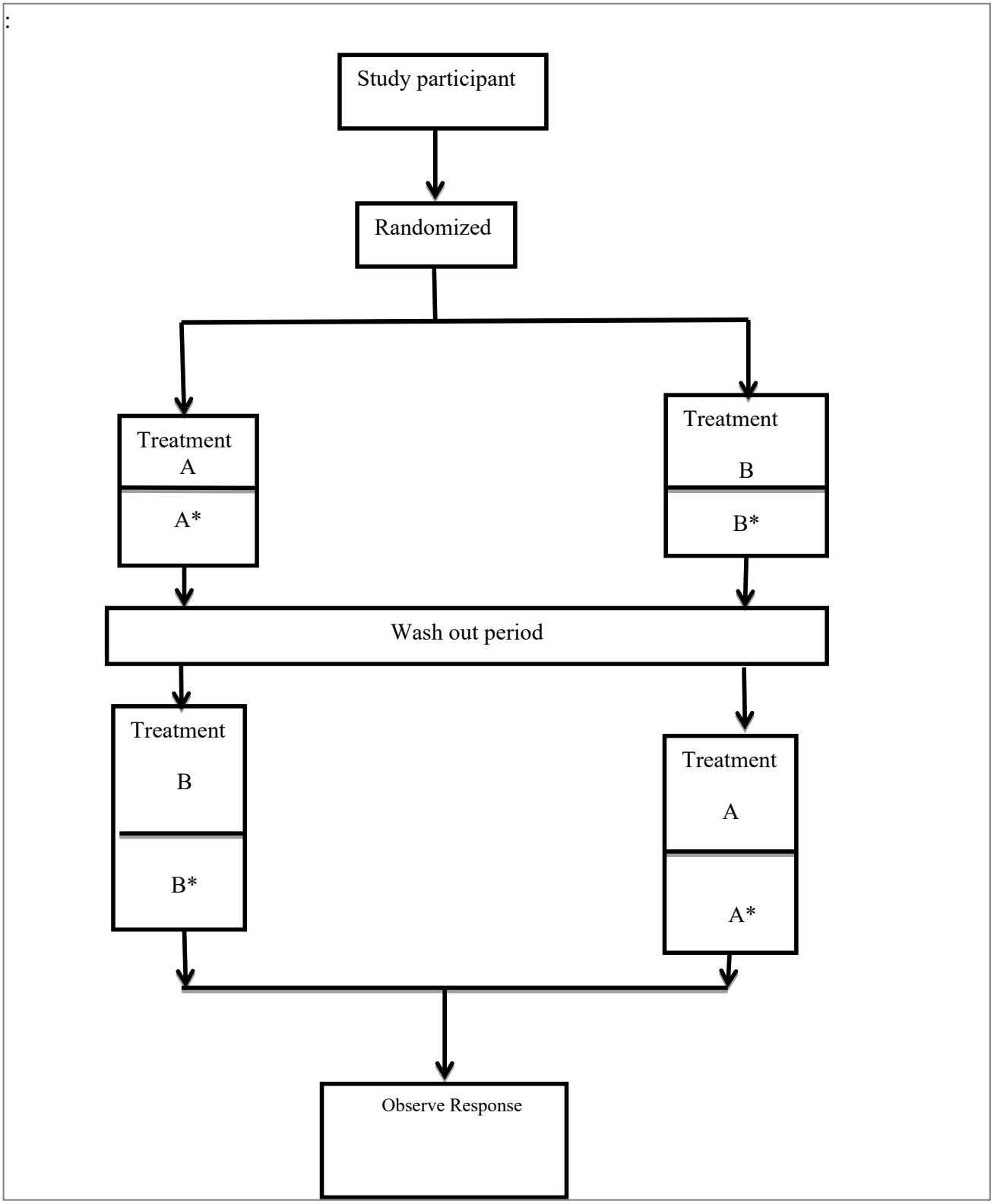

Figure 1: Design Architecture.

RESULTS AND DISCUSSIONS

In this section, we will delve into the examination and interpretation of the outcomes. Our discussion will center on the findings derived from the conducted experiment, which involved observing the weight gains of 100 chickens fed two formulated feeds (soybean cake and groundnut cake) along with two supplements (turmeric powder and ginger powder).

Table 3 provides a summary of the data collected during a seven-week experiment conducted at the Animal Science Farm, Institute of Agricultural Research (IAR), Ahmadu Bello University, Zaria. The experiment is divided into two periods: period one (P1) and period two (P2), each spanning three weeks with a one-week washout period in between. The subjects are categorized into four groups (1, 2, 3, and 4), each consisting of 100 1-day-old chicks, distributed evenly across the groups.

Table 3: Summary of Data

Subject		P1	P2
I		IG	2T
	Week 1	75.19	270.46
	Week 2	108.62	272.72
	Week 3	212.96	243.92
II		IT	2G
	Week 1	69.62	400.21
	Week 2	125.00	195.24
	Week 3	209.61	271.43
III		2G	1T
	Week 1	72.00	276.93
	Week 2	68.00	239.09
	Week 3	128.70	311.04
		2T	1G
IV	Week 1	67.72	245.66
	Week 2	60.00	295.45
	Week 3	111.17	159.097

During period one (P1), the data for weeks one, two, and three is presented for subjects I (received diet one and supplement one, 1G), II (received diet one and supplement two, 1T), III (received diet two and supplement one, 2G), and IV (received diet one and supplement one, 2T). Week four represents the washout period. Subsequently, period two (P2) includes data for weeks five, six, and seven for subjects I (received diet two and supplement two, 2T), II (received diet two and supplement one, 2G), III (received diet one and supplement two), and IV (received diet one and supplement one).

Table 4 presents the results of the analysis of variance for the crossover design using data from the experiment. The outcome indicates that there are no significant differences between the subjects and the feed, while there are significant differences between the supplements and the periods.

Table 4: Analysis of Variance Table

	Response: Observation				
	Df	**Sum Sq**	**Mean Sq**	**F Value**	**Pr (>F)**
Subject	3	11740	3913	1.1364	0.362542
Suppliment	1	42679	42679	12.3931	0.002625
Feed	1	0.150	0.150	0.0000	0.994817
Period	1	103758	103758	30.1293	3.992e-05
Residuals	17	58544	3444		

CONCLUSION

This study evaluates the impact of dietary supplementation on chicken weight gain. The results indicate no significant differences among subjects, feeds, and periods ($p > 0.05$), while a significant difference exists with the supplement ($p < 0.05$). In summary, the research suggests that turmeric supplementation serves as an effective natural growth promoter for chickens. Additionally, optimal weight gain is observed when both feed and supplements are combined, underscoring their synergistic performance in enhancing chicken growth.

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