Journal of Animal Research: v.13 n.03, p. 419-428. June 2023

DOI: 10.30954/2277-940X.03.2023.17

Effect of Vitamin C, E, Organic Chromium and its Combination on Production Performance and Economics of Narmadanidhi Birds in Winter Season

Laxmi Chouhan[1]*, S.S. Atkare[1], Girraj Goyal[1], Anil Shinde[1], S.K. Joshi[2] and Surbhi Yadav[3]

[1]*Department of Poultry Science, C.V.Sc. & A.H., NDVSU., Jabalpur, M.P., INDIA*
[2]*Department of Animal Genetics & Breeding, C.V.Sc. & A.H., NDVSU., Jabalpur M.P., INDIA*
[3]*Department of Livestock Product Technology, C.V.Sc. & A.H., NDVSU., Jabalpur, M.P., INDIA*

**Corresponding author: L Chouhan; E-mail: drlaxmimhow@gmail.com*

Received: 08 April, 2023 **Revised:** 07 May, 2023 **Accepted:** 10 May, 2023

ABSTRACT

The present study was conducted to assess the effect of vitamin C (ascorbic acid), vitamin E, organic chromium and its combination on growth performance and economics of Narmadanidhi birds in winter season. A total of 240, day-old coloured dual type Narmadanidhi chicks were distributed into 12 dietary treatment groups with each consisting 20 chicks in 2 replicates. The chicks were housed in individual pens as per treatment groups and reared on litter system. Dietary treatment supplements in starter and finisher ration were C_0 control, C_1 (150 mg AA/kg), C_2 (250 mg AA/kg), E_1 (125 mg vit-E/kg), E_2 (200 mg vit-E/kg) Cr_1 (1.25 mg Cr-propionate/kg), Cr_2 (2.0 mg Cr-Propionate/kg). Combined supplements were C_2E_1, C_2E_2, C_2Cr_1, C_2Cr_2, and $C_2E_1Cr_2$. The data of body weight, feed intake, feed efficiency and economics of rearing were recorded and measured on 6th week interval. Analysis (One way ANOVA) was carried out to study the effect of treatments on production performance. At 12 week, body weights in combined supplement C_2Cr_2, $C_2E_1Cr_2$ were significantly higher and non-significant from control. Combined supplements C_2Cr_2, $C_2E_1Cr_2$ improved feed intake significantly than all other treatments.. Cumulative feed efficiency of E_2, Cr_1, Cr_2, C_2E_2, C_2Cr_2 and $C_2E_1Cr_2$ were non-significantly different and significantly better than control group. Treatment C_2Cr_2 has highest gross profit/bird and Cr_1 has highest gross profit/kg live weight than control and all other treatment groups. Finally, concluded that combined supplement C_2Cr_2, $C_2E_1Cr_2$ had superior performance and Cr_1 had better economy in winter season with significantly better performance than control.

HIGHLIGHTS

- Combined supplementation of C_2Cr_2, $C_2E_1Cr_2$ had superior performance on Narmadanidhi birds in winter season.
- Lower level of chromium Cr_1 had better economy in winter season with significantly better performance.

Keywords: Vitamin C, Vitamin E, Chromium, Narmadanidhi, Winter season

The Poultry sector is considered as rapidly growing sector of Indian agriculture and has an important role in Indian economy. As per the 20th livestock census the poultry population is 729.21 million. Although the population of poultry is increasing, there are some factors which hamper the growth of poultry sector among which summer and winter stress is also important one. There are lots of literatures available on effect of summer stress on poultry but very less research work has been carried out in winter season or cold stress, though some of researchers reported effect of vitamin C, E and Cr on growth traits on poultry in winter season.

Increased cold climatic condition produces physiological stress which influences productive efficiency including health and disease resistance capacity (Phuong *et al*.,

How to cite this article: Chouhan, L., Atkare, S.S., Goyal, G., Shinde, A., Joshi, S.K. and Yadav, S. (2023). Effect of Vitamin C, E, Organic Chromium and its Combination on Production Performance and Economics of Narmadanidhi Birds in Winter Season. *J. Anim. Res.,* **13**(03): 419-428.

