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Organic and inorganic minerals in Sonali chicken diets: Effect on growth performance and meat quality

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ABSTRACT

Background: This study investigated the effects of inorganic minerals and organic trace minerals supplementation on the production and carcass characteristics of Sonali chickens. Materials and methods: A total of 180 Sonali chicks (RIR and Fayoumi cross) were randomly divided into 4 experimental groups, each group occupying 3 replications. Dietary groups were considered as control (T0), organic trace minerals at 100 g/100 kg feed (T1), inorganic minerals at 250 g/100 kg feed (T2), and organic trace minerals at 100 g/100 kg feed + inorganic minerals at 250 g/100 kg feed (T3), respectively. Weekly body weight and feed intake data were taken to 60 days. Results: Initial body weight was not significantly different among the experimental groups (P > 0.05). But the final body weight was significantly different among the experimental groups (P <0.05), with the highest value recorded at T3 (857.67 g). Total body weight gain was significantly different among the experimental groups (P<0.05) and was the highest value recorded in the T3 group (833.99 g). Total feed intake was non-significant among the experimental groups. Feed conversion ratios differed significantly among the experimental groups (P<0.05), with the lowest but best FCR found in the T3 group (1.96). Daily live weight gain was significantly different among experimental groups (P< 0.05). Carcass weight, breast, thigh, and drumstick weights were significantly different among the dietary groups (P< 0.01). Faecal ash (17.33%) and calcium (2.10%) secretion was lower in the organic trace minerals(T1) group than in the inorganic minerals(T2) group as well as the combined group, but phosphorus secretion (2.65%) was lower in the combined(T3) group than in the organic trace minerals group and the inorganic minerals group. The experimental groups differed considerably (P <0.01) in net profit, with T3 having the highest value (39.47 Bangladeshi taka) and T0 having the lowest (17.04 BDT). The benefit over control differed considerably (P< 0.01) among the experimental groups, with the highest value in the T3 group (22.43 BDT) and the lowest in the T2 group (6.89 BDT). Conclusion: So, Sonali commercial farmers may combine organic trace minerals and inorganic minerals with basal feeds to increase Sonali chicken production efficiency and profit.

Keywords: organic trace mineral, inorganic mineral, productive performances, carcass characteristics.

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Introduction

Bangladesh's poultry sector, a key part of the country's economy, is a significant contributor to the country's GDP(Gross domestic product). Sonali chicken, a hybrid of Rhode Island Red and Fayoumi chickens, is gaining popularity due to meats unique aroma, taste, and texture. Despite limited herd size and yield, Sonali chickens are two to three times more expensive than commercial chickens. Traders can sell Sonali chicken at a higher price than broiler (Hasan, 2019). Sonali chicken consumption increased 45% in July 2019 compared to 20% in July 2018 (Hasan, 2019). There are two forms of trace elements available for birds: inorganic and organic. Inorganic trace elements such as oxides, chlorides, carbonates, and sulphates have

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long been used in poultry feed (Aksu et al., 2011). The efficacy of minerals is an important issue in modern poultry nutrition. Microelements are essential for normal growth and many metabolic processes in living organisms, as they are catalysts or constituents of the enzymatic systems of many cells (Swiatkiewicz et al., 2014). Inorganic trace minerals (ITM) are unstable and rapidly dissociate in the gastro-intestinal tract and interact with other compounds, leading to their loss before absorption (Aksu et al., 2011). Owing to the low digestibility of ITM, higher levels of dietary ITM are supplemented to meet the requirements of birds (Yan and Waldroup, 2006; Mezes et al., 2012), which eventually increase the cost of production and environmental problems. These problems could be overcome by substituting ITM with organic trace minerals (OTM). OTM is more stable due to its organically bound structure that is better digested and absorbed in the intestine (Sandoval et al., 1998), which in turn increases their bioavailability (Bhoyar, 2015) and consequently reduces the faecal and urinary excretion (Wang et al., 2019). Trace elements such as Cu, Fe, Mn, and Zn are essential for growth and are involved in many digestive, physiological, and biosynthetic processes in the body. Organically complexed zinc has been found to be more bioavailable and more beneficial to birds than the inorganic form (Salim et al., 2011). In poultry farming, these compounds are often used in excess of 2 to 10 times the amounts recommended by the National Research Council to prevent trace element deficiencies and promote bird growth (Esenbu et al., 2008). However, higher concentrations of trace elements, including copper, in diets can affect the bioavailability of other elements (Wapnir, 1998). High levels of confinement result in mineral waste and environmental pollution due to excessive bird excretion (Leeson, 2003). For example, 94% of absorbed zinc is excreted into the environment and can cause phytotoxicity in soil (Zafar et al., 2018). Excretion of phosphorus can lead to eutrophication. Therefore, the purpose of this study was to investigate the effects of organic trace minerals and inorganic minerals on Sonali birds' meat quality and bedding quality in reducing mortality and examining faecal material to determine mineral excretion. Objectives of the experiment was:To determine the effects of organic trace elements and inorganic minerals on the productive performance of sonali chicken. To investigate the effects of organic trace elements and inorganic minerals on the carcass characteristics and assess cost effective benefit of Sonali chicken. To determination the mineral excretion by fecal material examination of sonali chicken.

