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# Optimization of digestible valine requirements for growth performance, carcass and immunological parameters in commercial boilers

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**Abstract**
250 commercial broiler chicks (Ven Cobb) were used in current biological research to evaluate effect of varying levels of digestible valine (100, 75, 70, 65, and 60% of the digestible lysine) on growth performance, carcass characteristics as well as immunological parameters in commercial broiler diets to identify optimum level of valine required for maximum performance of commercial broilers without affecting growth performance and slaughter variables. The chicks were distributed into 5 treatments, each consisting of 10 replicates with 5 chicks in every replicate, in a completely randomized design (CRD). During the experiment, corn-soybean meal-based diet was prepared, as well as supplemented with digestible valine at varying concentrations in relation to digestible lysine. Supplementation of digestible valine at 0.885%, 0.787%, and 0.712% (75% digestible lysine) during pre-starter, starter, and finisher phases significantly ($p$<0.05) enhanced body weight gain, with highest overall gain observed at 70% valine levels. Feed intake was significantly higher during the pre-starter phase in the 75% group, while no significant differences were noted in starter as well as finisher phases. Lowest feed intake and weight gain occurred at 60% valine levels. FCR remained comparable across 100%, 75%, and 70% valine groups. Liver and heart weights have been significantly ($p$<0.05) influenced by valine levels, with the lowest liver weight at 65% and the lowest heart weight at 100% valine. Gizzard weight and immune responses (humoral and cell-mediated) have not been significantly affected by valine supplementation. It is determined that dietary digestible valine content of 0.826, 0.735, & 0.665 percent (70 percent digestible lysine) is sufficient throughout pre-starter, starter, and finisher phases, respectively, to optimize growth performance in commercial broilers without harming giblet weights as well as immunological parameters.

**Keywords:** Digestible valine, growth performance, giblet weights, NDV titers, immune organs and commercial broilers

## Introduction
In order to meet the growing demand for poultry products, worldwide poultry production has grown significantly over past 50 yrs. Feed constitutes around 70% of the overall expense of broiler production. Increasing concerns regarding environmental effects of farming, including nitrogen as well as phosphorus contamination, as criteria in feed formulation, feeding optimum, as well as balanced nutrients, have an essential role in precision nutrition. Corn, as well as SBM (soybean meal), contributes to majority of broiler chicken diets. Broiler chicks exhibit rapid growth and generally consume diets rich in protein or AA (ERS, USDA, 2001) [5]. Such diets' amino acid (AA) concentrations are insufficient to satisfy needs of today's rapidly increasing broilers in order for them to maximize their full genetic potential. In diets as per corn and SBM, valine is fourth limiting AA. Protein is a vital element of all animal tissues and significantly influences the growth performance of chickens (Kamran *et al.*, 2004) [8]. If broiler diets lack this AA, growth performance would be hampered. The emphasis currently is on meeting the requirements of this AA in broiler diet as feed-grade valine became commercially available. In diets lacking animal protein ingredients, Val can be next-limiting to threonine. Its primary biological role is to aid in muscle protein synthesis, or growth performance. Val is also a limiting amino acid in broilers, and a minimum digestible Val to lysine ratio of 80% is recommended. As feed grade L-Val is now available, the feed industry has an opportunity to further lower the quantity of protein in the diet.

Goals related to nutrition, economy, and the environment, such as increasing feed efficiency, lowering the quantities of protein that birds consume, which improves health and lowers digestive disorders, lowering feed costs, and lowering nitrogen excretion from birds into the environment, can all encourage use of feed-grade L-Val. Currently, it is unclear to what extent L-Val supplementation can replace dietary protein without adversely impacting broiler performance. This biological experiment aimed to evaluate growth performance, carcass traits, as well as immunological parameters of commercial broiler diets with optimized val. requirements for diets with decreased dietary protein levels.

