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Impact of digestible lysine and TSAA requirements on performance, immune competence and livability of commercial broilers

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Abstract
The first two tests were done at the same time to see how digestible Lysine (Trial - I) and digestible TSAA (Trial - II) affected performance, immunological competence, and livability in commercial broilers. The 6-week growth studies on broilers were designed using 650 one-day-old commercial male broiler chicks in a fully randomised design (CRD) (VenCobb). The chicks were divided into thirteen treatments at random, each with ten duplicates of five chicks. Initially, different amounts of lysine and TSAA (Meth+Cys) were tested while maintaining the appropriate ME and CP for commercial broilers (Cobb 400). Performance, immunological response, and livability are among the response criteria. During the pre-starter period, the group given NRC levels of (1.10 percent lysine and 0.90 percent TSAA) had the lowest body weight increase of all the dietary groups. During the starter, finisher, and overall experimental periods, however, variations in dietary amounts of NRC and Cobb prescribed lysine and TSAA had no significant effect on body weight. Similarly, no significant differences in feed intake or feed efficiency were detected in commercial broilers over the research period related to dietary lysine and TSAA levels. The relative weight of bursa was considerably improved (P0.05) when the content of digestible lysine and TSAA was increased. Treatment group T3 had a considerably (P0.05) larger weight of bursa than the other treatment groups due to a higher dietary concentration of Cobb recommended digestible lysine (1.18 percent) and TSAA (0.880 percent). The weight of the bursa was recorded at the highest concentration of Cobb suggested lysine (100%) and the lowest concentration of Cobb recommended TSAA (110%). The weight of spleen in broilers was not affected by the NRC and Cobb approved concentrations of digestible lysine and TSAA in corn-soybean meal diets. The fluctuation in digestible lysine and TSAA concentrations in corn-soybean meal diets had no significant effect on humoral immunity as measured by antibody titers against NDV at the 28th and 42nd days. The dietary content of digestible lysine and TSAA in diets had no effect on cell mediated immunity as measured by CMI response to PHA-P injection at 24 hours after inoculation. Variations in digestible lysine and TSAA concentrations in broiler diets had little effect on livability.

Keywords: digestible lysine, TSAA, amino acids, FCR, broilers, immunuity, livablity

Introduction

To meet rising demand for chicken products, global poultry production has expanded dramatically during the last fifty years. The cost of feed accounts for around 70% of the entire cost of broiler production. Environmental problems, such as nitrogen and phosphorus contamination, may be added as criteria in feed formulation as a result of growing worries about the environmental effect of animal agriculture. Precision nutrition necessitates the consumption of optimal and well-balanced protein. Protein is a vital component of all tissues in an animal's body and has a significant impact on chicken growth (Kamran *et al.*, 2004) [14]. The use of the digestible amino acids (DAA) approach might assist reduce dietary protein while still ensuring optimal chicken performance. Diverting a larger proportion of dietary amino acids (AA) for protein synthesis, minimizing environmental pollution, lowering feed costs, and lowering the dietary needs of the limiting amino acid are only a few of the benefits of the DAA idea. Corn and soybean meal are commonly used in broiler chicken diets (SBM). The amino acid content of such diets is insufficient to satisfy the needs of today's fast-growing broilers in terms of expressing their genetic potential. To achieve the AA needs, crystalline amino acids are supplied to the corn-SBM based diets. Since proteins are made up of amino acids, and specific amino acids are dietary needs for maximal development and performance, the idea of a dietary protein requirement has been disputed.

For broilers given corn-soybean meal diets, methionine (Met) is the first limiting amino acid, and sulphur amino acids are required for lean tissue accretion, feather development, and methyl donation (Garcia and Batal. 2005) [11]. In broiler chicken, nutritional methionine (Met) and arginine also boost immunity. Protein synthesis, glutathione precursor, polyamine synthesis, and methyl donation are the four basic actions of dietary Met (Rubin *et al.*, 2007) [20]. The majority of prior investigations on reducing the dietary protein level (DPL) in broiler chicks with amino acid (AA) fortification have been undertaken globally under a variety of agro-climatic situations. As a result, it's currently uncertain how much AA supplementation may replace dietary protein without compromising broiler performance. The goal of this biological investigation was to examine how commercial broiler performance was affected by diets with low amounts of dietary protein (approximately 1% of breeder guidelines) and high levels of L-Lysine and total sulphur amino acids (TSAA).

