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Effect of chromium supplementation from different sources on performance of broilers

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Abstract
A feeding trial was carried out to determine effect of chromium supplementation from different sources on performance of broilers. The five treatments were designated as C i.e. control group fed on basal diet and T_1 and T_2 treatment groups supplemented with 200ppb and 400ppb level of chromium picolinate in and likewise T_3 and T_4 treatment group were supplemented with 200ppb and 400ppb level of Chromium chloride in the experimental broiler starter and finisher ration, respectively All the rations formulated for various treatments were made iso-caloric and iso-nitrogenous. Body weight, weight gain, feed consumption and feed conversion ratio (FCR) were measured. Chromium supplementation in diet had a significant effect on Body weight, weight gain, feed consumption and FCR. Looking to the performance of broilers in terms of live body weight gain suggested that inclusion of 400ppb feed of chromium picolinate is quite effective and could be a viable proposition for lucrative rearing of broilers for meat production.

Keywords: Chromium picolinate, chromium chloride, FCR, growth, performance

1. Introduction
India has 1.30 billion people and the number is growing every year. The focus is on "Development" meaning Good Food, Better Health & Better Living conditions to everyone. Healthy food at attractive price will be the issue in focus. Within a span of 25 years, the egg production has gone up to 70 billion from few millions and the broiler production has gone to 3.8 million tons. As per the Annonymas (2012) [1] 19th Livestock census 2012, poultry population of India is 729.2 million and out of which Rajasthan has 8.024 million. Poultry meat production increased from 0.069 million tons in 1961 to 3.725 million tons in 2014. The per capita availability of poultry meat is 2.8 kg; against ICMR recommended level of 11 kg (Prabakaran, 2014; Rajendran *et al*. 2014) [2, 3]. Poultry is the most organised sector in animal agriculture, worth rupees one lakh crores. The growth is 6-8% in layers and 10-12% in broilers per year against the growth of agriculture as a whole, which is around 2.5%. There is scope for enhancing the production. Production is being more organised and move ahead of consumption resulting in optimum prices and with maximum profits.

In nature, Chromium exists mostly in the Cr^{3+} form; it was observed to have antioxidant properties *in vivo* (Tezeuka *et al.* 1991) [4] as well as to be an integral part of activating enzymes and maintaining the stability of proteins and nucleic acids (Borel and Anderson, 1984[5]; Anderson, 1994) [6]. The primary role of Chromium in metabolism is to potentiate the action of insulin through its presence in an organometallic molecule, called the glucose tolerance factor (GTF) (Anderson, 1987 [7]; Sahin *et al.* 2001 [8]; Pechova *et al.* 2002 [9]; Sahin *et al.* 2003) [10]. Chromium (Cr) was recognized as an essential element of diet in mammals by Schwarz and Mertz in 1957 [11].

Research with animals has confirmed that chromium from dietary organic complexes, such as Chromium picolinate (Cr Pic), Chromium nicotinate (Cr Nic) and high-chromium yeast, is absorbed more efficiently than Chromium from inorganic forms. The reasons for the low availability of inorganic sources of Cr^{3+} are numerous and probably related to: the formation of insoluble Chromic oxide; the binding to natural-chelating agents in feedstuffs (such as phytate); the interference by ionic forms of other elements as well as slow or no conversion of inorganic Chromium to the bioactive form (Beitz and Horst, 1997) [12]. There is no specification for Chromium requirements in poultry diets (NRC, 1994) [13], and most poultry diets are composed of plant-origin ingredients, usually low in Chromium (Giri *et al.* 1990) [14].

2. Materials and Methods

2.1 Experimental site

The experiment was conducted at Poultry Farm and Department of Animal Nutrition of College of Veterinary and Animal Science, Bikaner (Rajasthan).

