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Effects of an Early Nutrition Supplement, Chikimune® and A Natural Growth Promoter on the Performance and Health of Commercial Broiler Chicks

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A B S T R A C T

In commercial broiler hatcheries, chicks hatch over a period of 20–36 hours. The chicks are removed from the hatch tray of the incubator after a majority of them have cleared from the eggshell. Then, the chicks undergo various hatchery practices like sexing, vaccination, packaging, and transport before they are placed in a commercial broiler farm. Thus, under practical conditions, chicks remain deprived of feed and water for about 48–72 hours after hatching. Although residual yolk serves as a source of nutrients till access to exogenous source of feed is secured in the newly hatched chicks, this delay in access to feed and water causes mobilization of body reserves to support metabolism and thermal regulation in the neonatal chicks, which results in retardation of bodyweight and impairment of overall performance. Approximately 2 to 5% of the hatchlings do not survive the critical post-hatch adjustment period and many survivors show stunted growth, poor feed utilization, reduced immunity, and low meat yield. These problems can be avoided by the early provision of nutrients to the chicks. The present study evaluates the effects of an early chick nutrition supplement, Chikimune® (M/s Ayurvet Limited, India), on the performance and immunity of broilers.

Introduction

Bodyweight of chicks increases approximately 50-folds within 40 days of hatch. This includes an adaptation period from utilizing embryonic yolk. During embryonic development, the yolk is the sole nutrient source. In the pre-hatching chick, yolk comprises approximately 15 to 20% of the bodyweight, containing 20 to 25% protein and 20 to 40% lipids (Moran and Reinhart, 1980; Reidy *et al.,* 1998). This yolk is also utilized by chicks after hatching. In practice, eggs within a tray will hatch over 20-36 hours, during which period the chicks that have piped remain without feed. It has been reported that though the residual yolk may be sufficient to keep the birds alive for the first 3 to 4 days, it does not support their genetic potential for bodyweight gain and the development of gastrointestinal tract or immune system. Often, birds remain held for 48 hours or more

before initial access to feed and water is secured (Hill and Green, 1977). During this time, there is a decrease in the bodyweight of chicks approximately at a rate of 4 g per 24 hours due to moisture loss as well as yolk utilization. However, in chicks with access to feed, the rate of yolk utilization is faster. This is likely due to increased intestinal mechanical activity (Noy *et al.*, 1996). The intestinal development is faster in chicks receiving feed immediately after hatch than in the chicks not receiving feed immediately after hatch. The broilers with early access to nutrients were 8-10% heavier than held or watered birds. Breast meat increased by 7-9% in the birds with immediate access to nutrients after hatch (Noy and Sklan, 1998). An experiment was designed with the following objectives:

To assess the efficacy of an early nutritional supplement (Chikimune) and a natural growth promoter on early gut development and growth performance in broilers,

To evaluate the immunomodulatory effects of Chikimune in broilers, and

To evaluate the effects of Chikimune and a natural growth promoter on the carcass characteristics and cost economics of broiler production.

Materials and Methods

The experimental trial was conducted at the Department of Animal Nutrition, Veterinary College and Research Institute, Tirunelveli, India, for 6 weeks. 360 one-day-old broiler chicks (Vencobb 400) belonging to a single hatch were purchased from M/s Annai Hatchery, Tirunelveli, Tamil Nadu. Within 30 minutes of hatching, chicks were randomly assigned to either of five groups: control (T1) and treatments (T2-T5). Six replicates of twelve birds (6 × 12 = 72) were maintained per group. Birds in all groups were maintained under identical standard management and environmental conditions. Nutritional supplements were included in the diet as per the scheme shown in Table 1.

The experimental birds were housed individually in well-ventilated two-tier battery cages provided with artificial lighting for the first week of the experiment and moved to deep litter system thereafter. Experimental rations were formulated based on BIS (2007) specifications for broiler chicken (Table 4). All rations were isocaloric and isonitrogenous. The ingredient compositions of the experimental rations are shown in Table 2.