Materials and Methods

An experiment was conducted at the Poultry Experimental Station, Department of Poultry Science, College of Veterinary Science, Rajendranagar, Hyderabad-30, to assess the digestible lysine and TSAA needs of commercial broilers fed maize soya bean meal-based diets. A 6-week growth study in broilers was conducted using 650 day-old commercial broiler chicks in a fully randomised design (CRD) with thirteen nutritional treatments (Ven Cobb). The chicks were bought, wing-banded, weighed individually, and allocated to one of thirteen treatments, each with 10 replications and five chicks per duplicate. The chicks were grown in battery brooders with the finest possible brooding circumstances.

During the pre-starter (0-14 days), starter (15-28 days), (0.95, 0.98, 1.01, and 1.04) and finisher periods, the experimental meals were created with varied quantities of lysine (1.18, 1.23, 1.28, and 1.33). (29-42 d). Each level of lysine matched three levels of methionine in all three stages (90, 100 and 110 percent of the Cobb recommendation). The levels of lysine and TSAA as methionine in all three stages were determined based on the performance of birds in a prior study. The control diet is designated as T1, and all nutrient levels are maintained in accordance with Cobb's recommendations. By balancing the whole essential AA, the CP level in treatment group T1 was preserved at the breeder's suggestion, and the protein level in the remaining treatment groups was decreased to 1% below the Cobb guideline in each phase. All other critical nutrient concentrations in all experimental meals were kept at constant levels, as recommended by Cobb.

All of the experimental groups' chicks were kept under standard management and sanitary conditions throughout the trial. Chicks were kept in a battery brooder with a floor area of 0.5 sft / bird during the brooding period, and then provided 1.0 sft / bird after that. Light was continually provided during the first two weeks of the trial (24 hours). The animals were provided unrestricted food and drink during the study. The birds were all raised in the same environment. During the trial, birds were given the La Sota vaccination (Indovax) on the 7th (primary) and 28th (booster) days of life, as well as the IBD (Intermediate-Georgia strain) vaccine on the 14th (primary) and 21st (booster) days of life. Up to six weeks of age, body weight was recorded on an individual bird basis at weekly intervals, and feed consumption was computed replicate-wise at weekly intervals. The feed conversion ratio (FCR) was determined at weekly intervals from 0 to 6 weeks of age as feed intake per unit bodyweight growth.

At 28 and 42 years of age, ten blood samples were randomly obtained from each replicate for each food group, and antibodies specific for NDV were detected in sera of chicks using the hemagglutination inhibition (HI) test and represented as log2 titers (Allan *et al.*, 1978) [2]. The cutaneous basophilic hypersensitivity (CBH) to phytohaemagglutinin phosphate was used to measure the cell mediated immune (CMI) response (PHA-P). On the 40th day of the trial, a bird from each replicate was randomly chosen for testing. A micrometre was used to measure the thickness of the web between the third and fourth inter-digital spaces of the left and right feet. The web of the right foot was injected with 100 g of PHA-P suspended in 0.1 ml of phosphate buffer saline (PBS), whereas the web of the left foot was injected with 0.1 ml of PBS as a reference. A micrometre was used to measure the web thickness of both feet 24 hours after injection. The data were analysed with the Statistical Package for Social Sciences (SPSS) 15th version's one-way ANOVA. Duncan's multiple range test (Duncan, 1955) [10] was used to assess the differences between the treatment means at $P<0.05$.

Results

Body weight gain

When broilers were supplemented with extra Cobb recommendation during the prestart period, body weight gain was significantly ($P<0.05$) higher than when they were fed NRC guideline (T1). During the starter, finisher, and cumulative (0-42 d) body weight growth of broilers given graded concentrations of digestible lysine and TSAA, however, there was no significant difference in body weight gain.

During the pre-starter period, the amounts of digestible lysine and TSAA considerably ($P>0.05$) increased body weight growth compared to the NRC recommended dietary group (T1). During the pre-starter period, the group fed NRC approved AA 1.10 percent lysine and 0.90 percent TSAA gained the least weight of all the dietary groups. During the starter, finisher, and overall trial periods, however, there was no significant ($P>0.05$) change in dietary lysine and TSAA concentrations.

Feed intake

During the pre-starter period, dietary lysine and TSAA concentrations had a significant ($P<0.05$) impact on feed consumption (0-14 d). The therapies used throughout the starter, finisher, and total trial period had no effect on feed intake. During the pre-starter period, treatment group (T1) had the lowest feed intake of all the treatment groups, with 1.10 percent digestible lysine and 0.90 percent TSAA.

Feed conversion ratio

Only during the pre-starter and starter phases did the concentrations of digestible lysine and TSAA change substantially ($P<0.05$). During the finisher phase and overall development period, however, the amino acid contents in the diet had no effect on feed/gain ($P>0.05$) (0-42 d). During the pre-start (0-14 days) and starter phases, the NRC (T1) food categories T7, T8, and T13 had higher feed conversion ratios (15-28 d).