## Materials and Methods

A six-week growth trial has been performed in commercial broilers using 250-day-old men broiler chicks (Ven Cobb-400) with five dietary treatments using a completely randomized design (CRD). Chicks have been procured, their wings have been banded as well as weighed, and they were then randomly distributed to five treatments, each with ten replicates and 5 chicks in every replicate. Throughout experimental period, chicks have been raised in battery brooders with electrical heating under ideal brooding conditions.

### Experimental diets

A control diet based on corn and soy was formulated in accordance with Cobb breeder's recommendations. Other experimental diets have been prepared by lowering crude protein levels by 2, 1, & 1% throughout the pre-starter, starter, as well as finisher phases, respectively. Crystalline L-Valine was graded at a rate of 75, 70, 65, & 60% digestible Lysine throughout pre-starter (0 to 14 days); (0.885, 0.826, 0.767, & 0.708); during the starter (15-28 days); (0.787, 0.735, 0.682, & 0.630); as well as the finisher period (29 to 42 days); (0.712, 0.665, 0.617, & 0.570). The nutrient composition of experimental diets has been illustrated in Table 1.

### Collection of data

Body weight of every bird has been once noted at the end of each phase, which included the pre-starter (0-14 days), starter (15-28 days), finisher phase (29-42 days), up to 6 weeks of age. Amount of feed consumed by every bird has been noted replicate-wise for each phase. The feed intake per unit body weight gain from 0 to 6 weeks of age has been utilized to compute feed conversion ratio (FCR) for each phase. In order to study the immunity parameters, ten blood samples have been randomly gathered from every replicate for each dietary group at 28$^{th}$ and 42$^{nd}$ days of life. The HI (heamagglutination inhibition) test was used to ascertain NDV-specific antibodies in the chicks' sera, which were then denoted as log2 titers (Allan *et al.*, 1978) [1]. The measurement of CBH (cutaneous basophilic hypersensitivity) to PHA-P (phytohaemagglutinin phosphate) was used to assess CMI (cell-mediated immune) response. One bird has been selected at random from each replication on the 42$^{nd}$ day of the trial to test the CMI. A micrometer was used to measure the thickness of web between 3rd and 4th interdigital spaces of left and right feet. Left web (control) had an injection of 0.1 ml of PBS (phosphate buffer saline), while right foot's web had an injection of 100µg of PHA-P suspended in 0.1 ml of PBS. A micrometer has been used to measure web thickness of both feet 24 hrs after injection, alongside the CBH has been then computed utilizing a formula (Edelman *et al.*, 1986) [6]. In order to evaluate the giblets' characteristics (liver, heart, and gizzard) and the weight of their immune organs (spleen and bursa), which have been denoted in grams per kilogram of live body weight, 10 birds from every dietary group have been slaughtered at end of experiment. Data has been analyzed utilizing one-way ANOVA in 15th version of SPSS (Statistical Package for Social Sciences). Duncan's multiple range test (Duncan, 1955) [4] has been used to analyze differences between treatment means at $p<0.05$.

## Results and Discussion

### Growth performance

#### Body weight gain

Supplementation of digestible valine at 0.885, 0.787, & 0.712 percent throughout pre-starter, starter, as well as finisher phases, respectively (75 percent of digestible lysine), resulted in a statistically significant increase ($p<0.05$) in BWG during weekly, pre-starter, as well as finisher phases of commercial broilers fed corn-SBM-based diets (Table 2). Total body weight gain is significantly ($p<0.05$) greater in group fed diet having 0.826, 0.735, & 0.665 percent digestible valine (70 percent digestible lysine) in pre-starter, starter, as well as finisher phases, correspondingly. Lowest body weight gain was recorded at 0.708, 0.630, & 0.570 percent digestible valine (sixty percent of digestible lysine) fed diet than 100% Cobb recommended digestible valine 0.89, 0.81, & 0.73% fed group in pre-starter, starter, as well as finisher phases, respectively, in commercial broilers. This is contrary to results of Goodgame *et al.* (2011) [7], who noted a rise in body weight gain by 0.90% and 0.84% dietary Val supplementation during 1-21d and 21-35 d of Cobb broilers.