Samples of experimental feeds were analyzed for their proximate composition *viz.* crude protein (CP); ether extract (EE), crude fiber (CF), and total ash (TA) as per the methods described in AOAC (2000) and the nitrogen-free extract was calculated. All the values estimated were expressed as a percentage on a dry matter basis (DMB). The bodyweight of the broiler birds was recorded individually at hatch and at weekly intervals up to six weeks. The feed offered and the leftover feed on the next morning were weighed to record the feed intake. The overall feed conversion ratio of the birds was calculated at finishing. All birds were vaccinated against Newcastle Disease virus (NDV) on day 7 and hemagglutination inhibition (HI) titers were recorded in each group at weekly intervals. The duodeni of the sacrificed birds from each replicate (6 birds from each treatment) were collected in 10% formalin. Paraffin-embedded tissue was cut into 4-6 micron thick sections and stained with Hematoxylin and Eosin. Duodenal villous length and crypt depth were measured under an Olympus CX41 microscope with infinity camera and ImageJ software. The birds were slaughtered by halal method on day 42. The carcass characteristics *viz.* dressed carcass weight, dressing percentage and cut off parts *viz.* breast, legs, wings, and neck were

recorded. Group-wise economics of product was calculated, on the basis of production, performance and feed consumption. One-way ANOVA was performed with SPSS statistics for Windows, version 17.0 (SPSS, 17.0, 2008).

Results and Discussion

Proximate feed composition

The percent nutrient composition of broiler pre-starter, starter, and finisher rations is presented in Table 3. Both starter and finisher rations met the nutrient requirements as per NRC. The metabolizable energy and crude protein content of pre-starter, starter, and finisher ration were 3.06, 3.16, and 3.25 Mcal/Kg diet and 22.7, 21.73, and 19.78 percent, respectively, across all groups. The supply and source of early nutrition or natural growth promoter or their combination were the key variables in these rations. There were no significant differences in the percent proximate composition of feeds for broiler pre-starter, starter, and finisher between the analyzed and calculated values. Minor numerical variations could be attributed to the variation in the chemical composition of the feed ingredients.

Growth and performance

Mean bodyweight gain (g) in the broilers at weekly intervals is presented in Table 4 and average daily weight gain (g), feed consumption and overall feed conversion ratio are presented in Table 5. Supplementation of the birds with early nutrition (Chikimune) alone or natural growth promoter alone or their combination significantly ($P<0.05$) influenced the weekly bodyweight gain. A significant difference was first noticed in the 2^{nd} week and the trend continued up to the end of the trial. At day 42, birds of T5 group showed significantly higher weight gain followed by the birds of the groups T3, T4, T2, and T1. A similar trend was observed in the average daily weight gain.

Nutritional demands of embryos and early aged chicks have been changed over decades due to selection for productivity and efficient birds (Jha *et al.*, 2019). Providing early nutrition to the chicks until they have a fully mature digestive system (Uni and Ferket, 2003), results in improved yolk utilization, growth rate, development of the digestive system, and immune system (Prabakar *et al.*, 2016). The chicks need quick transit from yolk-dependent nutrition to an external source for better growth (Sklan, 2001). Chicken weight in 6-7 weeks was found to have alinear relationship with their weight in the first week (Saki, 2005) which was not due to breeder age and day-old chick weight (Pezeshkian, 2002).

Chikimune supplemented birds were having more bodyweight, which might be because of its constituents such as Spirulina, which has properties like increasing protein utilization, rich protein source and have immunomodulatory properties (Khan *et al.*, 2005;). Feeding of Chikimune granules improved growth and performance parameters (Jadhav *et al.,* 2015). There was no significant difference in the total feed consumption between the control and other treatment groups but there was a significant difference in the feed conversion ratio between the groups. Like bodyweight gain and average daily gain (ADG), T5 group showed significantly higher feed conversion ratio followed by T3, T4, T2, & T1 groups.

