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Effect of dietary inclusion of nano-chromium and phytase enzyme on growth performance and carcass quality of broiler chickens

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Abstract
This study was conducted to investigate the effects of dietary supplementation of nano-chromium and phytase enzyme on the performance and carcass characteristics of broiler chickens. A total of 240 day-old broiler chickens (Vencobb-430) were assigned to eight treatment groups according to a completely randomized design. Each treatment consisted of three equal replicates, each contained ten chicks. Chicks were fed on basal diets supplemented with different concentrations of nano chromium without and with phytase at the level of 0, 400ppb Nano-cr, 800 ppb Nano-cr, 1600ppb Nano-cr and with phytase at the level of 250FTU Phytase, 400ppb Nano-Cr+250 FTU Phytase, 800ppb Nano-Cr+250 FTU Phytase and 1600 Nano-Cr+ 250 FTU Phytase, respectively, for period of 42days. Dietary nanochromium (800ppb) supplementation with phytase (250ftu) increased final body weight (BW) at the end of the experimental period (6 weeks). Average weight gain was significantly (P<0.05) higher in chickens fed on nano chromium and phytase supplemented diet. Feed intake was also significantly (P<0.05) improved by incorporation of nanochromium with phytase in basal diet. However, the efficiency of feed conversion was better in treatment group T_2 which fed with 400ppb nano chromium. Carcass traits such as dressing and eviscerated percentage was significantly (P<0.05) greater in T_4 (Nano chromium supplemented @ 1600ppb) treatment group. Defeathered weight was increased in treatment group which was supplemented with nano chromium (1600ppb) with phytase. Cholesterol level and ether extract in meat was also significantly (P<0.05) decreased in nano chromium supplemented groups in comparison to control group and phytase supplemented group. The present results suggest that dietary chromium supplementation with phytase improved growth performance and increasing level of nano chromium in diet may produce lean meat with decreasing muscle cholesterol and fat percentage.

Keywords: nano chromium, phytase, growth performance, lean meat

Introduction
Micronutrients are vital components in poultry diet and have a high degree of nutritional importance. Trace elements are often found in bound form in natural feedstuffs which renders them unavailable to utilization for bird or may not be in adequate concentrations. Hence, it is needed in the diet and most of the minerals must be incorporated to the diet for optimal growth and egg production.
Most poultry diets are corn-soybean based diet, which have usually low content of chromium [1]. Chromium (Cr) is an essential micro element that plays an important role in nutrition of animal and human being [2]. Chromium exists in nature mostly in the trivalent form (Cr^{+3}), which is considered to be essential for activating certain enzymes and for stabilizing proteins and nucleic acids [3]. The Chromium helps in metabolism of fat, carbohydrates and protein in animals. It is also integral part of an organometallic molecule known as glucose tolerance factor (GTF) which is potentiating of insulin metabolism [4]. The Chromium deficiency impairs the glucose tolerance and cause the immuno-suppression in the body that may lead susceptible to the disease and even death [5]. Inclusion of Chromium can improve the bioavailability of other minerals [2]. It can play important role in decreasing the cholesterol level of blood, blood plasma, muscles and egg yolk [6]. It is needful trace element which is important for physiological and nutritional activity [7]. Chromium has a potent hypocholesteremic and antioxidant properties and has useful impacts on feed utilization, antioxidant defense system, immune response, lean carcass quality, growth and production indices and quality of egg [8].

Nanoparticles exhibit new electrical, magnetic and biological properties due to its nano metric scale size [9]. It was noticed as a critical factor influencing nutrient uptake [10]. According to previous work, chromium nanoparticles were shown to produce beneficial effects on growth performance, body composition, resulting in increases in tissues Cr concentration in selected muscles. Additionally, their effects have been shown on enhancement of Cr digestibility and absorption in rats when supplemented with 200 ppb Nano Cr as well as altering certain blood metabolite concentrations [11, 12]. Wang and Xu (2004) [13] observed that on supplementation of 200μg/kg chromium nanoparticles (NanoCr) produce beneficial effects on carcass characteristics, pork quality and individual skeletal muscle weight, with higher tissue chromium deposition in selected muscle and organs compared to control group, which implicated higher absorption and bioavailability of nano size chromium.