Immune organ weights

The relative weight of bursa was significantly ($P<0.05$)

improved when the content of digestible lysine and TSAA was increased. However, treatment group T3 had a significantly (*P*<0.05) higher weight of bursa than the other treatment groups due to a higher dietary concentration of Cobb suggested digestible lysine (1.18 percent) and TSAA (0.880 percent). Treatment group T4 had the lowest weight of bursa due to the highest concentrations of Cobb suggested lysine (100 percent) and TSAA (110 percent of Cobb guideline). The NRC and Cobb approved concentrations of digestible lysine and TSAA in corn-soybean meal diets, on the other hand, had no effect on the weight of the spleen in broilers (*P*>0.05).

Humoral and cell mediated immune response

The variations in digestible lysine and TSAA concentrations in corn-soybean meal diets had no significant (*P*>0.05) effect on humoral immunity as measured by antibody titers against NDV at the 28th and 42nd days. The 42nd-day HI titers were higher than the 28th-day HI titers, but the difference was not statistically significant (*P*>0.05). The concentrations of lysine and TSAA, on the other hand, had no effect on the humoral immune response to NDV at the 42nd day. The dietary content of digestible lysine and TSAA in diets had no effect (*P*>0.05) on the cell mediated immunity measured in terms of response to PHA-P injection, CBH response at 24 hours after PHA-P injection.

Livability

During the whole study period, dietary differences in digestible lysine and TSAA concentrations had no significant (*P*>0.05) impact on the livability of commercial broilers (0-42 d).

Discussion

Body weight gain

When broilers were supplemented with extra Cobb recommendation during the pre-start period, body weight gain was considerably (*P*<0.05) higher than when they were given NRC recommendation (T1). During the starter, finisher, and cumulative (0-42 d) body weight growth of broilers given graded concentrations of digestible lysine and TSAA, however, body weight gain was not substantially altered (*P*>0.05). During the pre-start phase, the amounts of digestible lysine and TSAA considerably (*P*>0.05) increased body weight increases when compared to the NRC recommended dietary group (T1). During the pre-starter period, the group fed NRC approved AA 1.10 percent lysine and 0.90 percent TSAA gained the least weight of all the dietary groups. During the starter, finisher, and overall trial periods, however, there was no significant (*P*>0.05) change in dietary lysine and TSAA concentrations.

These findings are consistent with those of Dozier and Payne (2012) [9], who found a significant (*P*<0.05) effect on body weight gain in broiler diets during the pre-starter period with an increase in dietary lysine concentration (1.18 percent) higher than NRC recommendation and TSAA supplementation (0.873 percent) lower than NRC and Cobb recommendations (0-14 d). In broilers, Dirain and Waldroup (2002) [8] found that dietary lysine levels had no influence (*P*>0.05) on body weights during 21-42 days and 42 days. According to Baker *et al*., (1980) [4] increased amounts of methionine produce toxicity, which can lead to growth and development depression. Buttery and D'Mello (1994) [7] also indicated that a modest amount of methionine in the meal can be harmful to birds. An overabundance of amino acids, it was stated, cannot be turned into body protein, lowering performance and resulting in inefficient and uneconomical meat production.

Excess lysine and TSAA as methionine addition to corn-soybean meal diets had no effect on body weight increase in this research. These findings are consistent with those of Adeyemo (2012) [1], who found that supplementing corn-soya diets with methionine in excess of the National Research Council's (NRC, 1994) [19] guideline did not result in changes in average daily weight increases in commercial broilers.

Feed intake

During the pre-starter period, dietary lysine and TSAA concentrations had a significant (*P*<0.05) impact on feed consumption (0-14d). The therapies used throughout the starter, finisher, and total trial period had no effect on feed intake. During the pre-starter period, treatment group (T1) had the lowest feed intake of all the treatment groups, with 1.10 percent digestible lysine and 0.90 percent TSAA. These findings are consistent with those of Borges *et al.* (2002) [5], and Valerio *et al*. (2003) [21], who found that increasing lysine levels above the NRC standard had a significant (*P*<0.05) influence on broiler feed consumption from 0 to 14 days of age. In contrast to the outcomes of this investigation, feeding Ross TP 16 broilers 1.0 percent digestible Lys increased feed consumption considerably (*P*<0.05) (Dozier *et al*, 2009b) [9].