Early nutrition supply to the chicks appears to increase the intestinal mechanical activity, enhance the intestinal development, and increase the assimilation of feed, thereby improving overall growth performance of the birds. It appears that the herbal constituents of Chikimune along with other essential nutrients

such as carbohydrate and protein source prevent the early post-hatch energy deficit in chicks so that the yolk can be utilized for initial intestinal growth and development for a longer period ultimately having a positive impact on intestinal health, bodyweight gain, and feed conversion ratio.

Natural growth promoter (AV/AGP/10) with its essential oils might have positively influenced the intestinal development by its bacteriostatic property against the harmful pathogens, thereby, improving gut health leading to better utilization of nutrients in the feed, improved bodyweight gain, and FCR. The birds that were supplemented with Chikimune for first 48 hours and followed by natural growth promoter from day 3 to 42 showed significantly highest bodyweight gain, ADG, and best feed conversion ratio. This might be due to the additive effect or synergistic effect of both products Chikimune and AV/AGP/10.

Intestinal Morphology

The data on mean duodenal villous height and duodenal crypt depth are presented in Table 6. Supplementation with Chikimune or natural growth promoter or combination of both significantly influenced the intestinal histology in broilers, especially the duodenal villous height and crypt depth. The duodenal villous height on days 2, 8, and 21 for T5, T3, and T2 groups were significantly higher as compared to T1 & T4 groups. By day 28, the duodenal villous height of group T5 was significantly increased followed by T3 and T4 groups over T2 and T1 groups. Similar trends were observed in the duodenal crypt depth.

Table.1 Experimental design to evaluate early nutrition supplement and natural growth promoter on performance and immunity of commercial broiler chicken (N=360, n=72, m=6)

Treatments	T1	T2	T3	T4	T5
Basal diet (Corn-soy)	✓	✓	✓	✓	✓
Brand A	-	✓	-	-	-
AV/NNC/14**	-	-	✓	-	✓
AV/AGP/10***	-	-	-	✓	✓

**@3g/chick/day for first two days and normal standard feed from 48h post-hatch (leftover paste, if any, was weighed & recorded)

***@250g/tonne of feed from 2nd day to 6th week

Table.2 Percent ingredient and chemical composition of basal broiler ration

Ingredients	Pre-starter	Starter	Finisher
Maize	55.00	51.11	56.17
Pearl millet	4.10	5.20	5.20
Soybean meal	28.20	29.83	24.00
Dry Fish	9.80	8.00	7.00
Oil	0.50	3.40	5.00
Salt	0.20	0.20	0.60
Mineral Mixture	0.50	1.00	1.00
Calcite	0.50	0.10	-
Dicalcium phosphate	-	0.35	0.50
Vit. AB_2D_3K	0.30	0.30	0.10
Choline chloride	0.340	0. 40	0.30
Lysine	0.50	0.10	0.15
DL-Methionine	0.15	0.10	0.15

Table.3 Proximate percent composition of basal broiler ration

Proximate Compositions	Pre-starter	Starter	Finisher
Crude Protein	22.76	21.73	19.78
ME (Mcal/Kg)	3.06	3.16	3.25
CF	3.13	3.00	2.85
Lysine	1.12	1.06	0.94
Calcium	1.31	1.30	1.22
Available P	0.49	0.49	0.46

Table.4 Effect of early nutrition and natural growth promoter on weekly bodyweight gain of commercial broilers (Mean ± SE)