Source of Support: None; **Conflict of Interest:** None

2016). Environmental temperature below 18ºC induced cold stress (Dhanalakshmi *et al*., 2007). Olfati *et al*. (2018) reported that cold stress modulates immune response and haematological parameters. Depressive effect of cold stress in chicken can be alleviated by vit C and chromium supplementation (Sahin and Sahin, 2001). Beneficial effect of vitamin E supplementation during winter season has been also reported in literature (Kant *et al.,* 2015).

In a past few decades use of chromium in nutrition of domestic animals has been focus of research. Dietary chromium has been reported to have positive effect on growth rate and feed efficiency (Toghyani *et al*., 2006). Some other report also showed beneficial effect of chromium supplementation on growth performance during cold stress (Abedayo *et al*., 2020) and on blood biochemical parameters of broilers (Khukhodzinaii *et al*., 2021). In many research experiments, significantly better effect on performance of birds in combined supplementation of vitamin C with Chromium (Haq *et al*., 2016) and vit-C with vit-E (Attia *et al*., 2017) has been reported during environmental stress condition.

In view of the above facts and vital role of vitamin C, E and chromium in metabolism during environmental stress condition, the present study was planned to study the effect of vitamin C (ascorbic acid), vitamin E and chromium as individual and combined supplementation on growth traits and economics of Narmadanidhi birds in winter season.

MATERIALS AND METHODS

The present experiment was conducted at All India Co-ordinated Research Project on Poultry Breeding, Department of Poultry Science, N.D.V.S.U. Jabalpur, (M.P.). A completely randomized design (CRD) was utilized to conduct present experiment. A total of 240, day old coloured dual type Narmadanidhi sexed chicks (75% Jabalpur colour and 25% native Kadaknath inheritance) with equal numbers of male and females were distributed into 12 dietary treatment groups with each consisting 20 chicks in 2 replicates. The chicks were housed in individual pens as per treatment groups and reared on litter system. Starter ration was prepared containing 21% CP with 2800 Kcal ME/kg and fed up to 6 weeks. Finisher ration was prepared containing 19% CP with 2900 Kcal ME/kg and fed 7 to 12 weeks of age. Dietary treatment supplements in starter and finisher ration were C_0 control, C_1 (150 mg AA/kg), C_2 (250 mg AA/kg), E_1 (125 mg vit-E/kg), E_2 (200 mg vit-E/kg) Cr_1 (1.25 mg Cr-propionate/kg), Cr_2 (2.0 mg Cr-Propionate/kg). Combined supplements were C_2E_1, C_2E_2, C_2Cr_1, C_2Cr_2, and $C_2E_1Cr_2$.

During 0 to 12 weeks treatment trials, data of body weight, feed intake and feed efficiency were recorded and measured on 6th week interval. Analysis (One way ANOVA) was carried out to study the effect of treatments on production performance (Snedecor and Cochran, 1994). The gross economics of rearing the chicks for

Table 1: Distribution of chicks as per experimental design and treatments

Sl. No.	Treatments		Concentration in diet (mg/kg)	No. of chicks per replicate		No. of chicks/ treatment
				R1	R2	
T0	Control	C_0	Basal diet	10	10	20
T1	Ascorbic Acid	C_1	150	10	10	20
T2	Ascorbic Acid	C_2	250	10	10	20
T3	Vitamin-E	E_1	125	10	10	20
T4	Vitamin-E	E_2	200	10	10	20
T5	Chromium Propionate	Cr_1	1.25	10	10	20
T6	Chromium Propionate	Cr_2	2.0	10	10	20
T7	Ascorbic acid + Vitamin-E	C_2E_1	250+125	10	10	20
T8	Ascorbic acid + Vitamin-E	C_2E_2	250+200	10	10	20
T9	Ascorbic acid + Cr Propionate	C_2Cr_1	250+1.25	10	10	20
T10	Ascorbic acid + Cr propionate	C_2Cr_2	250+2.0	10	10	20
T11	Ascorbic acid + Vitamin-E + Cr propionate	$C_2E_1Cr_2$	250+125+2.0	10	10	20
Total						**240**

Table 2: Composition of basal diet and ingredients used

Sl. No.	Ingredients (part/100kg)	Starter diet (0-6 week) CP 21%, 2800 kcal ME/kg	Finisher diet (7-12 week) CP 19%, 2900 kcal ME/kg
1	Maize	47.5	55
2	Deoiled rice polish	14.5	12
3	Soyabean meal	35.0	30
4	Mineral mixture	1.50	1.50
5	Vitamins mixture	0.25	0.25
6	Limestone powder	0.35	0.35
7	Dicalcium phosphate	0.40	0.40
8	Salt	0.30	0.30
9	Coccidiostat (diclazuril)	0.10	0.10
Total		100	100