Materials and Methods

Location of study

The experiment was conducted at a poultry farm in the campus of Hajee mohammad Danesh Science and Technology University, Dinajpur. The experiment was conducted from February to April 2022. The ethical committee of the Institute of Research & Training (IRT), HSTU(HSTU/IRT/112/2021-2022).

Experimental Sonali birds

A total of 180-day-old Sonali chicks were purchased from Polli Chicks Limited in Sadar, Dinajpur, Bangladesh. The experimental bird was healthy and disease-free. Adequate lighting, proper ventilation, and heating were ensured for up to 7 days of brooding and the rest of the days up to 60. There were 4 experimental groups, each group occupying 3 replications.

Design of the experiment

The experiment was conducted in complete randomized design (CRD). The day-old sonali chicks were kept in brooder house for up to 7 days to adapt with the environmental conditions. A total of 180 chicks were randomly divided into 4 experimental groups, each group occupying 03 replications. Dietary groups were considered as control (T0), Organic trace minerals (A-vaila Z/M) at 100 gm/ 100 Kg feed (T1), Inorganic mineral (Rena grower premix) at 250 gm/ 100 Kg feed (T2) and Organic trace minerals (A-vaila Z/M) at 100 gm/ 100 Kg feed+ Inorganic mineral (Rena grower premix) at 250 gm/ 100 Kg feed (T3) respectively. The A -vaila Z/M contains zinc amino acid complex and manganese amino acid (Association of American Feed Control officials, AAFCO), and Rena grower powder contains vitamins & minerals. On the last day of the experiment, for each replication, 2 birds were slaughtered.

Collection of experimental materials

Basal feed was collected from the local market of Dinajpur town. Feed was supplied in two phases as starter diet and finisher diet. Inorganic mineral (Rena Grower premix) and Organic trace minerals (A-vaila Z/M) were collected from local market of Dinajpur town and stored in a plastic bag on a clean dry place and normal room temperature.

Preparation of the experimental diet

The ration formulation was done for chicken feed. Feed ingredients were mixing properly by using hands for the preparation of basal feed. Digital weight balance was used to weight feed ingredients. The experimental period was divided into three phases (Brooding, Sonali-starter and Sonali–finisher). The sonali chicks were fed ready feed (package commercial feed) in brooding period, sonali starter for 8 to 20 days and sonali finisher for 21 to 60 days of age. Control group (T0) was supplied formulated feed without organic and inorganic trace minerals. Treatment group (T1) was supplied with 100 g organic trace minerals with 100 kg basal feed, (T2) was supplied with 250 g inorganic minerals with 100 kg basal feed and (T3) was supplied with both 100 g organic trace minerals as well as 250 g inorganic minerals with 100 kg basal feed. Before mixing the trace minerals. This experiment was used to prepare the basal feed by mixing all the ingredients (Table no.1) properly.

Table.1. Composition of basal diets

Ingredient	Starter diet (Days 8 to 20)	Finisher diet (Days 21 to 60)
Maize	58 kg	58 kg
Rice polish	10 kg	10 kg
Soyabean meal	21 kg	20 kg
Soyabean oil	500 g	1 kg
Molasses	500 g	500 g
Fish Meal	6.5 kg	6 kg
Lime Stone	1.5 kg	2 kg
DCP	700 g	1 kg
Methionine	100 g	120 g
Lysine	50 g	80 g
Vitamin Premix	350 g	350 g
SQ Zyme SME	100 g	100 g
Hemeco Sal Dry Powder	200 g	200 g
Turbo Tox	100 g	100 g
Bicarbonate	150 g	150 g
Amprium vet powder	50 g	50 g
Salt	200 g	350 g
Total	100 kg	100 kg

Hemeco Sal Dry Powder = blood meals, Turbo Tox = toxin binder, Amprium vet powder = anti coccidiosis

Managemental practices

Housing, litter, feed (Naurish Feed Co. Ltd. Sonali starter: 1–25, Sonali grower: 25-60 days), water, lighting, sanitization, and vaccination (Table 2) are all necessities. Adequate precautions were implemented throughout the study period.