Age (wks)	Bodyweight (g)				
	T1	T2	T3	T4	T5
Hatch ^{NS}	46.37± 0.42	47.35± 0.31	47.37± 0.38	46.75± 0.24	47.37± 0.34
1	143.81^{a}± 1.22	146.90^{ab}± 1.41	150.51^{b}± 1.21	148.30^{ab}± 1.63	150.55^{b}± 1.78
2	462.29^{a}± 16.03	469.00^{b}± 14.14	505.15^{c}± 8.59	496.44^{abc}± 7.82	513.27^{c}± 10.08
3	749.51^{a}± 11.42	765.94^{a}± 10.70	825.22^{b}± 16.05	815.30^{b}± 14.90	847.03^{b}± 20.12
4	1149.79^{a}± 14.66	1160.21^{a}± 11.53	1243.43^{b}± 25.63	1237.30^{b}± 20.96	1309.62^{c}± 30.65
5	1446.81^{a}± 19.02	1538.65^{b}± 18.20	1618.50^{c}± 15.99	1546.68^{b}± 34.46	1632.34^{c}± 23.27
6	2149.79^{a}± 14.66	2160.21^{a}± 11.53	2343.43^{c}± 24.18	2253.96^{b}± 21.47	2431.29^{d}± 35.84

Table.5 Effect of early nutrition and natural growth promoter on the performance of commercial broilers (Mean ± SE)

Characteristics	T1	T2	T3	T4	T5
Initial bodyweight (g)	47.08± 0.07	47.78± 0.25	47.37± 0.39	47.09± 0.20	47.16± 0.18
Final Bodyweight (g)	2149.79^{a}± 14.66	2160.21^{a}± 11.53	2343.43^{c}± 24.18	2253.96^{b}± 21.47	2431.29^{d}± 35.84
Bodyweight gain (g)	2102.70^{a}± 14.70	2112.42^{a}± 11.60	2296.06^{c}± 23.94	2206.87^{b}± 21.55	2384.12^{d}± 35.93
Average daily weight gain (g)	50.06^{a}± 0.34	50.29^{a}± 0.27	54.67^{c}± 0.57	52.54^{b}± 0.51	56.76^{d}± 0.86
Total feed consumed (g)	4341.28^{a}± 68.71	4361.49^{a}± 59.33	4163.06^{b}± 46.89	4230.87^{b}± 59.71	4290.08^{b}± 30.74
Feed conversion ratio	2.06^{a}± 0.03	2.06^{a}± 0.04	1.81^{c}± 0.03	1.91^{b}± 0.04	1.75^{d}± 0.02

Table.6 Effect of early nutrition and natural growth promoter on duodenal villous height (µm) and crypt depth (µm)) in commercial broilers (Mean ± SE)

Characteristics	Day	T1	T2	T3	T4	T5
Villous height (µm)	2	545.78^{a}± 19.18	708.23^{b}± 30.19	790.08^{bc}± 31.88	604.58^{a}± 28.57	842.22^{c}± 55.82
	8	735.88^{a}± 55.66	800.50^{ab}± 31.41	843.74^{ab}± 47.22	777.13^{a}± 42.73	917.84^{b}± 20.47
	21	873.81^{a}± 27.02	958.42^{b}± 25.65	1093.61^{c}± 22.79	1051.12^{c}± 41.70	1114.76^{c} ± 38.09
	28	972.20^{a}± 17.96	1032.04^{ab}± 33.19	1137.33^{c}± 13.62	1073.97^{b}± 17.00	1222.50^{d}± 19.40
Crypt depth (µm)	2	37.23^{a}± 1.31	41.80^{abc}± 2.06	45.12^{c}± 1.52	39.61^{ab}± 1.45	2.34^{bc}± 1.32
	8	30.34^{a}± 1.30	36.55^{b}± 1.33	40.54^{bc}± 1.16	40.19^{bc}± 1.17	40.72^{c}± 1.14
	21	41.77^{a}± 1.84	42.26^{a}± 1.38	46.97^{ab}± 1.73	43.83^{ab}± 2.41	46.08^{b}±1.26
	28	42.37^{a}±0.56	43.01^{ab}±0.74	47.06^{c}±1.11	45.23^{bc}±1.13	50.83^{d}± 1.04

Table.7 Effect of early nutrition and natural growth promoter on HI titer against NDV (Mean ± SE)

