RESEARCH ARTICLE

Effect of Early Feeding with Synbiotics on Nutrient Digestibility, Carcass Characteristics and Gut Morphology of Broiler Chicken

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Abstract

This study was aimed to assess the effect of early feeding with synbiotics on nutrient digestibility, carcass characteristics and gut morphology of broiler chicken. A total of 144 day-old chicks were randomly assigned to four treatment groups, each comprising 9 birds per replicate, with 4 replicates per group. In Control group, birds received synbiotics (Probiotics + Prebiotics) in water and pre-starter feed upon arrival at the farm for 24 h. The Negative Control group received water and pre-starter feed without synbiotics. In Transport group, birds got synbiotics via beak dip at the hatchery and continued with synbiotics at the farm for 24 h. In the Treatment On-farm group (OF), birds received synbiotics immediately after hatching on the farm for 24 h. Early access to feed and synbiotics added water resulted in numerically higher retention of dry matter and organic matter in the OF group compared to the Control, Negative Control and Transport groups. The average daily positive nitrogen balance (g/bird) was significantly higher ($p<0.05$) in the Negative Control group compared to the Control, Transport and OF groups. The weight of gizzard, giblet, small intestine and large intestine were found significantly higher ($p<0.05$) in the OF group. The villus height of duodenum at the age of 21 and 42 days was significantly higher in early feeding with synbiotics in OF group. Livability remained statistically similar throughout the experimental period. The result suggests that early feeding with synbiotics to newly hatched chicks as soon as they hatched on the farm increases the weight of gizzard, giblet and intestine with better gut health.

Keywords: Broilers, Carcass characteristics, Early feeding, Gut morphology, Nutrient digestibility, Synbiotics.

Ind J Vet Sci and Biotech (2025): 10.48165/ijvsbt.21.3.07

Introduction

In commercial poultry operations, the hatching process is often extended by more than two days, with chicks being moved from the hatchery only after most have emerged. This period, from late embryonic development to the initial days post-hatching, is vital for the development of the gastrointestinal tract and immune system in poultry (Wang *et al*., 2020). After hatching, chicks undergo procedures such as sexing, vaccination, and packaging before Transportation, which can result in them being without feed or water for 48-72 h. Prolonged feed deprivation post-hatching can reduce organ weight (Lamot *et al*., 2014), delay gastrointestinal development (Liu *et al*., 2020), harm intestinal health (Panda *et al*., 2015), and decrease chick survival rates (Wijnen *et al.,* 2021). Rapid gut development is crucial for improving body weight and overall performance, as it is the primary site for nutrient absorption. Delayed access to feed post-hatch has been shown to adversely affect intestinal development, slaughter weight, and carcass yield (Halevy *et al*., 2000; Noy and Uni, 2010). This study was undertaken with the objective to evaluate the effect of early feeding with synbiotics on nutrient digestibility, carcass characteristics and gut morphology of broiler chicken.

Materials and Methods

The trial was conducted in the months of February and March with the approval of the Institutional Animal Ethics Committee of the Veterinary College, Anand, Gujarat, India (No. 417/AN/23). The experimental birds were reared at the Poultry Research Station, Anand, and samples were analyzed at animal nutrition research station, Anand. The experimental birds were randomly allotted into four treatment groups: Control, Negative control, Transport, and On-farm (OF). Each group had 36 birds, divided into four replicates of 9 birds each.

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How to cite this article: Patel, M. M., Vahora, S. G., Rajpura, R. M., Vansola, J. H., Gameti, C. B., & Desai, D. M. (2025). Effect of Early Feeding with Synbiotics on Nutrient Digestibility, Carcass Characteristics and Gut Morphology of Broiler Chicken. Ind J Vet Sci and Biotech, 21(3), 33-37.

Source of support: Nil

Conflict of interest: None

Submitted 31/01/2025 **Accepted** 28/02/2025 **Published** 10/05/2025

Treatment Groups

The experimental feed for all groups was prepared according to the BIS (2007) standards for broiler chickens, divided into pre-starter (0 to 7 days), starter (8 to 21 days) and finisher (22 to 42 days) phases. These diets were given based on daily requirements. Synbiotics (Probiotic: *Bacilluas coagulans, Bacillus subtilis* and *Enterococcus faecus*. Prebiotics: Mannan oligosaccharides, and extra- & intra-cellular metabolites matrix from spore forming & non-spore forming bacteria) were added to the drinking water (1 g/liter) for the first 24 h in the treatment groups. After this period, normal feeding and watering resumed for all groups.

In the Control group, birds received synbiotics-supplemented water and pre-starter feed upon arrival at the farm from the hatchery for 24 h. The Negative control group received pre-starter feed and water without synbiotics upon arrival for 24 h. In the Transport group, synbiotics were administered via the beak dip method at the hatchery and continued with synbiotics-supplemented water and pre-starter feed at the farm for the first 24 h post-hatch. In the Treatment On-farm (OF) group, synbiotics-supplemented water and pre-starter feed were provided as soon as the chicks hatched on the farm.