Calculated composition of diet- 21% CP and 2800 Kcal ME/ Kg in starter ration and 19% CP and 2900 K cal ME/ Kg in finisher ration.

complete experimental period was calculated by taking in to account treatment wise estimation of feed cost and feeding cost up to 12 week of age. The gross profit per bird and per kg live weight over feeding cost was determined by taking into account sale prize of bird at prevailing rate in the local market.

RESULTS AND DISCUSSION

Body weight of Narmadanidhi birds

Bi-weekly body weight (g) of pooled sex birds wise during winter season presented in table 3 to 4.

Table 3: Effect of vitamin C, E, organic chromium and its combination on body weight of Narmadanidhi birds (Pooled sex) in winter season

Treatments	Body weight (g)	
	6^{th} Week	12^{th} Week
C_0	$584.75^{c}\pm7.99$	$1243.75^{e}\pm4.91$
C_1	$588.00^{bc}\pm7.65$	$1246.25^{de}\pm5.22$
C_2	$590.50^{bc}\pm7.78$	$1250.25^{cde}\pm5.12$
E_1	$595.25^{bc}\pm7.39$	$1243.75^{e}\pm4.93$
E_2	$600.50^{bc}\pm8.42$	$1260.75^{bcde}\pm4.28$
Cr_1	$592.50^{bc}\pm7.51$	$1252.00^{bcde}\pm7.20$
Cr_2	$588.00^{bc}\pm8.66$	$1260.00^{bcde}\pm6.56$
C_2E_1	$594.00^{bc}\pm8.52$	$1252.00^{bcde}\pm5.88$
C_2E_2	$610.50^{abc}\pm8.62$	$1269.50^{b}\pm6.59$
C_2Cr_1	$615.10^{ab}\pm9.84$	$1271.75^{b}\pm8.53$
C_2Cr_2	$630.00^{a}\pm10.03$	$1311.50^{a}\pm6.91$
$C_2E_1Cr_2$	$631.75^{a}\pm10.52$	$1314.50^{a}\pm6.49$

^{a,b,c} Means bearing different superscripts in a column differ significantly (P<0.05).

Table 4: Means sum of squares for body weight of Narmadanidhi birds (Pooled sex) in winter season

Source	DF	6^{th} Week	12^{th} Week
Treatment	11	5069.90**	10234.88**
Error	228	1491.32	1165.89
Total	**239**		

Bi-weekly body weight (g) of birds

Sixth week of age

Pooled sex body weight in C_0 control (584.7 g ± 7.99) was non-significantly different from C_1, C_2, E_1, E_2 Cr_1, Cr_2, C_2E_1 and C_2E_2 treatments and significantly lower than C_2Cr_1, C_2Cr_2, $C_2E_1Cr_2$ birds. Body weight of birds in C_2Cr_2 and $C_2E_1Cr_2$ were non-significantly different from C_2E_2, C_2Cr_1 and significantly higher than all other treatment groups.

Twelfth week of age

Pooled sex at 12^{th} week body weight in C_2Cr_2 (1301.7 g ± 6.91) and $C_2E_1Cr_2$ (1303.7 g ± 6.49) were non-significantly different and these were significantly heavier in body weight than control and all other treatment groups. Following higher body weight recorded in C_2Cr_1 (1271.7 g ± 8.53) and C_2E_2 (1269.5 g ± 6.59) with non-significant different from E_2, Cr_1, Cr_2, C_2E_1 treatments and significant from other treatment groups (C_0, C_1, C_2, E_1). Body weight in C_0, C_1, C_2, E_1, E_2, Cr_1, Cr_2 and C_2E_1 were non-significantly different.

Effect of Ascorbic acid (Vitamin C) on body weight

Non significant effect of ascorbic acid supplementation on body weight from control group birds during winter season was in agreement with the result of Kutlu and Forbes (1994). As ascorbic acid is normally synthesized in chicken (ELkheir *et al.,* 2008) and its synthesis and absorption is normal under moderate cold climate (Gous and Morris, 2005 and Khan, 2011), therefore supplemental ascorbic acid might have no effect on body weight of birds during winter season.