An important consideration for phosphorus in most feedstuffs used in broiler diets is that present in the form of phytate which is unavailable for utilization. Because of phytic acid acts as an anti-nutritional factor by binding proteins and chelating minerals and reduces their bioavailability in chickens. Phytase were originally proposed as an animal feed additive to enhance the nutritional value of low quality plant material in feed for single-stomached animals by liberating phosphate [14]. It is an enzyme that hydrolyzes phytic acid to inositol and inorganic phosphate. Exogenous microbial phytase is a common ingredient added to broiler diets to improve availability of phytate phosphorous because that enzyme is at a low level in the chicken gastro-intestinal tract [15]. On supplementation of exogenous microbial phytase, utilization of phosphate from phytate phosphorus was improved and phosphate pollution was decreased [16, 171, 18, 19]. On supplementation of phytase, the nutritional value of plant-based feeds can be improved by enhancing protein digestibility and improving digestive health of animals [16, 20]. Selle *et al.* (2006) [21] observed that phytase improved mineral utilization as well as metabolizable energy value (1.5–3.0%).

Hence, the present study aimed to compare the effect of Nano chromium and phytase enzyme supplementation on growth performance and carcass quality of broilers from 1 to 42 days of age.

Materials and Methods

Birds, housing and management

For the experiment, 240 male VENCOBB-430 day-old broiler chicks were procured from commercial hatchery and weighed initially and then randomly distributed into 8 experimental groups of 30 chicks per treatment with three replicates of ten chicks in each. The birds distribution was under complete randomized design. The feeding trial was lasted for period of six weeks. Birds were reared under deep litter system with proper standard manage mental practices i.e., brooding, feeding, lighting and watering throughout the trial period. Broiler chickens had free access to feed and water throughout and were maintained on a constant light for 24-hours. All chickens were vaccinated with ND vaccine (F1 strain) against Ranikhet disease on 7th day, IBD vaccine on 14th day against Infectious Bursal disease and ND vaccine (Lasota strain) booster on 28th day. Chicks were checked twice daily for mortality, if any.

Experimental diets

The basal diets were formulated to meet the recommendations of the bureau of Indian standards (BIS, 2007). Chickens in eight treatments were fed three phases: 1st phase was broiler pre-starter from (1st to 7th day), 2nd phase was broiler starter (8th day to 21st day) and finisher (22nd to 42nd day). Supplementation of nano-chromium particles and phytase with dietary levels of 0, 400, 800, 1600 ppb Nano-Cr, 250FTU Phytase, 250FTU+400ppb, 250FTU+800 ppb and 250FTU+1600 ppb of feed and were used to make eight experimental diets T_1, T_2, T_3, T_4, T_5, T_6, T_7 and T_8, respectively. Chromium nano particles (CAS No. 7440-47-3) were purchased from Nano Research Elements, New Delhi and Phytase enzyme was procured from local market and mixed with the experimental diets. Broiler chicks were offered water and feed at *ad-libitum*. The ingredients of pre-starter, starter and finisher di*et al.*ong with their composition have been shown in given Table 1.

Growth performance

Feed intake was recorded from all replicates of each dietary treatment. It was calculated daily and weekly basis. Weekly body weight was recorded for all broiler chicken replicate wise. On the basis of feed intake and the body weight, feed conversion ratio was determined for all treatment groups on weekly basis.

Carcass evaluation

On the 42nd day of age, randomly six birds were selected from each treatment for evaluation of carcass characteristics and visceral organs. Prior to slaughter, feed was withheld for six to eight hours to emptying of gastrointestinal tract. Effect of nano chromium particles and phytase enzyme on carcass quality was measured in terms of muscle proximate and cholesterol level in meat muscle.

Ethical approval

The study was conducted after approval of research committee and institutional ethics committee (registration no: 330/GO/Re/SL/01/CPCSEA).