Metabolic Trial and Proximate Analysis

A metabolic trial was conducted during the 6th week, involving one bird per replicate. The trial included a 2-days adaptation period followed by a 3-days collection period. Birds were transferred from a communal deep litter system to individual deep litter systems to ensure precise Control over feeding and watering. Throughout the collection period, data on feed intake, leftovers, and excreta output were meticulously recorded to evaluate nutrient utilization. Excreta samples were collected using weighed and numbered plastic sheets placed beneath the birds. One-fifth of the collected excreta was preserved in concentrated H_2SO_4 for nitrogen analysis, while the remainder was oven-dried to determine dry matter (DM) content. Samples collected over three days for each bird were pooled, ground, and preserved for subsequent analysis. Proximate analysis of the feed, leftovers, and excreta was performed according to AOAC (2000) standards. Nitrogen content was determined using the Kjeldahl method (AOAC, 2000). Calcium estimation followed ISI (1962) guidelines, and phosphorus estimation was performed using a BIOMATE 3S spectrophotometer (AOAC, 1995).

Carcass Characteristics

At 42 days of the experiment, one bird from each replicate was randomly selected and slaughtered using a scientific method. The birds were fasted for 12 h prior to slaughter, and their pre-slaughter weight was recorded. After complete bleeding, the carcass was subjected to feather removal, skinning, and evisceration. Organs such as the liver (without gall bladder), heart (without pericardium), and gizzard were separately collected and weighed. The dressed carcass and abdominal fat content of each bird were also weighed. Giblet weight was calculated by summing the weights of the liver, heart, and gizzard. Dressing percentage was calculated based on the pre-slaughter weight, while giblet percentage and abdominal fat percentage were calculated based on the dressed weight.

Gut Morphology

On the 7th, 21st and 42nd day of the experiment, one bird per replicate from each treatment group was sacrificed. Intestinal segments (duodenum and jejunum) were collected to measure villi height, Villi width, crypt depth and the villi height to crypt depth ratio. These samples were preserved in 10% formalin. After evisceration, 2 to 3 cm sections of the middle duodenum and jejunum were removed, rinsed with PBS and fixed in 10% neutral buffered formalin. The samples were processed using paraffin embedding for histo-morphological examination. Sections were cut to 4-5 microns thickness using an automatic microtome (Leica, Germany) and stained with Haematoxylin and Eosin (H&E) stains (Luna, 1968). The H&E-stained slides were observed under a light microscope and measurements were taken using Image J software. Intact lamina propria was used for villus selection. Villi height (VH) was measured from the villus crypt junction to the villus tip, crypt depth (CD) from the base of the villus to the invagination between two villi, and villus width (VW) as an average of the apical and basal widths.

Livability

The percent livability was calculated based on the number of birds that remained alive after deducting mortality for each treatment diet during experimental period.

Statistical Analysis

The data generated following a Completely Randomized Design was analyzed as per Snedecor and Cochran (2014). Means of replication under each treatment were considered for analysis using software SPSS (version 20).

Results and Discussion

Nutrient Digestibility (Retention)

The results (Table 1) indicate that the average daily positive nitrogen balance (g/bird) was significantly higher ($p<0.05$) in the Negative Control group compared to the Control, Transport and OF groups. Early feeding with synbiotics either in OF or Transport group revelled higher ($p<0.05$) positive nitrogen balance than Control. The average daily positive Ca and P balance values (g/bird) were at par with each other.

Early access to feed and synbiotics added water resulted in numerically higher dry matter and organic matter, while crude fat and crude fiber was numerically reduced particularly in the OF group compared to the Control, Negative Control and Transport groups (Table 2). These findings were in

accordance with Ojebiyi *et al*. (2022), while in contrast with findings of Obun and Osaguona (2013).

Table 1: Means for balance (g/day/bird) of nitrogen, calcium and phosphorus of experimental broilers under feeding experiment