Feed conversion ratio

Only during the pre-starter and starter phases did the concentrations of digestible lysine and TSAA change substantially (*P*<0.05). During the finisher phase and overall development period, however, the amino acid contents in the diet had no effect on feed/gain (*P*>0.05) (0-42 d). AA concentrations suggested by the NRC (T1) food categories T7, T8, and T13 resulted in a higher feed conversion ratio during the pre-start and start phases (0-14 d). These findings are in line with those of Nasr and Kheiri (2011) [18] who found that adding lysine and TSAA to broiler diets had no impact on feed efficiency. Hickling *et al.* (1990) [13] reported that increasing dietary lysine and TSAA in broiler diets decreased feed efficiency from 3 to 6 weeks, contrary to the previous findings.

Immune organ weights

These findings contrast those of Bouyeh (2012) [6], who claimed that lysine and TSAA (Met) as carnitine precursors might be beneficial to the immune system since L-carnitine has been shown to have immuno-modulatory properties, resulting in increased bursa weight in commercial broilers. In this study, the NRC and Cobb suggested concentrations of digestible lysine and TSAA in corn-soybean meal diets had no effect on the weight of spleen in commercial broilers (*P*>0.05). These findings contrast those of Bouyeh (2012) [6], who found that lysine and TSAA (Met) enhanced spleen weights in commercial broilers given corn-soybean meal diets considerably (*P*<0.05).

Humoral immune response

The fluctuation in digestible lysine and TSAA concentrations in corn-soybean meal diets had no significant (*P*>0.05) effect on humoral immunity as measured by antibody titers against NDV at the 28th and 42nd days. The 42nd-day HI titers were greater than the 28th-day HI titers, but the difference was not statistically significant (P>0.05). The concentrations of lysine and TSAA, on the other hand, had no effect on the humoral immune response to NDV at the 42nd day. These findings contrast those of Bouyeh (2012) [6], who found a linear rise in Newcastle antibody in 42-day-old broilers (*P*<0.01) rather than 21-day-old broilers in response to increased dietary Lys and TSAA (Met).

Cell mediated immunity

The dietary content of digestible lysine and TSAA in diets had no effect on the cell mediated immunity measured in terms of response to PHA-P injection, CBH response at 24 hours after PHA-P injection (*P*>0.05). CBH reaction rose 24 hours after PHA-P injection in all treatments, although not statistically significant. T cells mediate the CBH response to PHA-P, which is thymus-dependent (Aslam *et al.*, 1998) [3]. An excess supply of amino acids in the diet might be harmful to the immune system because of the unfavourable influence of amino acid imbalance and antagonism on nutritional intake and utilisation (Li *et al.*, 2007) [17]. These results contrast those of Geraert and Mercier (2010) [12], who found that a lack of dietary lysine reduced antibody response and cell-mediated immunity in commercial broilers.

Livability

During the whole study period, dietary differences in digestible lysine and TSAA concentrations had no significant (*P*>0.05) impact on the livability of commercial broilers (0-42 d). These findings support those of Kidd and Fancher (2001) [16], who found that lysine supplementation had no effect on broiler mortality. According to Kidd and Kerr (1996) [15], broilers supplied with higher doses of lysine in their diets had a significantly higher mortality rate.

Table 1: Effect of digestible lysine and TSAA supplementation on phase wise and cumulative body weight gain of male broilers.

Treatment	Body weight gain (g / bird)			
	Pre-starter (0-14 d)	Starter (15-28 d)	Finisher (29-42 d)	Cumulative body weight gain (0-42 d)
T_1	305^b	788	1043	2137
T_2	337^a	790	999	2128
T_3	350^a	801	986	2139
T_4	348^a	777	954	2081
T_5	347^a	791	1019	2158
T_6	333^a	782	1038	2154
T_7	345^a	798	972	2116
T_8	352^a	805	1008	2167
T_9	350^a	787	972	2110
T_{10}	339^a	758	1002	2100
T_{11}	347^a	786	985	2120
T_{12}	343^a	774	977	2096
T_{13}	340^a	796	972	2108
SEM	1.973	4.308	6.597	9.391
N	10	10	10	10
P-Value	0.000	0.816	0.212	0.869

Note: Values bearing different superscripts within a column are significantly (*P*<0.05) different.

Conclusion

The current Cobb standards guidelines are sufficient to enhance the productivity of fast-growing broilers. During the pre-starter, starter, and finisher periods, commercial broilers require 1.18, 1.05, and 0.95 percent digestible lysine, respectively. TSAA requirements for commercial broilers are 0.88 percent (100 percent of the Cobb guidelines) during pre starter, 0.72 and 0.66 percent during starter and finisher phases, respectively.

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