Day	T1	T2	T3	T4	T5
0	6.42± 0.08	6.35± 0.05	6.40± 0.05	6.37± 0.05	6.36± 0.06
14	3.59± 0.09	3.55± 0.03	3.50± 0.06	3.54± 0.06	3.52± 0.03
21	2.75^{a}± 0.04	3.03^{b}± 0.15	3.63^{cd}± 0.07	3.40^{c}± 0.09	3.85^{d}± 0.03
28	2.98^{a}± 0.06	3.28^{b}± 0.13	3.61^{c}± 0.04	3.37^{b}± 0.07	3.86^{d}± 0.05
35	3.36^{a}± 0.03	3.33^{a}± 0.04	3.78^{c}± 0.05	3.50^{b}± 0.03	3.94^{d}± 0.05
42	3.32^{a}± 0.04	3.35^{a}± 0.04	3.88^{c}± 0.06	3.64^{b}± 0.04	4.29^{d}± 0.03

Table.8 Effect of early nutrition and natural growth promoter on carcass yield and Cut-off parts in commercial broilers (Mean ± SE)

Characteristics	T1	T2	T3	T4	T5
Dressed Carcass Weight (Kg)	1508.67^{a}± 7.23	1521.85^{a}± 15.00	1682.52^{b}± 32.18	1627.67^{b}± 18.52	1785.57^{c}± 27.48
Dressing Percentage (%)	70.18^{a}± 0.91	70.44^{ab}± 0.86	71.84^{b}± 1.04	71.48^{ab}± 0.46	73.43^{c}± 0.17
Breast (%)^{NS}	38.16± 0.20	37.86± 0.26	38.63± 0.38	38.59±0.36	38.18± 0.30
Legs (%)^{NS}	41.20± 0.43	41.47± 0.48	41.53±0.21	41.69±0.22	41.90±0.14
Wings (%)^{NS}	12.11±0.16	12.10±0.28	11.28±0.35	11.85±0.36	11.38±0.37
Neck (%)^{NS}	8.52± 0.27	8.50± 0.31	8.55±0.19	7.86±0.27	8.52± 0.31

Table.9 Effect of early nutrition and natural growth promoter on cost economics in Commercial broilers

Particulars	T1	T2	T3	T4	T5
Cost of day-old chick (Rs.)	27.00	27.00	27.00	27.00	27.00
Total feed consumed (Kg.)	4341.28	4361.49	4163.06	4230.87	4290.08
Total Feed cost (Rs.)	121.54	122.10	116.56	118.44	120.12
Supplementation cost per bird (Rs./bird)	-	2.85	5.50	2.20	7.70
Miscellaneous cost (Rs./bird)	5.00	5.00	5.00	5.00	5.00
Total production cost (Rs.)	153.54	154.10	154.06	152.64	159.82
The final weight of the bird (Kg.)	2149.79	2160.21	2343.43	2253.96	2431.29
Market price Rate/Kg of live bird (Rs./Kg.)	75.00	75.00	75.00	75.00	75.00
Market sale price/bird (Rs.)	161.17	162.00	175.72	168.97	182.32
Net profit per bird (Rs./bird)	7.63	7.90	21.66	16.33	22.50
Net profit per bird over T1 (control group)	-	0.27	14.03	8.70	14.87
Cost: Benefit ratio	-	1:0.094	1:2.55	1:3.95	1:1.93

It appears that the constituent herbs and nutrients of Chikimune enhanced the intestinal development in the early stages. The supplement also had a long term effect on intestinal growth. The improvement in the intestinal growth of Chikimune supplemented groups could be attributed to the effect of the constituent herbs and essential oils of early nutrition on the villous growth and differentiation of enterocytes.