Nutrient	Particulars	Treatment groups			
		Control	Negative Control	Transport	On-Farm (OF)
Nitrogen	Total intake	$3.72^{c} \pm 0.09$	$7.50^{a} \pm 0.49$	$5.72^{b} \pm 0.07$	$6.50^{ab} \pm 0.48$
	Excreted in faeces	1.05 ± 0.22	1.13 ± 0.07	0.89 ± 0.07	1.50 ± 0.25
	Balance	$2.67^{c} \pm 0.22$	$6.36^{a} \pm 0.47$	$4.83^{b} \pm 0.05$	$5.01^{b} \pm 0.42$
Calcium	Total intake	$1.12^{b} \pm 0.04$	$1.82^{a} \pm 0.25$	$1.13^{b} \pm 0.04$	$1.90^{a} \pm 0.23$
	Excreted in faeces	$0.47^{b} \pm 0.11$	$0.95^{a} \pm 0.13$	$0.52^{b} \pm 0.06$	$0.76^{ab} \pm 0.15$
	Balance	0.65 ± 0.09	0.87 ± 0.26	0.60 ± 0.04	1.14 ± 0.15
Phosphorus	Total intake	$0.56^{b} \pm 0.02$	$0.91^{a} \pm 0.12$	$0.56^{b} \pm 0.02$	$0.95^{a} \pm 0.12$
	Excreted in faeces	0.36 ± 0.00	0.44 ± 0.03	0.31 ± 0.03	0.45 ± 0.23
	Balance	0.20 ± 0.02	0.47 ± 0.15	0.25 ± 0.02	0.50 ± 0.33

Means with different superscripts within the row differ significantly ($p<0.05$).

Table 2: Average nutrient retention (%) of experimental broilers during metabolic trail

Nutrient	Treatment groups			
	Control	Negative Control	Transport	On-Farm (OF)
Dry matter	71.31 ± 5.65	70.72 ± 7.12	69.82 ± 1.96	71.93 ± 5.09
Organic matter	75.39 ± 4.26	72.89 ± 7.00	75.33 ± 1.85	77.57 ± 3.06
Crude fat	80.81 ± 3.06	81.51 ± 4.26	81.04 ± 1.47	80.65 ± 2.10
Crude fiber	44.00 ± 3.98	40.47 ± 2.27	40.87 ± 3.99	36.92 ± 8.07

Carcass Characteristics

The results of the present study revealed statistical similarity in dressing percentage, abdominal fat percentage, giblet percentage between treatments that added synbiotics early or late in the feeding regimen (Table 3). Similar to our findings Alireza *et al*. (2022) and Mahapatra *et al*. (2017) found non-significant differences in dressing percentage and abdominal fat percentage.

The weight of gizzard, giblet, small intestine (SI) and large intestine (LI) were significantly higher ($p<0.05$) in the OF group compared to the Control, Negative Control and Transport groups. A larger gizzard enhances feed particle breakdown for better enzymatic action in the intestines, resulting in better nutrient absorption and utilization, efficient digestion through strong gizzard leads to better fermentation and healthy balance of gut microbiota, reducing the risk of intestinal disorders by reducing the substrate available for harmful bacteria in the gut. In accordance with present study, Ganjali *et al*. (2015), Abousekken *et al*. (2017), and Khadem *et al*. (2018) observed significantly higher ($p<0.05$) gastrointestinal length (cm) in early post-hatch feeding group.

Table 3: Carcass characteristics of experimental broilers under feeding experiment

Particulars	Treatment groups			
	Control	Negative Control	Transport	On-Farm (OF)
Pre-slaughter Wt (g)	2143.75±15.33	2325.75 ±35.69	2030.00 ± 41.73	2222.50 ±151.69
Dressed Wt (g)	1303.90±17.03	1439.13 ± 31.33	1239.70 ± 36.26	1373.10 ± 90.46
Dressing%	60.83 ± 0.87	61.87 ±0.69	61.09 ±1.58	61.83 ± 0.92
Liver Wt (g)	$57.40^{a} \pm 6.35$	$50.63^{ab} \pm 2.50$	$39.28^{b} \pm 3.10$	$40.40^{b} \pm 3.06$
Heart Wt (g)	10.33 ± 0.59	9.90 ±0.10	8.30 ± 0.23	11.05 ± 1.43
Gizzard Wt (g)	$43.68^{b} \pm 2.06$	$43.93^{b} \pm 0.80$	$38.00^{b} \pm 2.39$	$80.18^{a} \pm 4.21$
Giblet Wt (g)	$111.40^{b} \pm 8.50$	$104.45^{bc} \pm 3.22$	$85.58^{c} \pm 5.22$	$131.63^{a} \pm 8.07$
Giblet (%)	8.55 ± 0.67	7.28 ± 0.37	6.89 ± 0.29	9.63 ± 0.5
Abd fat Wt (g)	31.08 ± 5.61	26.58 ± 2.49	36.28 ± 4.54	31.25 ± 2.43
Abd fat (%)	2.39 ± 0.45	1.84 ± 0.16	2.95 ± 0.44	2.27 ± 0.08
S.I. length (cm)	$142.75^{b} \pm 2.93$	$165.25^{a} \pm 6.97$	$167.75^{a} \pm 4.46$	$154.25^{ab} \pm 7.11$
S.I. Wt (g)	$74.39^{a} \pm 3.58$	$67.39^{a} \pm 3.08$	$55.16^{b} \pm 4.22$	$77.04^{a} \pm 5.31$
L.I. Wt (g)	$8.81^{b} \pm 0.60$	$8.11^{b} \pm 1.04$	$8.96^{a} \pm 1.17$	$9.15^{b} \pm 0.41$
Livability	94.44	97.22	91.67	94.44

Means with different superscripts within the row differ significantly ($p<0.05$).