Performance traits

1. Total gain in weight = final weight – initial weight. 2. Dressing percentage = (dressed weight ÷ body weight) x 100. 3.Total feed consumption = total feed offered – total left-over. 4. Feed efficiency = total feed consumed / total gain in weight. 5. Mortality rate (%) = no. of dead chickens / total no. of birds as a group × 100.

Statistical analysis

Data was analyzed with a one-way ANOVA, using the General Linear Models (GLM) procedure of the SAS (SAS, 1994) with the help of SPSS (Version 25.0). Duncan`s Multiple Range Test option of the SAS was used to separate significant differences between means and data symmetrically distributed. All results were considered significant at the 1 and 5% level of significance ($P<0.05$).

Results

Live weight (g)

At the start of the experiment, the average body weight of the birds did not differ significantly among the treatment group. The live weight of birds in 7th and 14th days of age did not significantly ($P>0.05$) vary among the treatment groups (Table. 3). At 21st day, the body weight was significantly different ($P<0.05$) where the highest values were found in T3 (199.00±2.08) and the lowest value was found in T0 (182.33±2.91). The body weight was significantly ($P<0.01$) among the treatment groups during the 28th, 35th, 42th, 49th, and 56th days of age. Final live weight (60th days of age) was also significantly different ($P< 0.01$) among the dietary groups. Feed supplemented with Organic trace minerals + Inorganic mineral among the birds showed the highest body weight T3 (857.67±4.06) and the lowest body weight was found in control group T0 (741.00±2.08). The T1 group had (806.33±3.84) and T2 had (782.00±4.93).

Live weight gain (g)

The live weight gain of the experiment is presented in Table 4. From the 1st to the 4th weeks of the trial period, this result demonstrated a non-significant difference in the average weight gain of the birds between the treatment groups ($P>0.05$). From the table, it is found that from the 5th week to the 8th week and at the 60th day of sonali, the body weight gain was statistically significant ($P<0.05$). The organic trace minerals + inorganic minerals -supplemented group T3 (833.99±20.66) showed the highest final live weight gain, and control group T0 (717.33±19.4)

Table 2. Vaccination

Name of vaccine	Diseases	Age (Days)	Time	Route
ND+IB	New Castle & Infectious Bronchitis	4th	Evening	Eye drop
IBD	Gumboro	12th	Evening	Eye drop
IBD	Gumboro	17th	Evening	Drinking water
ND+IB	New Castle & Infectious Bronchitis	22th	Evening	Drinking water
ND	New Castle	42th	Evening	Drinking water

Source: Vaccine, prepared by ACI pharmaceutical company was applied as per recommendation of the manufacturer.

Table 3. Effect of dietary supplementation of organic trace minerals and Inorganic mineral on live weight (g) in different treatment groups of Sonali birds.

Live weight (g)/ bird	Treatment groups				
	T_0	T_1	T_2	T_3	Level of significant
Initial body weight	24.67 ± 0.33	24.33 ± 0.33	24.67 ± 0.33	24.67 ± 0.33	NS
7th Days	69.00 ± 0.58	69.00 ± 0.58	69.00 ± 0.58	69.67 ± 0.33	NS
14th Days	122.67 ± 1.76	129.67 ± 1.45	126.67 ± 0.88	131.00 ± 0.58	NS
21st Days	182.33 ± 2.91^{a}	194.33 ± 1.33^{bc}	190.00 ± 1.53^{b}	199.00 ± 2.08^{c}	*
28th Days	282.67 ± 2.33^{a}	301.00 ± 3.46^{bc}	294.00 ± 1.73^{b}	309.33 ± 2.60^{c}	**
35th Days	373.67 ± 1.76^{a}	400.67 ± 5.36^{c}	388.67 ± 1.45^{b}	419.67 ± 4.06^{d}	**
42th Days	476.33 ± 2.40^{a}	512.33 ± 5.33^{c}	494.67 ± 2.85^{b}	541.33 ± 5.90^{d}	**
49th Days	574.67 ± 1.86^{a}	626.67 ± 4.33^{c}	602.67 ± 6.89^{b}	665.67 ± 3.53^{d}	**
56th Days	679.00 ± 3.06^{a}	738.67 ± 4.91^{c}	717.67 ± 6.12^{b}	792.67 ± 2.96^{d}	**
60th Days	741.00 ± 2.08^{a}	806.33 ± 3.84^{c}	782.00 ± 4.93^{b}	857.67 ± 4.06^{d}	**

Values are expressed as mean ± standard error of means (SEM). NS: Statistically not significant (P>0.05). a b c d means having different superscript in the same row differed significantly (P<0.05)*indicates 5% level of significance.**indicates 1% level of significance.