2.2 Experimental design

One hundred and Fifty day-old, unsexed, apparently healthy broiler chicks individually weighed and randomly divided into five groups of 30 chicks each having almost similar average body weight. Each group of 30 chicks was further subdivided into two replicates having 15 chicks each. Identical to standard management practices were followed for each group. Five dietary treatment groups designated at C, T_1, T_2, T_3 and T_4 were formulated by incorporating basal diet with no chromium supplement, Chromium picolinate @ 200ppb, 400ppb and Chromium chloride @200ppb, 400ppb, respectively.

2.3 Ration Formulation

The nutrient composition of experimental starter and finisher rations have been presented in Table 1

Table 1: Proximate composition of experimental starter and finisher ration (% DM basis)

Type of ration	Dry matter	Crude protein	Crude fiber	Ether extract	Nitrogen free extract	Total ash
Starter ration	90.56	21.79	5.37	2.68	63.92	6.58
Finisher ration	90.82	19.22	4.96	3.83	64.99	7.15

2.4 Data collection

a) Body weight (g)

The chicks were weighed individually at the start of the experiment and subsequently at weekly intervals for 6 weeks.

b) Body weight gain (g)

The weekly average live weight gain was calculated from the difference in body weight attained at the end and the start of the concerned period.

c) Average daily body weight gain (ADG)

ADG in grams will be estimated by dividing the total body weight gain by number of days.

d) Feed consumption (g)

Feed consumption of each pen as recorded weekly and average feed intake in gram/chick/week was calculated by dividing the total amount of feed by the number of chicks in the particular pen. Cumulative feed consumption for the experimental period was also recorded.

e) Feed conversion ratio (FCR)

Feed conversion ratio (FCR) was calculated by dividing the cumulative feed intake by body weight gain of chicks for every week.

3. Results and Discussion

3.1 Body weight

The weekly average body weights, for the broiler in the five groups, are presented in Table-1 as well as in figure 1. The comparison of means at I and II weeks for different treatment groups revealed highest body weight in T_2 group which was though comparable with T_3 in statistical terms but significantly higher than rest of the groups. At IV week highest body weight was observed in T_2 group which was comparable with T_1, T_3 and T_4 but significantly higher than C i.e. control. At V week highest body weight was observed in T_1 group which was comparable with other chromium supplemented groups but significantly higher than C i.e. control. At VI week highest body weight was observed in T_2 group which was comparable with T_1 but significantly higher than rest of the groups and lowest body weight was observed in C i.e. control. The improvement in mean body weight due to supplementation of Chromium in study corroborate well with the findings of Lien *et al*. (1999) [15] who reported significant improvement in body weight by supplementation of Chromium picolinate. Mohammed et *al*. (2014) [16] also reported an significant increase in body weight of broilers under heat stress conditions when supplemented with organic and inorganic Chromium.

Table 4.2: Effect of Chromium supplementation on body weight (g) at different weeks

Main effects	Periods (weeks)						
	0	I	II	III	IV	V	VI
C	46.06	160.16^{ab}	424.83^{a}	725.40	1116.33^{a}	1352.58^{a}	1729.55^{a}
T_1	46.10	152.13^{a}	416.73^{a}	725.06	1221.60^{b}	1584.00^{b}	1887.19^{bc}
T_2	46.20	171.87^{c}	449.33^{b}	772.06	1239.23^{b}	1570.93^{b}	1966.06^{c}
T_3	46.20	164.27^{bc}	433.06^{ab}	750.10	1226.00^{b}	1579.55^{b}	1812.76^{b}
T_4	46.06	157.13^{ab}	419.33^{a}	724.83	1197.83^{b}	1574.40^{b}	1849.50^{b}
SEM	0.4558	3.1098	7.9365	13.7852	28.2199	38.2804	29.5299
Significance	NS	S**	S*	NS	S*	S**	S**

a, b, c - Means superscripted with different letters within a column differ significantly from each other.SEM: Standard error of means; NS: Non significant; S**: Highly significant (P<0.01); S*: Significant (P<0.05)