#### Feed intake

Phase-wise feed intake demonstrated significant ($p<0.05$) rise in feed consumption throughout pre-starter phase in group $T_2$ broilers' diet, which included 0.89 percent digestible Val (75 percent of digestible lysine) (Table 2). Nonetheless, there has been no statistically significant difference ($p>0.05$) in feed intake throughout starter as well as finisher periods in commercial broilers provided with diets containing varying concentrations of digestible Val. Lowest cumulative feed intake was observed in broilers fed digestible Val as 0.708, 0.630, & 0.570 percent (60 percent of digestible lysine) throughout pre-starter, starter, as well as finisher phases, correspondingly, in group ($T_5$) in commercial broilers fed corn-SBM-based diets. These findings are from Rodehutscord *et al.* (2005) [9]. Some studies proposed that dietary Val supplementation has significantly ($p<0.05$) enhanced feed intake in commercial broilers (Corzo *et al.*, 2007) [2].

#### Feed conversion ratio (FCR)

Phase-wise FCR values in current research showed that significantly ($p<0.05$) better FCR has been seen in groups fed 0.767 percent digestible valine (65 percent of digestible lysine) throughout pre-starter and 0.630 & 0.570 percent digestible valine (sixty percent digestible lysine) throughout starter as well as finisher phase in commercial broilers (Table 2). This is in concurrence with results of Corzo *et al.*

(2004) [2], Rodehutscord *et al.* (2005) [9]. The studies suggested that the 0.45% and 0.67% dietary valine supplementation significantly ($p$<0.05) improved FCR in commercial broilers. In present study, dietary valine of 0.826, 0.735, and 0.665% recorded poorer FCR throughout pre-starter, starter, as well as finisher phases, respectively, in broilers.

**Carcass parameters (Giblet weights)**

Liver weight has been "significantly ($p$<0.05) affected by dietary Val supplementation in broiler diets (Table 3). Lower liver weight has been noted in treatment group ($T_4$) supplemented with digestible valine" and sixty-five percent of lysine than in other dietary groups. This is based on results of Selvarasu *et al.* (2016) [10]. The heart weight was significantly influenced by graded concentration of Val in broiler diets. Nevertheless, heart weight has been noted lower at 100 percent Val concentrations in diet ($T_1$) among other valine concentration in the diet. This is result of Selvarasu *et al.* (2016) [10]. Supplementation of graded concentrations of (75, 70, 65, & 60 percent of digestible lysine) of digestible Val did influence the gizzard weight of commercial broilers.

**Immune parameters**

"Supplementation of digestible Val in corn-SBM-based diets did not significantly ($p$>0.05) affect weights of bursa as well as spleen in" this current study (Table 4). Humoral immunity assessed in relation to antibody titers against NDV at 28$^{th}$ day & 42$^{nd}$ day has not been significantly ($p$>0.05) influenced by dietary variations in digestible Val. However, humoral immune response to NDV at 42$^{nd}$ day on the supplementation of digestible Val at 0.708, 0.630, & 0.570 percent (60 percent of digestible lysine) in pre-starter, starter, as well as finisher phases, respectively, fed group showed higher antibody titer. However, variation in antibody titer values was observed at 28$^{th}$ day and 42$^{nd}$ day age in broilers fed different concentrations of digestible Val, but not statistically significant ($p$>0.05) among groups. CMI "(cell-mediated immune) response evaluated using DTH (delayed-type hypersensitivity) reaction to PHA-P, quantified by SFT (skin fold thickness) in broilers. No significant difference ($p$>0.05) has been seen in CMI response to PHA-P inoculation because of variation in digestible Val concentration in diet".