Statistical analysis

The obtained data were statistically assessed by the analysis of variance (ANOVA) through General Linear Model procedure of SPSS (22.0) software considering replicates as experimental units and the values were expressed as means ± standard error. Duncan's multiple range test (DMRT) (Duncan 1955) [22] was used to test the significance of difference between means by considering the differences significant at $P<0.05$.

Results

Growth performance

The effects of different treatments on body weight, weight gain, feed intake and feed conversion ratio (FCR) throughout the experiment are presented in Table 2.

During starter phase, treatment group T_3 (supplemented with 800ppb Nano Cr) has significantly higher body weight and daily weight gain in comparison to T_1 (Control) and other treatment group but treatment group T_7 had a highest final body weight and weight gain during the experiment period (d 21-42) and throughout feeding trial (d 0-42) among different treatment groups which was significantly differ from T_1 (Control), T_2, T_5 and T_6 treatment groups. Weight gain was ($P<0.05$) significantly improved with supplementation of Nano chromium and phytase enzyme the different treatment groups than control group during starter, finisher and entire experiment period.

During starter phase, feed intake significantly decreased among different experimental groups in comparison to control group. Lowest feed intake was found in T_2 treatment group among different treatment groups which was supplemented with 400 ppb Nano Cr. During finisher phase, feed intake was significantly increased with supplementation of Nano chromium and phytase enzyme in comparison to control group. Overall highest feed intake was recorded in T_7 which was (P<0.05) significantly differ from control and other treatment groups.

FCR value was found lowest in T_2 group which was significantly (P<0.05) better in comparison to T_1 (control), T_5, T_6 and T_7 groups during entire period of experiment.

During starter phase, performance index value was found significantly (P<0.05) higher in T_4 treatment group than T_1 (control) and T_5 while during finisher, performance index value was found higher in T_2 treatment group. Overall highest performance index value was recorded in T_2 treatment group which was significantly (P<0.05) differ from T_1 (control), T_5 and T_6 group.

Meat quality parameters

Statistical analysis of data on carcass traits relative to the live weight of broiler chickens is presented in Table 3 and revealed that dressing percentage with and without giblet was found greater in T_4 treatment group than other treatment group. The mean value of dressing percentage without and with giblet was significantly (P>0.05) different for experimental groups T_4 compared with the group T_5, T_1 andT_5, respectively. Similarly, eviscerated percentage was also recorded higher in T_4 treatment group among experimental group and significantly (P>0.05) greater than treatment group T_5. Defeathered percentage was not affected by dietary supplementation of nano chromium and phytase.

Analysis of data revealed that the breast and thigh muscle moisture, protein and total ash percentage at 6 weeks of age did not differ significantly among the treatment groups by supplementing Nano chromium and Phytase enzyme. It was observed that a non-significant increase in protein accretion in broiler meat when 800ppb/kg nano chromium was supplemented with phytase in broiler diet.

The mean value of breast and thigh muscle ether extract percentage showed a significant (P<0.05) reduction in treatment groups T_3, T_4 and T_7, than other treatment groups. Significantly lower muscle ether extract levels of 16.42, 16.48 and 17.21 per cent were recorded in breast muscle of birds supplemented with 800 ppb, 1600 ppb Nano Cr and 800 ppb Nano Chromium with 250 ftu phytase per kg diet, respectively. Similarly, significantly lower thigh muscle ether extract percentage of 16.94, 17.08 and 17.79 were observed in birds received 800 ppb, 1600 ppb Nano Cr and 800 ppb Nano Chromium with 250 ftu phytase per kg diet, respectively. The control group recorded the highest breast and thigh ether extract muscle content of 18.76. The other treatment groups recorded intermediate muscle ether extract in both breast and thigh muscle ether extract content at six weeks of age, with no significant difference. Analysis of variance of data on breast and thigh muscle total cholesterol showed a significant (in P<0.05) reduction in Nano chromium and phytase supplemented groups than control group. The birds supplemented with 1600ppb Nano chromium per kg diet (T_4) recorded lowest breast muscle cholesterol level of 61.73 mg percent while control group (T_1) had significantly (P<0.05) high breast meat cholesterol level of 77.67 mg per cent. The other treatment groups (T_2, T_3, T_6, T_7 and T_8) recorded the intermediate levels, which were also significantly (P<0.05) lower than control group. Similarly, the broilers fed diet with 1600 1600ppb Nano chromium per kg diet (T_4) had significantly (P<0.05) less thigh muscle cholesterol (91.38 mg per cent) followed by T_8 (92.43 mg per cent), T_3 (95.31 mg per cent) T_7 (96.11 mg per cent), T_2 (97.56 mg per cent) and T_6 (98.04 mg per cent) as compared to control group (106.67mg per cent) and T_5 treatment groups (106.26 mg per cent). However, the total cholesterol in breast and thigh muscle significantly lowest in T_4 and T_8 among Nano chromium and phytase supplemented groups.