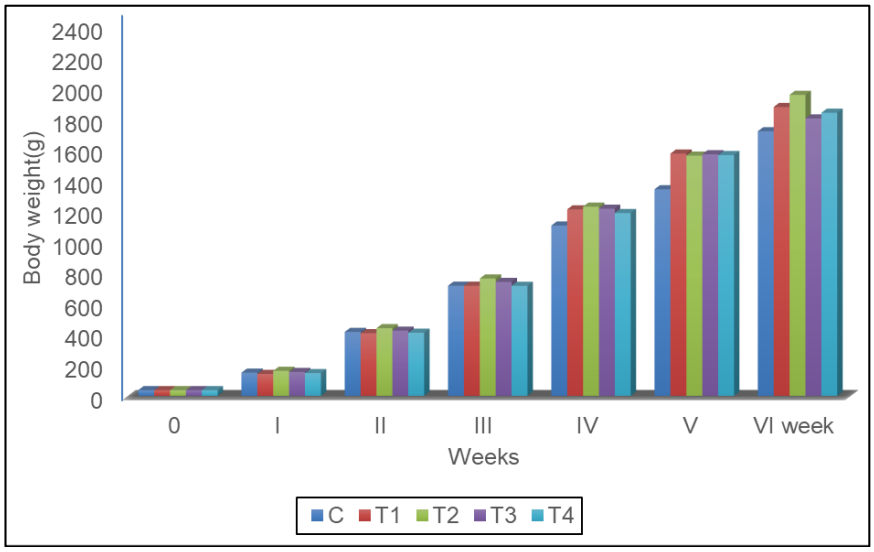

Fig 3: Effect of Chromium supplementation on body weight at different weeks

3.2 Body weight gain

The weekly gain in weight is presented in Table-2as well as in figure 2. The weekly gain in body weight was highly significant (P<0.01) effect of supplementation of Chromium on body weight gain of chicks at I, V and VI weeks and significant (P<0.05) effect at IV week. The overall body weight gain for entire experimental period of six weeks was also highly significant (P<0.01).

Further, the comparison of means at I week for different treatment groups revealed highest body weight gain in T_2 group which was though comparable with T_3 in statistical terms but significantly higher from C, T_1, and T_4. At IV week highest body weight gain was observed in T_1 group which was comparable with T_2, T_3 and T_4 but significantly higher than C i.e. control. At V week highest body weight gain was observed in T_1 group which was comparable with T_2, T_3 and T_4 but significantly higher than C i.e. control. At VI week highest body weight gain was observed in T_2 group which was significantly higher from rest of groups and followed by C, T_1, T_4 and T_3.The body weight gain of entire experimental period of six weeks highest overall body weight gain was observed in T_2 group which was comparable with T_1 in statistical terms but significantly higher from C, T_3 and T_4.

The improvement in mean body weight gain due to supplementation of Chromium in study corroborate well with the findings of Lien *et al.* (1999)[15], who reported dietary supplementation of Chromium picolinate significantly (P<0.05) improve the body weight gain of broiler chicken. Mohammed *et al.* (2014)[16] also reported significant increase in body weight gain of broilers under heat stress conditions when supplemented with organic and inorganic Chromium.

Table 4.4: Effect of Chromium supplementation on body weight gain (g) at different weeks