**Table 1:** Nutrient composition of digestible valine supplemented diets in commercial broilers.

| **Pre starter phase (0-14 days)** | | | | | |
|---|---|---|---|---|---|
| **Nutrient** | **$T_1$ (Cobb std. 100%)** | **$T_2$ (75%)** | **$T_3$ (70%)** | **$T_4$ (65%)** | **$T_5$ (60%)** |
| ME (k cal/kg) | 3035 | 3035 | 3035 | 3035 | 3035 |
| CP (%) | 20.88 | 20.78 | 19.63 | 18.47 | 17.32 |
| Ca (%) | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 |
| Sodium (%) | 0.16 | 0.16 | 0.16 | 0.16 | 0.16 |
| Avl. Phosphorus (%) | 0.45 | 0.45 | 0.45 | 0.45 | 0.45 |
| Lysine (%) | 1.18 | 1.18 | 1.18 | 1.18 | 1.18 |
| M+C (TSAA) (%) | 0.88 | 0.88 | 0.88 | 0.88 | 0.88 |
| Threonine (%) | 0.770 | 0.770 | 0.770 | 0.770 | 0.770 |
| Valine (%) | 0.890 | 0.885 | 0.826 | 0.767 | 0.708 |
| **Starter phase (15-28 days)** | | | | | |
| ME (k cal/kg) | 3108 | 3108 | 3108 | 3108 | 3108 |
| CP (%) | 19.05 | 18.46 | 17.49 | 16.45 | 15.41 |
| Ca (%) | 0.84 | 0.84 | 0.84 | 0.84 | 0.84 |
| Sodium (%) | 0.16 | 0.16 | 0.16 | 0.16 | 0.16 |
| Avl. Phosphorus (%) | 0.42 | 0.42 | 0.42 | 0.42 | 0.42 |
| Lysine (%) | 1.05 | 1.05 | 1.05 | 1.05 | 1.05 |
| M+C (TSAA) (%) | 0.80 | 0.80 | 0.80 | 0.80 | 0.80 |
| Threonine (%) | 0.69 | 0.63 | 0.63 | 0.63 | 0.63 |
| Valine (%) | 0.810 | 0.787 | 0.735 | 0.682 | 0.63 |
| **Finisher phase (29-42 days)** | | | | | |
| ME (k cal/kg) | 3180 | 3180 | 3180 | 3180 | 3180 |
| CP (%) | 16.81 | 16.50 | 16.10 | 15.11 | 14.14 |
| Ca (%) | 0.76 | 0.76 | 0.76 | 0.76 | 0.76 |
| Sodium (%) | 0.16 | 0.16 | 0.16 | 0.16 | 0.16 |
| Avl. Phosphorus (%) | 0.38 | 0.38 | 0.38 | 0.38 | 0.38 |
| Lysine (%) | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 |
| M+C (TSAA) (%) | 0.74 | 0.666 | 0.666 | 0.666 | 0.666 |
| Threonine (%) | 0.65 | 0.57 | 0.57 | 0.57 | 0.570 |
| Valine (%) | 0.800 | 0.712 | 0.665 | 0.617 | 0.570 |