Gut morphology is one of the most commonly used parameters to determine the status of gut health. The chicks fed with good nutrition within 48 hours of hatching had longer intestines as compared to those which were unfed (Brink and Rhee, 2007). Early feeding improved intestinal weight and development (Prabakar *et al.,* 2015). Villous height, crypt depth, and villous height: crypt depth ratio and crypt proliferation are good indicators for checking the functional status of the intestines (De Jong *et al.,* 2017). Deeper crypts are indicative of faster tissue turnover and, perhaps of, higher demand for new tissue (Tiwari *et al.,* 2018). The morphological development of the small intestine can be increased by feeding immediately after hatching (Noy and Sklan, 1999). Overall health performance, feed efficiency, and optimum performance of poultry depend on the health of the gastrointestinal tract (GIT). Since the GIT of newly hatched chicks is functionally immature, therefore, early growth and development of the GIT are of critical importance in optimizing the growth of poultry (Jha *et al.,* 2019). The GIT, especially, the small intestine of poultry has the highest post-hatch relative growth during the first week of growth (Katanbaf *et al.,* 1988). Feed deprivation can cause decreased intestinal enterocyte length and villus surface area, which further decreases nutrient utilization and growth (Noy *et al.,* 2001). The first day of the hatch is very critical for mucosal development; therefore, early availability of nutrients is very necessary for the chicks (De Jong *et al.,* 2017).

Immunity

The effect of early nutrition and natural growth promoter on HI titer against NDV is shown in Table 7. Chikimune and natural

growth promoter had a significantly positive effect on the development of immunity, the HI titer was better in the supplemented birds. HI titer was significantly higher in T5 followed by T3, T4, T2, and T1 on day 21. A similar trend was noticed up to day 42. This might be due to the immunity-enhancing effect of the herbs present in Chikimune and natural growth promoter. The herbs alone or in combination may have acted as adaptogen and immunomodulators in the birds.

Addition of polyherbal nutritional supplements has been shown to enhance the immune response among the chicks (Kadam *et al.,* 2009). Early nutritional status plays an important role in the development of the immune system of chicks (Cook, 1991). Weights of spleen and bursa of Fabricius in chicks fed immunobiotic diets containing *Lactobacillus spp.* were more than control values at day 1 and 3 (Sato *et al.,* 2009). Chikimune supplementation has also been shown to increase the antibody titer against NDV (Jadhav *et al.,* 2015).

Carcass characteristics

Carcass characteristics of different groups of commercial broiler chicken are shown in Table 8. T5 group had significantly higher dressing percentage than other groups. There were no significant differences in the cut-off parts of carcass *viz.* breast, legs, wings, and neck.

Significantly higher slaughter weight and carcass dressing percentage could be attributed to the active ingredients present in early nutrition supplement and natural growth promoter. Early nutritional supplements improve muscle growth rate in broilers (Uni and Ferket, 2004). Early nutrition increases the nuclei in muscle mass, increasing its growth potential and helps in improving the carcass characteristics (Prabakar *et al.*, 2015).

Economics

Supplementation with Chikimune or natural growth promoter or combination of both positively influenced the cost economics of production in broilers. The production cost due to the additional supplementation of early nutrition supplement alone or natural growth promoter alone or combination of both was higher than non-supplemented (control) but the T5, T4, T3 groups fetched higher net profit per bird due to higher bodyweight gain and more effective utilization of the nutrients in the diet (Table 9).

In conclusion, the supplementation of early nutrition, supplement Chikimune @ 3g/chick/day during first 48 hours prevented the early post-hatch energy deficit in chicks allowing better intestinal growth and development, resulting in long term and significant improvements in intestinal health, bodyweight gain, feed conversion ratio, carcass yield, immune response, and overall efficiency of growth and performance of broilers. Supplementation with early chick nutrition, Chikimune (AV/NNC/17), @ 3g/chick/day during first 48 hours and followed by supplementation with natural growth promoter (AV/AGP/10)@ 250 g/tonne of feed from the 3rd day to 6th week, resulted in significant improvements in duodenal villous height, crypt depth, overall bodyweight gain, feed conversion ratio, immunity, carcass yield, and cost economics.

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