Main effects	Periods (weeks)						
	0-I	I-II	II-III	III-IV	IV-V	V-VI	I-VI
C	114.10^{ab}	264.66	300.56	410.75^{a}	256.35^{a}	337.59^{c}	1668.67^{a}
T_1	106.03^{a}	264.6	308.33	496.53^{b}	362.40^{b}	290.42^{b}	1789.60^{bc}
T_2	125.66^{c}	277.46	322.73	467.16^{b}	331.70^{b}	386.10^{d}	1897.96^{c}
T_3	117.93^{bc}	268.79	317.03	475.89^{b}	344.07^{b}	236.62^{a}	1694.82^{ab}
T_4	111.06^{ab}	262.20	305.50	473.00^{b}	376.56^{b}	280.28^{ab}	1789.93^{b}
SEM	**3.19958**	**5.6979**	**9.5552**	**18.0827**	**15.8979**	**16.8552**	**37.5512**
Significance	**S****	**NS**	**NS**	**S***	**S****	**S****	**S****

a, b, c - Means superscripted with different letters within a column differ significantly from each other.SEM: Standard error of means; NS: Non significant; S**: Highly significant (P<0.01); S*: Significant (P<0.05)

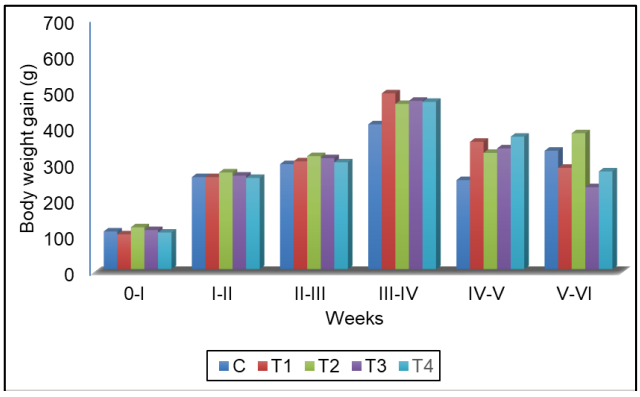

Fig 4: Effect of Chromium supplementation on body weight gain at different weeks

3.3 Average daily body weight gain

The average daily gain in weight is presented in Table-3as well as in figure 3. The average daily gain in body weight was revealed highly significant (P<0.01) effect at I week and cumulative average daily body weight gain for entire experimental period and significant (P<0.05) effect at V week and no significant effect for rest of the weeks was observed by supplementation of Chromium in broiler chicks on average daily body weight gain.

Further, the comparison of means showed that at I week highest average daily body weight gain was recorded in T_2 which was though comparable with T_3 but significantly higher than C, T_1 and T_4 in statistical terms. T_1 group had lowest average daily body weight gain. At II, III, IV and VI week though statistically significant differences could not be

recorded but apparently on observing the average daily body weight gain. The lowest gain was recorded in T_4 and highest gain was recorded for T_2 at II and VI weeks. At III and IV lowest gain was recorded in C i.e.control. At V week highest average daily body weight gain was recorded in T_4 which was though comparable with T_1, T_2 and T_3 but significantly higher than C i.e. control.

Table 4.6: Effect of Chromium supplementation on average daily body weight gain (g) at different weeks

Main effects	Periods (weeks)						
	0-I	I-II	II-III	III-IV	IV-V	V-VI	I-VI
C	16.3^{ab}	37.80	42.93	59.00	36.62^{a}	48.02	39.71^{a}
T_1	15.14^{a}	37.80	44.04	70.93	51.77^{b}	41.48	42.60^{bc}
T_2	17.95^{c}	39.63	46.10	66.73	47.38^{ab}	55.11	45.16^{c}
T_3	16.85^{bc}	38.41	45.32	67.95	48.92^{b}	33.30	40.35^{ab}
T_4	15.86^{ab}	37.45	43.64	67.57	53.79^{b}	41.23	42.6^{bc}
SEM	0.2926	1.0428	1.4831	4.7818	2.7630	4.6677	4.2084
Significance	S**	NS	NS	NS	S*	NS	S**

a, b, c - Means superscripted with different letters within a column differ significantly from each other.SEM: Standard error of means; NS: Non significant; S**: Highly significant (P<0.01); S*: Significant (P<0.05)