Table 1: Basal diets of broiler Pre-starter, starter and broiler finisher.

Ingredients	Pre-starter (%)	Starter (%)	Finisher (%)
Yellow Maize	51.25	52.25	55.5
Deoiled soybean	29.25	28.75	26.25
Groundnut cake-solvent extracted	10.6	9.5	7.75
Rice polish	5.0	4.5	4.25
Dicalcium Phosphate	1.00	1.00	1.00
Vegetable Oil	1.879	2.98	4.345
Lysine	0.15	0.14	0.13
DL- methionine	0.3	0.3	0.3
Choline Chloride	0.05	0.05	0.05
Hepatocare	0.1	0.1	0.1
Mineral mixture[1]	0.2	0.2	0.2
Common salt	0.15	0.15	0.15
Vitamin Premix[2]	0.025	0.025	0.025
coccidiostats	0.05	0.05	0.05
Proximate Analyses			
Dry Matter (%)	90.73	91.20	92.09
Crude Protein (%)	21.39	20.76	19.29
Ether Extract%	4.47	7.07	7.18
Crude Fiber%	4.41	4.34	4.29
NFE%	60.68	59.46	62.18
Total Ash	9.05	8.37	7.06
ME (kcal/kg)	2975.08	3011.13	3113.53

[1]Mineral premix supplied per kilogram contain: Fe (Fe2 (SO4)3) 153 mg; Mn (MnSO4) 200 mg; Cu (CuSO4)17.60 mg; Zn (ZnO) 105.6 mg; Mg (MgSO4) 25.3 mg; Co (Co SO4) 0.4 mg; I (KI) 0.057 mg; Se (Na2SeO3) 0.25 mg.

[2]Vitamin premix supplied per kilogram contain: Vitamin-A 12,500 IU; Vitamin-D3 25,000 ICU; vitamin-E 2,000 IU; Vitamin-K 250 mg; B1 200 mg; B6 300 mg; B_{12} 12 mg; B5 120 mg; B3 350 mg; biotin 200 µg; folic acid 100 mg.

Table 2: Effects of nano chromium and phytase supplementation on body weight, average daily gain (ADG), feed intake (FI), and feed conversion ratio (FCR) in broiler chickens