**Table 2:** Effect of digestible Valine supplementation on phase wise growth performance of commercial broilers.

| Treatment | Body weight gain (gm/bird) | | | Feed Intake (gm/bird) | | | FCR | | |
|---|---|---|---|---|---|---|---|---|---|
| | Pre-starter (0-14 d) | Starter (15-28 d) | Finisher (29-42 d) | Pre-starter (0-14 d) | Starter (15-28 d) | Finisher (29-42 d) | Pre-starter (0-14 d) | Starter (15-28 d) | Finisher (29-42 d) |
| $T_1$ (100%) | 324$^{a}$ | 753$^{ab}$ | 994 | 411$^{a}$ | 1185 | 1927 | 1.267$^{cd}$ | 1.571$^{d}$ | 1.937$^{b}$ |
| $T_2$ (75%) | 325$^{a}$ | 788$^{a}$ | 972 | 411$^{a}$ | 1255 | 1936 | 1.263$^{d}$ | 1.593$^{cd}$ | 2.000$^{ab}$ |
| $T_3$ (70%) | 317$^{a}$ | 761$^{ab}$ | 1018 | 411$^{a}$ | 1235 | 2000 | 1.298$^{bc}$ | 1.624$^{bc}$ | 1.975$^{ab}$ |
| $T_4$ (65%) | 289$^{b}$ | 726$^{b}$ | 1019 | 388$^{ab}$ | 1197 | 1944 | 1.341$^{a}$ | 1.648$^{ab}$ | 1.911$^{b}$ |
| $T_5$ (60%) | 278$^{b}$ | 667$^{c}$ | 898 | 369$^{b}$ | 1122 | 1837 | 1.325$^{ab}$ | 1.681$^{a}$ | 2.050$^{a}$ |
| SEM | 4.082 | 9.255 | 17.06 | 4.767 | 12.92 | 27.26 | 0.007 | 0.009 | 0.016 |
| N | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| P-Value | 0.000 | 0.000 | 0.142 | 0.008 | 0.463 | 0.086 | 0.000 | 0.000 | 0.041 |

$^{ab}$Mean bearing at least one common superscript in a column do not differ significantly ($p$<0.05).

**Table 3:** Effect of digestible Valine supplementation on carcass parameters (Giblets) of commercial broilers.

| Treatment | (g / kg slaughter live weight) | | |
|---|---|---|---|
| | Liver | Heart | Gizzard |
| $T_1$ (100%) | 20.08$^{ab}$ | 4.567$^{b}$ | 15.33 |
| $T_2$ (75%) | 21.87$^{a}$ | 4.775$^{b}$ | 16.03 |
| $T_3$ (70%) | 20.86$^{ab}$ | 5.516$^{a}$ | 15.61 |
| $T_4$ (65%) | 18.68$^{b}$ | 5.507$^{a}$ | 16.65 |
| $T_5$ (60%) | 23.18$^{a}$ | 5.750$^{a}$ | 16.06 |
| SEM | 0.490 | 0.117 | 0.263 |
| N | 10 | 10 | 10 |
| P-Value | 0.037 | 0.001 | 0.586 |

$^{ab}$Mean bearing at least one common superscript in a column do not differ significantly ($p$<0.05).

**Table 4:** Effect of digestible Valine supplementation on humoral, cell mediated immunity and immune organ weights of commercial broilers.

| Treatment | NDV titer values ($Log_2$) | | PHA-P thickness index (%) 6$^{th}$ Wk | Weight of immune organs(g / kg slaughter live weight) | |
|---|---|---|---|---|---|
| | 28$^{th}$ day | 42$^{nd}$ day | | Bursa | Spleen |
| $T_1$ (100%) | 2.2 | 5.4 | 52.2 | 1.67 | 1.98 |
| $T_2$ (75%) | 1.5 | 5.2 | 88.7 | 1.05 | 1.41 |
| $T_3$ (70%) | 2.4 | 5.6 | 63.3 | 1.37 | 1.81 |
| $T_4$ (65%) | 2.1 | 5.4 | 80.7 | 1.39 | 1.61 |
| $T_5$ (60%) | 1.9 | 5.8 | 59.1 | 1.45 | 1.39 |
| SEM | 0.112 | 0.183 | 5.90 | 0.107 | 0.083 |
| N | 10 | 10 | 10 | 10 | 10 |
| P-Value | 0.110 | 0.882 | 0.253 | 0.504 | 0.100 |

$^{abcd}$Mean bearing at least one common superscript in a column do not differ significantly ($p$<0.05).

## Conclusion

The findings of present study indicate that a digestible valine level equivalent to 70 percent digestible lysine throughout the pre-starter, starter, as well as finisher phases (0.826, 0.735, and 0.665%, respectively) is optimal for maximizing economic returns while maintaining growth performance, carcass quality, and immune function in fast-growing commercial broilers.

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