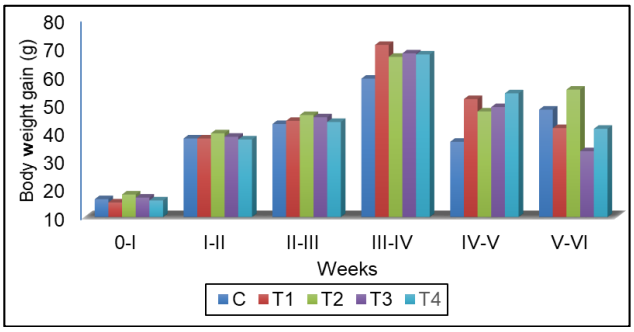

Fig 5: Effect of Chromium supplementation on average daily body weight gain at different weeks

3.4 Feed consumption

The weekly feed consumptions, for the birds in the five groups, are presented in Table‑ 4as well as in figure 4. Highly significant (P<0.01) effect at I week and significant (P<0.05) effect at V week and overall feed consumption for entire experimental period and non-significant for rest of the groups by supplementation of Chromium in broiler chicks.

At I week highest feed consumption was recorded in T_2 which was comparable with C and T_3 but significantly higher than rest of the groups. T_1 group had lowest feed consumption. At V week highest feed consumption was recorded in T_4 which was comparable with all Chromium supplemented groups and lowest in C i.e. control group. The overall feed consumption for entire experimental period was highest in T_2 followed by T_1, T_4, T_3 and lowest in C. The results obtained in study in text supported by the findings of Toghyani *et al.* (2006)[17] recorded an increase in feed consumption of under heat-stressed broilers when supplemented with Chromium.

Table 4.8: Effect of Chromium supplementation on feed consumption (g) at different weeks

	Periods (week)						
Main effects	0-I	I-II	II-III	III-IV	IV-V	V-VI	I-VI
C	188.26^{b}	471.68	519.92	756.97	474.26^{a}	635.76	3046.87^{a}
T_1	164.86^{a}	452.50	536.40	918.81	672.38^{b}	531.60	3276.58^{ab}
T_2	196.63^{b}	463.36	559.91	836.22	601.99^{ab}	702.37	3360.52^{b}
T_3	192.34^{b}	478.78	542.42	861.20	631.68^{b}	440.07	3146.51^{ab}
T_4	176.04^{a}	453.95	523.84	851.40	685.35^{b}	537.24	3227.83^{ab}
SEM	3.017612	25.21413	16.1223	61.23986	34.76835	65.5315	59.01338
Significance	S**	NS	NS	NS	S*	S	S*

a, b, c, d, e - Means superscripted with different letters within a column differ significantly from each other.SEM: Standard error of means; NS: Non significant; S**: Highly significant (P<0.01); S*: Significant (P<0.05)