Period	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8
Body Weight (BW)								
21day	679.10±5.59^{bcd}	666.91±5.85^{d}	717.53±5.66^{a}	700.14±5.24^{ab}	671.81±5.72^{cd}	682.29±5.23^{bcd}	693.20±5.15^{bc}	692.89±5.64^{bc}
42day	1794.53±18.98^{c}	1804.33±14.95^{c}	1963.83±13.89^{a}	1909.76±25.58^{ab}	1802.20±19.09^{c}	1842.04±26.95^{bc}	1973.51±16.03^{a}	1939.80±19.82^{a}
Daily Weight Gain								
0-21d	636.03±5.64^{b}	623.85±5.92^{b}	674.47±5.60^{a}	638.66±5.13^{ab}	628.74±5.88^{cb}	639.22±5.28^{ab}	650.10±5.34 ^{ab}	649.83±5.81 ^{ab}
21-42d	1115.44±19.45^{c}	1137.42±16.42^{bc}	1246.50±15.31^{a}	1209.63±24.41^{ab}	1131.75±18.81^{bc}	1159.75±25.56^{bc}	1280.32±16.73^{a}	1245.92±19.82^{a}
0-42 d	1751.47±18.86^{c}	1761.27±14.93^{c}	1921.00±13.91^{a}	1866.80±24.13^{ab}	1759.23±19.12^{c}	1798.97±25.51^{bc}	1930.42±16.07^{a}	1896.69±18.92^{a}
Feed Intake								
0-21d	1040.13±6.65^{a}	873.00±7.46^{e}	1013.40±6.81^{ab}	899.87±6.11^{de}	982.13±7.10^{bc}	984.47±6.69^{bc}	936.93±7.86^{d}	969.34±8.60^{bc}
21-42 d	1936.67±20.76^{d}	1761.80±9.90^{e}	2164.90±19.27^{b}	2068.62±9.22^{c}	2067.80±12.41 ^{c}	2062.11±12.95^{c}	2401.97±11.97^{a}	2185.38±9.93^{b}
0-42 d	2976.80±21.10^{d}	2634.80±15.10^{e}	3179.78±22.04^{b}	2996.45±10.05^{cd}	3049.74±13.90^{c}	3046.58±14.87^{c}	3338.90±11.99^{a}	3153.09±18.18^{b}
FCR								
0-21d	1.64±0.02^{a}	1.40±0.02^{d}	1.51±0.02^{bc}	1.41±0.01^{d}	1.57±0.02^{ab}	1.54±0.02^{b}	1.44±0.02^{cd}	1.50±0.02^{bc}
21-42d	1.75±.04^{ab}	1.56±0.02^{d}	1.75±.02^{ab}	1.73±.04^{b}	1.84±.04^{ab}	1.80±.04^{ab}	1.89±.03^{a}	1.77±.03^{ab}
0-42 d	1.71±.02^{a}	1.50±.01^{bc}	1.66±.01^{ab}	1.61±.02^{b}	1.74±.02^{a}	1.70±.03^{a}	1.73±.02^{a}	1.67±.02^{ab}
Performance Index(PI)								
0-21d	390.48±7.75^{c}	447.27±8.14^{a}	450.26±7.92^{a}	454.93±9.69^{a}	403.88±7.69^{bc}	416.87±8.40^{abc}	452.94±8.54^{a}	437.99±9.38^{ab}
21-42d	651.01±23.86^{ab}	738.38±19.90^{a}	719.79±16.69^{ab}	716.01±28.47^{ab}	625.53±21.23^{b}	660.90±27.34^{ab}	686.45±18.30^{ab}	716.11±23.97^{ab}
0-42 d	1036.33±24.27^{c}	1179.54±18.10^{a}	1163.00±16.58^{ab}	1169.16±30.69^{ab}	1018.61±22.02^{c}	1068.46±29.20^{bc}	1118.87±19.34^{abc}	1144.87±24.23^{ab}

^{abcd} Different superscript letters indicate significant differences on each row at $P<0.05$

Table 3: Carcass characteristics and chemical composition of breast muscles, leg muscles and cholesterol of broiler chicken at 6 weeks of age as influenced by dietary inclusion of Nano chromium and Phytase enzyme