Table 4. Effect of dietary supplementation of organic trace minerals and inorganic minerals on live weight gain (g) in different treatment groups of Sonali birds

Live weight gain (g)/bird	Treatment groups				
	T_0	T_1	T_2	T_3	Level of significant
7th Days	44.33 ± 0.33	44.67 ± 0.33	44.33 ± 0.67	45.00 ± 0.58	NS
14th Days	55.67 ± 2.33	60.67 ± 1.20	57.67 ± 1.33	61.33 ± 0.67	NS
21st Days	63.67 ± 2.67	64.67 ± 1.86	63.33 ± 0.88	68.00 ± 2.00	NS
28th Days	100.33 ± 2.60	106.67 ± 2.40	104.00 ± 1.15	110.33 ± 4.26	NS
35th Days	91.00 ± 3.51^{a}	99.67 ± 3.84^{a}	94.67 ± 1.45^{a}	110.33 ± 1.45^{b}	*
42th Days	102.67 ± 3.53^{a}	111.67 ± 1.45^{b}	105.33 ± 1.45^{ab}	121.67 ± 2.33^{c}	*
49th Days	98.33 ± 2.03^{a}	114.33 ± 2.85^{bc}	110.00 ± 4.58^{b}	124.33 ± 3.48^{c}	*
56th Days	104.33 ± 1.45^{a}	112.00 ± 0.58^{ab}	115.00 ± 1.15^{b}	127.00 ± 4.36^{c}	**
60th Days	60.00 ± 1.00^{a}	64.67 ± 0.88^{b}	63.00 ± 1.00^{b}	67.00 ± 1.53^{c}	*
(1-60th) Days	717.33 ± 19.45^{a}	782.02 ± 15.39^{c}	757.33 ± 13.66^{b}	833.99 ± 20.66^{d}	*

Values are expressed as mean ± standard error of means (SEM). NS: Statistically not significant (P>0.05). a b c d means having different superscript in the same row differed significantly (P<0.05)*indicates 5% level of significance.**indicates 1% level of significance.

Feed intake (g)

The effect of organic trace minerals and inorganic minerals on feed intake of Sonali birds is presented in Table 5. It was observed that at 7th day and 14th day of age, the feed intake was not significantly different (P > 0.05) among the treatment groups. The feed intake from 21st days to 60th days of age significantly differed (P<0.05) among the dietary treatment groups. But the total feed intake of 60 days was statistically non-significant (P>0.05). Total feed intake was lowest in dietary group T0 (1561.99±19.61) and highest in dietary group T3 (1634.32±14.28).

Feed conversion ratio (FCR)

The Feed Conversion Ratio (FCR) of the experimental birds is shown in Table 6. At 7th to 28th days of age, the FCR was non-significant (P > 0.05) in different treatment groups. A significant difference (P<0.05) was found among the treatment groups from 35th to 60th days of age. The lowest FCR was found in dietary treatment group T3(1.96±0.69) and the highest in dietary group T0 (2.18±1.01) at (1–60th) days of age. From the table, it was found that the Organic trace minerals + Inorganic minerals supplemented group (T3) showed the best but lower FCR, and the control diet supplemented group (T0) showed a higher FCR. Organic trace minerals supplemented group T1 had (2.06±1.21) and Inorganic minerals supplemented group T2 had (2.12±1.19).

Table 5. Effect of dietary supplementation of Organic trace minerals and Inorganic minerals on Feed Intake (g) in different treatment groups of Sonali birds

Feed intake (g)/ bird	Treatment groups				
	T_0	T_1	T_2	T_3	Level of significant
7th Days	50.33 ± 0.33	50.33 ± 0.33	50.00 ± 0.58	50.33 ± 0.33	NS
14th Days	95.00 ± 2.65	96.67 ± 1.45	96.33 ± 0.88	97.67 ± 0.33	NS
21st Days	122.00 ± 2.08^{a}	131.00 ± 0.58^{b}	129.67 ± 1.86^{b}	130.33 ± 0.88^{b}	*
28th Days	159.33 ± 1.45^{a}	163.00 ± 2.08^{b}	162.00 ± 1.53^{b}	165.00 ± 1.73^{c}	*
35th Days	188.33 ± 1.20^{a}	191.67 ± 2.91^{b}	195.00 ± 2.52^{bc}	197.00 ± 1.15^{c}	*
42th Days	231.00 ± 5.20^{a}	238.00 ± 3.21^{b}	238.33 ± 1.45^{b}	244.33 ± 1.76^{c}	*
49th Days	271.00 ± 1.15^{ab}	278.00 ± 1.00^{c}	268.67 ± 2.40^{a}	275.00 ± 2.31^{bc}	*
56th Days	285.33 ± 4.10^{a}	295.67 ± 4.48^{b}	298.00 ± 3.46^{b}	303.33 ± 3.93^{c}	*
60th Days	159.67 ± 1.45^{a}	167.33 ± 2.60^{bc}	165.00 ± 1.53^{b}	171.33 ± 1.86^{c}	*
(1-60th) Days	1561.99 ± 19.61	1611.67 ± 18.64	1603 ± 16.21	1634.32 ± 14.28	NS

Values are expressed as mean ± standard error of means (SEM). NS: Statistically not significant (P>0.05). a b c means having different superscript in the same row differed significantly (P<0.05)*indicates 5% level of significance.