Gut Morphology

The gut morphological data at the age of 7, 21 and 42 days are presented in Table 4. The early feed supplemented OF group had significantly higher villus height and villus width in the duodenum, while in the jejunum crypt depth was significantly higher ($p<0.05$) than Control, Negative Control and Transport groups at the age of 21 days. At 42-days, duodenal gut morphometry revealed significantly higher villus height in Transport and OF groups. Increasing gut villi height and width is highly beneficial for nutrient utilization, enhance gut health with a healthy gut microbiota balance, producing short chain fatty acids by beneficial bacteria.

Livability

The values obtained across all treatments were statistically similar in livability (Table 3). Non-significant results in livability showed that there was no any adverse effect of early feeding and watering with synbiotics. This finding aligned with Mahapatra *et al*. (2017), while contradicted with Kadam *et al*. (2009).

Table 4: Histo-morphological observation of duodenum and jejunum (µm) of experimental broilers under feeding experiment at the age of 7 days, 14 days and 42 days

Age	Organ	Particulars	Control	Negative Control	Transport	OF
7 days	Duodenum	Villi Height	597.23±13.43	591.09 ±8.03	620.97±14.38	620.01±8.29
		Villi Width	81.90 ±5.75	73.77 ±4.24	85.14±5.91	83.01±4.32
		Crypt Depth	109.54±5.04	112.67±3.92	119.15±8.42	116.10±4.48
		VH : CD	5.50 ±0.31	5.26 ±0.14	5.29 ±0.25	5.36 ±0.23
	Jejunum	Villi Height	490.99±2.10	460.36±22.93	486.52±2.08	497.13±1.19
		Villi Width	85.47±1.96	85.94±0.71	84.14±1.65	89.28±0.85
		Crypt Depth	91.43±3.70	91.18±3.46	90.09±1.71	93.44±0.75
		VH : CD	5.42 ±0.21	5.04 ±0.08	5.44 ±0.09	5.33 ±0.04
14 days	Duodenum	Villi Height	1353.61^{b}±23.68	1386.16^{b}±19.27	1374.68^{b}±27.73	1480.12^{a}±29.14
		Villi Width	242.67^{ab}±11.14	223.63^{b}±6.46	234.40^{b}±7.18	259.63^{a}±4.31
		Crypt Depth	236.82±7.11	222.70± 6.87	239.15±8.07	233.21±8.79
		VH : CD	5.74 ±0.28	6.24 ±0.23	5.76 ±0.24	6.37 ±0.26
	Jejunum	Villi Height	1285.15±56.58	1281.10±85.17	1242.57±37.84	1426.71±57.72
		Villi Width	170.90±2.59	168.97±3.47	161.74±2.31	171.00±3.59
		Crypt Depth	202.25^{b}±6.03	204.60^{b}±11.69	203.17^{b}±9.31	238.53^{a}±9.48
		VH : CD	6.37 ±0.34	6.30 ±0.45	6.14 ±0.19	6.02 ±0.40
42 days	Duodenum	Villi Height	2707.48^{ab}±68.11	2528.85^{b}±59.44	2791.73^{a}±67.51	2824.81^{a}±36.50
		Villi Width	357.79±11.65	380.61±8.51	352.56±12.37	379.55±4.45
		Crypt Depth	441.16^{a}±18.31	459.44^{a} ±6.33	399.11^{b}±12.69	468.03^{a}±3.32
		VH : CD	6.15^{b} ±0.15	5.50^{c} ±0.06	7.03^{a} ±0.36	6.04^{bc} ±0.09
	Jejunum	Villi Height	2577.11^{b}±41.36	2836.48^{a}±65.03	2646.32^{b}±32.17	2333.87^{b}±72.13
		Villi Width	332.63±14.24	343.04±3.24	358.68±16.97	373.58±27.10
		Crypt Depth	372.78±28.31	392.77±9.26	391.37±24.34	413.73±12.77
		VH : CD	7.06 ±0.64	7.22 ±0.09	6.85 ±0.46	6.18 ±0.14

VH: CD = Villi Height: Crypt Depth ratio. Means with different superscripts within the row differ significantly ($p<0.05$).

Conclusion

On the basis of present findings it is concluded that early feeding with synbiotics to newly hatched chicks as soon as they hatched on the farm increases the weight of gizzard, giblet, small intestine and large intestine with better gut health.

Acknowledgement

We gratefully acknowledge the Dean of the Veterinary College, Anand, and the Director of Research, Kamdhenu University, Gandhinagar, Gujarat, for providing funds and facilities for the conduct of research work.

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