Parameters	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8
Dressing (%) without giblet	64.43±1.52^{ab}	64.18±0.67^{ab}	64.80±1.01^{ab}	68.77±1.59 ^{a}	63.30±1.22 ^{b}	64.56±0.65^{ab}	66.24±0.57^{ab}	66.57±0.65^{ab}
Dressing (%) with giblet	68.93±1.15^{b}	70.45±0.40^{ab}	70.20±0.91^{ab}	74.22±1.55 ^{a}	69.41±1.41 ^{b}	70.32±0.58^{ab}	72.22±0.76^{ab}	72.88±0.71^{ab}
Eviscerated%	64.43±1.53^{ab}	64.18±.67 ^{ab}	64.80±1.01^{ab}	68.77±1.59^{a}	63.30±1.22^{b}	64.56±.65 ^{ab}	66.24±.57 ^{ab}	66.57±.65 ^{ab}
Defeathered%	89.92±0.67	91.05±0.22	91.36±0.58	91.62±1.11	90.06±1.32	91.98±0.74	91.23±0.25	92.96±0.59
Moisture (%)								
Breast	76.31±1.08	75.93±1.00	75.76±1.30	73.84±1.35	74.46±0.85	74.05±1.27	75.22±1.11	73.55±1.21
Thigh	72.62±1.30	73.07±1.31	72.51±1.10	71.64±1.69	72.25±1.27	71.33±1.50	71.05±1.55	70.80±1.39
Protein (% as dry basis)								
Breast	79.92±0.53	80.11±0.62	80.99±0.54	80.65±0.50	80.03±0.55	80.24±0.39	81.11±0.61	80.47±0.62
Thigh	78.35±1.04	78.54±0.45	79.42±0.75	79.08±0.75	78.46±0.68	78.67±0.61	79.53±0.74	78.90±0.59
Ether Extract (%)								
Breast	18.76±0.16^{a}	18.33±0.21^{a}	16.42±0.28^{b}	16.48±0.20^{b}	18.71±0.15^{a}	18.28±0.28^{a}	17.21±0.17^{b}	18.11±0.20^{a}
Thigh	19.41±0.25^{a}	18.88±0.17^{ab}	16.94±0.31^{c}	17.08±0.31^{c}	19.24±0.14^{a}	18.79±0.26^{ab}	17.79±0.30^{bc}	18.72±0.21^{ab}
Total Ash (%)								
Breast	1.23±0.24	1.45±0.30	1.50±0.28	1.52±0.25	1.17±0.23	1.39±0.27	1.61±0.28	1.31±0.21
Thigh	1.59±0.11	1.86±0.15	1.79±0.11	1.94±0.08	1.53±0.10	1.89±0.12	1.93±0.14	1.63±0.11
Cholesterol (mg percent)								
Breast	77.67±1.76^{a}	67.45±1.56^{b}	65.59±0.91^{bc}	61.73±0.76^{c}	77.14±1.00^{a}	67.69±0.98^{b}	65.23±0.74^{bc}	62.11±1.08^{c}
Thigh	106.67±1.09^{a}	97.56±1.48^{b}	95.31±1.09^{bc}	91.38±1.18^{c}	106.26±0.86^{a}	98.04±0.89^{b}	96.11±0.98^{bc}	92.43±1.05^{c}

^{abc} Different superscript letters indicate significant differences on each row at $P<0.05$

Discussion

There was no literature available, which have shown the effect of dietary Cr and phytase levels and their interaction on growth performance, meat quality and cholesterol level in muscles. The natural presence of Cr in the diets from the raw materials is not sufficient alone to adequately sustain the broiler chicken growth. In our research study, the addition of 800 ppb of nano-chromium with 250ftu phytase to the basal diets increase of feed intake which was responsible for the increased body weight and average daily gain. Feed conversion efficiency improved with supplementation of Nano chromium in diet. Best FCR value found in treatment group T_2 which was supplemented with 400 ppb nano chromium. In the current study, the Nano Chromium supplementation resulted in beneficial effects on feed conversion ratio (FCR) in the experimental period. It is theorized that smaller particle size can be easily absorbed through the intestinal mucosa. In addition, the surface area of particles will increase and then enhance the digestion. Therefore, feed at nanoparticle (nano chromium) scale may improve intestinal absorption. Observation in this study is in agreement with the results observed by Kim *et al.* (1996) [23] that 1,600 µg/kg Cr picolinate supplementation increased the mass gain and feed intake without affecting feed conversion ratio in broilers. Lien *et al.* (1999) [24] observed that supplementation of chromium picolinate @ 800, 1600 and 3200 µg/kg to basal diet of broilers increased body weight gain and feed consumption, whereas, feed efficiency was unaltered. Sahin *et al.* (2003) [25] also recorded that supplementation of chromium picolinate at various levels (0, 200, 400,800, or 1200 ppb) linearly increased in body weight, feed intake and feed efficiency in broilers with increased supplemental chromium levels under heat stress condition. Similar findings observed by Kheiri and Toghyani (2009) [26], wherein, significant improvement observed in body weight in broilers receiving 1600 ppb Cr chromium as CrCl3. Selle *et al.* (2007) [27]; Attia *et al.* (2003) [28]; Revy *et al.* (2004) [29] and Rodehutscord *et al.* (2006) [30] reported that the positive effect of phytase on growth performance of broiler chicken could be attributed to the increase in the availability of others inorganic and organic nutrients.