Table 6. Effect of dietary supplementation of organic trace minerals and inorganic minerals on feed conversion ratio (FCR) in different treatment groups of sonali birds

Feed conversion ratio	Treatment groups				
	T_0	T_1	T_2	T_3	Level of significant
7th Days	1.14 ± 0.00	1.13 ± 0.01	1.13 ± 0.03	1.12 ± 0.02	NS
14th Days	1.70 ± 0.14	1.59 ± 0.01	1.67 ± 0.03	1.59 ± 0.02	NS
21st Days	1.92 ± 0.09	2.03 ± 0.07	2.05 ± 0.06	1.92 ± 0.07	NS
28th Days	1.61 ± 0.04	1.53 ± 0.03	1.56 ± 0.03	1.50 ± 0.06	NS
35th Days	2.09 ± 0.09^{c}	1.93 ± 0.10^{b}	2.06 ± 0.06^{c}	1.79 ± 0.02^{a}	*
42th Days	2.25 ± 0.08^{c}	2.13 ± 0.02^{ab}	2.26 ± 0.03^{c}	2.01 ± 0.04^{a}	*
49th Days	2.76 ± 0.07^{c}	2.44 ± 0.05^{b}	2.45 ± 0.10^{b}	2.21 ± 0.07^{a}	*
56th Days	2.74 ± 0.00^{c}	2.64 ± 0.05^{b}	2.59 ± 0.01^{b}	2.40 ± 0.09^{a}	*
60th Days	2.66 ± 0.07^{d}	2.59 ± 0.06^{b}	2.62 ± 0.02^{c}	2.56 ± 0.04^{a}	*
(1-60th) Days	2.18 ± 1.01^{d}	2.06 ± 1.21^{b}	2.12 ± 1.19^{c}	1.96 ± 0.69^{a}	*

Values are expressed as mean ± standard error of means (SEM). NS: Statistically not significant (P>0.05). a b c d means having different superscript in the same row differed significantly (P<0.05)*indicates 5% level of significance.

Effect of dietary supplementation of Organic trace minerals and Inorganic minerals on carcass characteristics of sonali birds

Live weight and carcass weight (g)

The effect of organic trace minerals and Inorganic minerals on live weight and carcass weight is shown in table 7. It showed that live weight (g) and carcass weight (g) differed significantly (P<0.01) among the dietary treatment groups. The highest live weight was found in treatment group T3 (857.67±2.52) followed by T1 (806.33±0.88), T2 (782.00±1.15), and T0 (741.00±1.15). The T3 (604.33±1.76) group had significantly (P<0.01) higher carcass weight compared to T0 (487.33±0.88) whereas T1 and T2 had (547.00±1.15) and (525.67±1.20) respectively.

Breast, thigh muscle and drumstick weight, liver, heart, gizzard and wings weight (g)

Breast weight differed significantly (P <0.01) among the dietary treatment groups shown in table 7. The highest breast meat weight was found in T3 (129.00± 2.08) and the lowest in T0 was (96.67 0.88), whereas T1 (115.33± 1.45) and T2 (106.67± 1.45). The thigh meat weight and drumstick weight were also significantly (P 0.01) different among the dietary treatment group presented in Table 6. The highest drumstick + thigh meat weight was in T3 (225.00 ±1.53), and the lowest in control group T0 (184.67± 0.88), whereas T1 (206.67± 0.88), and T2 (197.33±1.20). Table 6 showed that there is no effect of organic trace minerals and Inorganic minerals on liver, heart, gizzard, and wings weight of broiler

Table 7. Effect of dietary supplementation of organic trace minerals and inorganic minerals on carcass characteristics in different treatment groups of Sonali birds