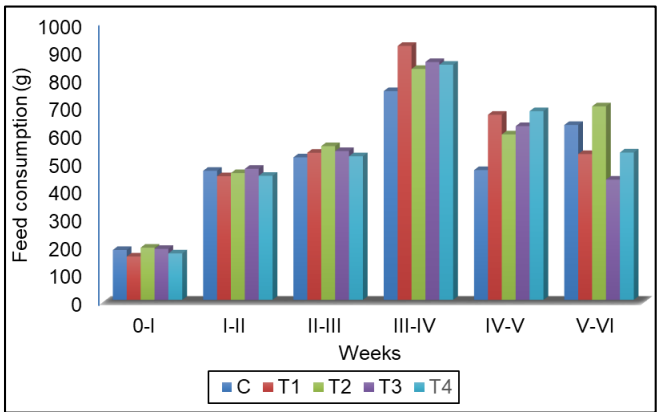

Fig 6: Effect of Chromium supplementation on feed consumption at different weeks

3.5 Feed conversion ratio (FCR)

Feed conversion ratios obtained in different treatments are shown in Table 5 as well as in figure 5. There was revealed highly significant (P<0.01) effect of supplementation of Chromium at I and V week and for cummulative FCR for six weeks and no significant effect for rest of the period. At II week though statistical differences were not recorded but upon observing mean FCR values of groups highest FCR was recorded in C and T_3 followed by T_4, T_1 and T_2. At III week lowest FCR was recorded in T_3 and T_4 which was comparable with C, T_1 and T_2 but T_1 group had highest FCR. At IV week lowest FCR was recorded in T_2 followed by T_4, T_3, C and T_1. At V week lowest FCR was recorded in T_2 which was comparable with T_4 but highly significantly improved than C, T_1, and T_3. At VI week lowest FCR was recorded in T_2 followed by T_1, T_4, T_3 and C. C group had highest FCR. On observing overall FCR for entire experimental period lowest

FCR was recorded in T_2 which was though comparable with T_1 and T_4 but significantly lower than C and T_3. C had highest FCR which had no-significant differences from T_3. The result obtained in present study fall in line with the findings of Sands and Smith (1999) [18] and Zhang *et al.* (2002)[19] who recorded improvement in FCR with inclusion of Chromium as feed supplement in the diet of broilers

Table 4.10: Effect of Chromium supplementation on feed conversion ratio (FCR) at different weeks

Main effects	Periods (week)						
	I	II	III	IV	V	VI	I-VI
C	1.65^{c}	1.78	1.73	1.83	1.85^{b}	1.89	1.78^{c}
T_1	1.55^{a}	1.71	1.74	1.85	1.85^{b}	1.83	1.75^{ab}
T_2	1.56^{a}	1.67	1.73	1.79	1.81^{a}	1.82	1.73^{a}
T_3	1.63^{bc}	1.78	1.71	1.81	1.84^{b}	1.88	1.77^{bc}
T_4	1.58^{ab}	1.73	1.71	1.80	1.82^{a}	1.86	1.75^{ab}
SEM	0.01387	0.04827	0.01753	0.01987	0.0041	0.01816	0.0062
Significance	S**	NS	NS	NS	S**	NS	S**

a, b - Means superscripted with different letters within a column differ significantly from each other.SEM: Standard error of means; NS: Non significant; S**: Highly significant (P<0.01); S*: Significant (P<0.05)

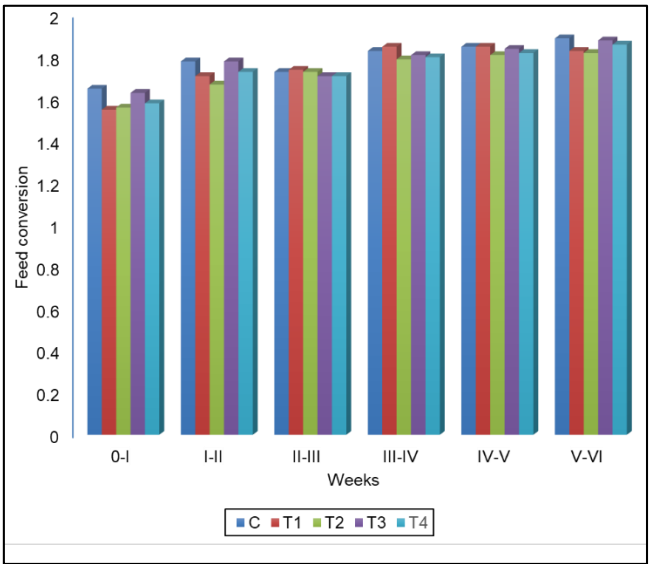

Fig 7: Effect of Chromium supplementation on feed conversion ratio at different weeks

Conclusion

The optimum performance and feed utilization of broiler chicks is observed at the 400ppb inclusion level of Chromium picolinate however on looking to the performance of broilers i.e. growth parameters and ultimately production in terms of live body weight gain suggested that 200-400ppb feed level of Chromium picolinate is most effective

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