The dressing percentage and eviscerated percentage increased with nano chromium and phyase supplementation but significantly greater found in 1600 ppb nano Cr supplemented group compared with only phyase supplemented group (T_5). The effect of nano chromium, phytase and their interaction was not significantly observed on defeathered percentage. These results are in line with the previous studies reported by many authors who confirmed the improvements in carcass quality with Cr supplementation (Anandhi *et al.*, 2006 [31]; Sahin *et al.*, 2003 [25]). Broch *et al.* (2018) [32] and Singh *et al.* (2003) [33] did not observe significantly differences by phytase supplementation on carcass characteristics and cuts consistent among treatments and carcass yield of broilers receiving diets supplemented with phytase, respectively.

The effect of nano chromium, phytase and their interaction was not observed on meat moisture, protein percentage and total ash but significant decrease in ether extract and cholesterol of breast and thigh muscle was recorded. The interaction effect was not noticed probably due to high concentration of Cr in the basal diet and low amount of Cr-phytate complexes in these diets. The findings of our study were in accordance to findings of Motozono *et al.* (1998) [34] also reported that muscle protein content was not affected by dietary supplementation of chromium at 200 and 400 ppb in broilers diet. However, Sands and Smith (1999) [35] supplemented 200 and 400µg/ kg Cr picolinate to broilers and observed increased protein and reduced ether extract from thigh and breast muscle under heat stress condition. Similarly, Debski *et al.* (2004) [36] showed that significantly decreased fat content of muscles and cholesterol content in pectoral muscles and liver when supplementation of Cr yeast at 0.2 ppm level to broilers in an industrial farming system. Likewise, Amatya *et al.* (2004) [37] observed a non-significant increase in protein accretion in broiler meat when 0.2 mg/kg chromium was supplemented to broiler diet. Kroliczewska *et al.* (2005) [38] reported cholesterol content of breast and leg muscles was significantly reduced by incorporation at 300ppb and 500 ppb of Cr yeast. Anandhi *et al.* (2006) [31] studied and concluded that dietary supplementation of organic chromium decreased the muscle cholesterol, improved the muscle protein and hence may be used to produce the lean meat. Al-Mashhadani *et al.* (2010) [39] evaluated the effects of supplementing Cr yeast at level of 0.5, 1.0, 1.5 and 2.0 ppm on broiler meat quality and resulted that the protein percentage of breast and thigh meat significantly increased while fat percentage of breast and thigh meat significantly reduced at all levels of chromium yeast supplementation. However, the moisture and ash content of breast and thigh meat were not affected. Attia, *et al.* (2016) [40] studied effect of zinc bacitracin and different doses of fungal and bacterial phytase and not observed any effect on moisture, protein, lipids and ash of meat muscles and Ghosh, *et al.* (2016) [41] reported that supplementation of Mn with phytase to a basal diet had no beneficial effects on growth performance and carcass traits in broiler chickens. Attia *et al.* (2019) [42] also not found any effects of dietary fungal and bacterial phytase supplementation on chemical and physical characteristics of meat.

According to the above description, Nano chromium absorbed more and easier and made a strong impact on performance. Phytase supplementation may increase availability of trace minerals as well as organic minerals.

Conclusion

The use of a combination of nano chromium and phytase enzyme may serve as an attractive means of facilitating nutrient availability for digestion and thus enhance the feeding value for poultry. Supplementation of Nano Cr and Phytase enzyme to chicken improved the body weight, daily gain, feed intake, feed efficiency and meat quality in terms of dressing percentage, eviscerated percentage, muscle protein and decreasing muscle fat and cholesterol level.

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