Carcass yield	Treatment groups T_0	T_1	T_2	T_3	Level of significant
Live weight (g)	741.00 ± 1.15^a	806.33 ± 0.88^c	782.00 ± 1.15^b	857.67 ± 2.52^d	**
Carcass weight (g)	487.33 ± 0.88^a	547.00 ± 1.15^c	525.67 ± 1.20^b	604.33 ± 1.76^d	**
Breast (g)	96.67 ± 0.88^a	115.33 ± 1.45^c	106.67 ± 1.45^b	129.00 ± 2.08^d	**
Drumstick+ thigh (g)	184.67 ± 0.88^a	206.67 ± 0.88^c	197.33 ± 1.20^b	225.00 ± 1.53^d	**
Thigh (g)	120.33 ± 0.88^a	134.00 ± 1.15^c	125.00 ± 1.15^b	145.00 ± 0.58^d	**
Drumstick (g)	64.00 ± 0.58^a	77.00 ± 0.58^c	73.33 ± 1.45^b	84.00 ± 0.58^d	**
Liver (g)	28.00 ± 0.58	26.50 ± 0.15	27.00 ± 0.58	26.00 ± 1.15	NS
Heart (g)	7.67 ± 0.09	6.47 ± 0.26	7.37 ± 0.15	6.63 ± 0.22	NS
Gizzard (g)	43.00 ± 0.58	43.00 ± 1.15	40.00 ± 0.58	46.67 ± 0.88	NS
Wings (g)	53.00 ± 0.58	57.00 ± 0.58	52.33 ± 0.88	57.67 ± 1.45	NS

Values are expressed as mean ± standard error of means (SEM). NS: Statistically not significant (P>0.05). a b c d means having different superscript in the same row differed significantly (P<0.05)**indicates 1% level of significance.

Table 8. Effect of dietary supplementation of organic trace minerals and inorganic minerals on fecal materials determination in different treatment groups of sonali birds

Parameters	Treatment groups T_0	T_1	T_2	T_3	Level of significant
Moisture%	13.17 ± 0.21	12.83 ± 0.49	12.17 ± 0.30	13.17 ± 0.45	NS
Dry Matter%	86.83 ± 0.21	87.17 ± 0.49	87.83 ± 0.30	86.83 ± 0.45	NS
Total Ash%	18.16 ± 0.47	17.33 ± 0.35	17.60 ± 0.20	17.50 ± 0.45	NS
Calcium%	2.18 ± 0.02	2.10 ± 0.07	2.17 ± 0.03	2.17 ± 0.03	NS
Phosphorous%	1.87 ± 0.18^a	2.80 ± 0.12^b	3.02 ± 0.09^c	2.65 ± 0.20^b	*

Values are expressed as mean ± standard error of means (SEM). a b c means having different superscript in the same row differed significantly (P<0.05).*indicates 5% level of significance.

pH and drip loss of meat

The average pH from the meat of slaughtered birds was recorded at 4.4 after 1 hour of slaughtering. Average drip loss was recorded at 1 g and 2 g from the experimental meat, which were stored in the refrigerator after 24 hours and 48 hours, respectively.

Fecal materials determination

Faecal material excretion feed supplemented with organic trace minerals and inorganic minerals is shown in table 8. Excretion of moisture, dry matter, total ash, and calcium was not significant among the different treatment groups. But excretion of phosphorus was significantly (P <0.05) higher in the treatment group T2 than other treatment groups.

Cost effectiveness of production

Cost-effective analysis of production performance of sonali birds supplemented with organic trace minerals and inorganic minerals is shown in Table 9. At the end of the experiment, total production cost per bird was found to be significantly (P < 0.05) different among the experimental groups. Total production cost per bird: T0 (153.39±0.47), T1 (156.31±0.13), T2 (155.93±0.06) and T3 (157.79±0.31). Net profit was found to differ significantly (P<0.01) differed among the experimental groups. It showed that net profit per bird (Tk.) in the T3 group had the highest profit (39.47±0.80) and the lowest profit was found in T0 (17.04±0.20) whereas T1 (29.15±0.76) and T2 (23.93±1.17). Benefit over control was found to significantly (P < 0.01) differ among the experimental groups. Benefit over control among T1 group (12.11±0.89), T2 group (6.89±1.33) and T3 group (22.43±0.67) were significantly (P< 0.01) differed from the control group.

Table 9. Effect of dietary supplementation of organic trace minerals and inorganic minerals on cost analysis in different treatment groups of Sonali birds

Carcass yield	Treatment groups				
	T_0	T_1	T_2	T_3	Level of significant
Cost / bird (Tk)	25.00 ± 0.00	25.00 ± 0.00	25.00 ± 0.00	25.00 ± 0.00	NS
Avg. feed consumed (kg/bird)	1.57 ± 0.01	1.61 ± 0.00	1.61 ± 0.00	1.63 ± 0.01	NS
Feed price (Tk/kg)	53.00 ± 0.00	53.00 ± 0.00	53.00 ± 0.00	53.00 ± 0.00	NS
Cost of A-vaila z/m (Tk/ bird)	0.00 ± 0.00^{a}	0.80 ± 0.06^{b}	0.00 ± 0.00^{a}	0.80 ± 0.06^{b}	*
Cost of Rena Grower premix (Tk/ bird)	0.00 ± 0.00^{a}	0.00 ± 0.00^{a}	0.60 ± 0.06^{b}	0.60 ± 0.06^{b}	*
Feed cost (Tk/bird)	83.39 ± 0.47^{a}	85.51 ± 0.18^{bc}	85.33 ± 0.00^{b}	86.39 ± 0.31^{c}	*
Miscellaneous (Tk/ bird)	45.00 ± 0.00	45.00 ± 0.00	45.00 ± 0.00	45.00 ± 0.00	NS
Total cost / sonali (Tk)	153.39 ± 0.47^{a}	156.31 ± 0.13^{b}	155.93 ± 0.06^{b}	157.79 ± 0.31^{c}	*
Average live weight (kg)	0.74 ± 0.00^{a}	0.81 ± 0.00^{c}	0.78 ± 0.00^{b}	0.86 ± 0.00^{d}	**
Sale price / kg live wt (Tk)	230.00 ± 0.00	230.00 ± 0.00	230.00 ± 0.00	230.00 ± 0.00	NS
Sale price /Sonali (Tk)	170.43 ± 0.48^{a}	185.46 ± 0.88^{c}	179.86 ± 1.13^{b}	197.26 ± 0.93^{d}	**
Net profit / Sonali (Tk)	17.04±0.20^{a}	29.15 ± 0.76^{c}	23.93 ± 1.17^{b}	39.47 ± 0.80^{d}	**
Benefit over control / sonali (Tk)	0.00±0.00^{a}	12.11±0.89^{c}	6.89 ± 1.33^{b}	22.43 ± 0.67^{d}	**

Values are expressed as mean ± standard error of means (SEM). NS: Statistically not significant (P>0.05). * Indicates 5% level of significance. **indicates 1% level of significance.

Discussions

Live weight and live weight gain

Organic trace minerals -supplemented group T1 showed a better result than inorganic minerals -supplemented group T2. The results of the present study seem similar to the findings of Vieira et al. (2020), who reported that improvements in broiler growth performance are usually observed at lower levels of organic trace element additions. In a recent study with White Pekin broiler ducks, Attia et al. (2013) evaluated the efficacy of inorganic (ZnO) and organic (Bio-Plex®) Zn sources added to the diets, and the obtained results indicate that BWG and FCR during the entire trial period (1–56 days of age) were better in birds fed a diet supplemented with ZnO. According to El-Samee et al. (2012), organic zinc has a positive effect on body weight in laying quail. In a study of laying hens, an organic source of manganese (manganese proteinate) produced better results than inorganic manganese sulphate in terms of weight gain and egg quality (Yildiz et al., 2011).

Feed intake (g)

The effect of organic trace minerals and inorganic minerals on feed intake of Sonali birds in this study, it was observed that the feed intake from 21st days to 60th days of age significantly differed (P<0.05) among the dietary treatment groups. But the total feed intake was statistically not significant (P>0.05). Total feed intake was lowest in dietary group T0 (1561.99±19.61 g) and highest in dietary group T3 (1634.32±14.28 g). These results agreed with Cao et al. (2000), who reported increased daily feed intake in birds supplemented with organic zinc and other minerals compared to birds supplemented with inorganic zinc and other minerals. Zinc and other mineral deficiency adversely affect protein and carbohydrate metabolism in animals, resulting in reduced feed intake, reduced growth, decreased FCR, abnormal immunological and reproductive processes, and skeletal and skin problems (Underwood and Suttle, 1999).

Feed Conversion Ratio (FCR)

It was found that the organic trace minerals + inorganic minerals supplemented group (T3) showed the best but lower FCR, and the control diet-supplemented group (T0) showed a higher FCR. organic trace minerals supplemented group T1 had (2.06±1.21) and inorganic minerals supplemented group T2 had (2.12±1.19). This result is in agreement with the result obtained by Vieira et al. (2020), who demonstrated that organic chelated trace minerals, even at substantially lower uptake rates, show improved FCR, viability, and growth compared to inorganic trace minerals supplied at equal or higher uptake rates. This is in accordance with similar results previously reported by several authors (Leeson and Caston, 2008; Bao et al., 2007; Nollet et al., 2007; Abdallah et al., 2009; Gheisari et al., 2010). The highest total feed conversion was observed in birds fed diets with the highest levels of added mineral forms of the element at various times during the experimental period. These results are consistent with a previous report that showed that supplementing a basal diet with Zn from A-vaila®zn, an aminoacid zinc complex, improved feed conversion without altering growth rate (Burrell et al., 2004). Proteinates are mineral-chelated proteins/peptides/amino acids with comparable bioavailability to short peptides and amino acids, making them ideal for creating diets with low trace mineral levels (Klis & Kemme,2002). Organic mineral sources enhance intestinal trace element absorption by reducing interference from insoluble complexes with ionic trace elements (Leeson, 2003).

Carcass yield characteristics

There was no effect of organic trace minerals and inorganic minerals on liver, heart, gizzard, and wings weight of broiler among the different treatment groups. The findings of the present study are in agreement with El-Husseiny et al. (2012), who showed that partial replacement (50%) of inorganic sources of Zn (ZnO), Mn (MnO), and Cu (CuSO4) with organic forms of these trace elements (Zn protein, Mn methionine hydroxy analogueue chelate, and Cu methionine hydroxy analogueue chelate) improved growth performance and carcass characteristics and decreased trace element levels in tibia, liver, and excreta. Manangi et al. (2012) reported that the simultaneous replacement of inorganic Zn, Cu, and Mn sulphates with significantly reduced levels of organic sources of these trace elements (complexed with 2-hydroxy-4-(methylthio) butanoic acid Mintrex) not only adversely affected the performance and slaughter yield but also significantly reduced trace element concentrations in litter. Gheisari et al. (2010) reported that dietary treatments had only a significant ($P<0.05$) effect on carcass yield at 49 d of age. Birds fed Zn, Mn, and Cu in sulphate forms (E treatment) significantly ($P<0.05$) had a higher carcass yield than those fed oxide forms of Zn, Mn, and Cu.

pH and drip loss of meat

The average pH from the meat of slaughtered birds was recorded at 4.4 after 1 hour of slaughtering. Average drip loss was recorded at 1 g and 2 g from the experimental meat, which were stored in the refrigerator after 24 hours and 48 hours, respectively, which was non-significant. These results are in good agreement with Lu et al. (2006), who reported that diets supplemented with organic mineral sources did not affect pH, drip loss, or share forces.

Intestinal material determination

Faecal material excretion feed supplemented with organic trace minerals and inorganic minerals showed the excretion of moisture, dry matter, total ash, and calcium was not significant among the different treatment groups. But excretion of phosphorus was significantly ($P <0.05$) higher in the treatment group T2 than other treatment groups, with lower excretion found in the T0 group. Lower excretion of calcium was found in organic trace minerals supplemented group T1 (2.10±0.07) which gives a better result than other treatment groups. The present study supports the finding of Swiatkiewicz et al. (2014), who stated that the use of organic trace elements can reduce the excretion of minerals in faeces, thereby reducing the negative environmental impact of intensive poultry production. The result also agreed with Zafar and Fatima (2018). Zafar and Fatima (2018) reported that it reduced environmental pollution by reducing trace mineral emissions in bird droppings. The most commonly used and evaluated organic forms in poultry are zinc, copper, and manganese amino acid complexes, proteins, and chelates. Most of the discussed studies have indicated the positive effects of organic minerals over inorganic in both broilers and layers. The main benefit is their lower inclusion rates due to their better absorption and low output in excreta. The low addition of trace elements in this study resulted in lower concentrations of Cu, Zn, and Mn in the faeces and thus lower concentrations in the litter, which have been reported before in other trials (Bao et al., 2007; Leeson and Caston, 2008). According to Wang et al. (2018), mineral removal rates with each organic treatment were generally lower than the commercial ITM treatment. OTM also decreased the concentration of Cu ($P < 0.05$) and Zn in the excreta compared with ITM.

Cost effectiveness of production

The present result showed that net profit significantly ($P< 0.01$) differed among the experimental groups. It showed that net profit per bird (Tk) in the T3 group had the highest profit (39.47±0.80) and the lowest profit was found in T0 (17.04±0.20) whereas T1 (29.15±0.76) and T2 (23.93±1.17). Benefit over control (Tk) among the T1 group (12.11±0.89), T2 group (6.89±1.33) and T3 group (22.43±0.67) were significantly ($P< 0.01$) differed from the control group. The present findings support Zafar and Fatima (2018), who stated This trend towards using organic rather than inorganic sources of minerals in poultry is growing very rapidly. Because they are more bioavailable and efficient, they are said to reduce feed costs through reduced dose rates without adversely affecting performance. According to Abdallah et al. (2009), the organic mineral diet has had a positive impact on the economy. It concluded that replacing inorganic minerals with organics improves bird performance and chick immune responses.

Conclusions

The results showed significant differences in daily live weight gain, final body weight, feed intake, feed efficiency, and benefits over control. This study finds that sonali chicken farmers in Bangladesh can use organic trace minerals and inorganic minerals alongside basal feed for better production. The study suggests that using organic trace minerals and inorganic minerals combined can improve Sonali chicken production.

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Conflicts of interest

The authors declare that there are no conflicts of interest.

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