Effect of Vitamin-E on body weight

During winter season body weight were significantly higher with E_2 level of vit-E supplementation than control group, at initial and later age growth period. E_1 lower level was non-significantly different from control. Pooled sex analysis shown significantly higher body weight of E_2 at 6 weeks of age whereas non-significant difference observed at 12 weeks of age. In agreement to our study result, Rebole *et al*. (2006) reported significantly higher body weight of broiler supplemented 200 mg vit-E/kg during winter season. Positive effect of vit-E supplementation during winter season was in line with the result of above authors. However, result was in disagreement for effect of vit-E at 100-125 mg lower level reported by Guo *et al.* (2003) and Alm- EL- dein *et al.* (2013). The present-study result did not observe increased body weight at 125 mg /kg lower level in diet. Contrary to present study Rao *et al*. (2009) and EL-Gogary *et al.* (2015) reported non-significant effect on growth during winter season. This differed observation might be due to some other factors i.e. variation in concentration, feed composition, micro environment of house during winter season.

Effect of Chromium on body weight

Body weight of birds in C_0 control group was non-significantly different from Cr propionate supplemented groups during initial and later growth period. Levels of chromium propionate (Cr_1 and Cr_2) did not differ significantly in body weight. Haq *et al.* (2017) reported numerically increased body weight in 0.5 mg Cr propionate/kg diet during normal environmental condition and significantly increased effect during heat stress. The present study conducted in winter season was in collaboration with the result of Arif *et al.* (2019) and Abedayo *et al*. (2020) who reported non-significant effect during winter season. The result partially supported finding of Haq *et al.* (2017). Similar to present study, Rajalekshmi *et al.* (2014) supplemented Cr propionate at level of 800 μ g/kg to 3200 μg/kg during winter season and found non-significantly different body weight from control group. However, result was in disagreement with the finding of Mohammed *et al.* (2014) who reported significantly higher body weight with chromium yeast supplementation during normal climatic condition.

Effect of combined supplementation of vitamin C and E on body weight

During winter season combined supplement (C_2Cr_2 and $C_2E_1Cr_2$) were significantly higher in body weight than control and all other treatment. This study result shown that vit-C and chromium as individual supplement under winter season did not improved body weight over control group and hence has little significance, however found beneficial in combined supplementation.

Many studies suggested that chromium perform better in terms of weight gain in combination with ascorbic acid especially in case of stress condition such as high and cold temperature and humidity (Sahin and Sahin, 2002, Perai *et al*., 2014 and Attia *et al*., 2015). Ipek and Sahin (2007) reported higher body weight of chicks in combined supplementation of 240 mg vit C and 240 mg vit-E/kg of diet during cold stress. Sahin *et al.* (2002) reported significantly decreased cold stress effect on performance of birds by supplementing Cr with vit-C. Perai *et al*. (2014) and Ali *et al*. (2018) found improved parameters of birds in terms of weight gain and feed efficiency, supplemented chromium and chromium with antioxidants during cold stress and normal environmental condition respectively. In the present study higher body weight of birds in combined supplementation of vit-C with Cr and vit-C with chromium and vit-E was in agreement with the finding of above authors.

Fall in minimum temperature during night hours might have imposed some stress on birds together with higher NH_3 level in house due to use of curtain (Campbell *et al*. 2008). These factors might have caused some adverse effect on physiology, metabolism and immune status which are probably alleviated or minimized with combined supplementation of chromium and vitamin C resulting into increased body weight.

Feed intake and feed efficiency of narmadanidhi birds

Bi-weekly feed intake (g) and feed efficiency of pooled sex birds during winter season presented in table 5 to 6.

Bi- weekly cumulative feed intake (g)

Sixth week of age

During 6th week of age CFI of C_2Cr_1, C_2Cr_2 and $C_2E_1Cr_2$ were non-significantly different and among this FI of $C_2E_1Cr_2$ were significantly higher than control and all other treatment groups. Control group C_0 was non-significantly different from C_1, C_2, Cr_1, Cr_2, C_2E_1 and significantly lower than all other treatment groups. Among single supplement groups E_2 had significantly higher feed intake with non-significant difference from E_1 and significantly higher than control and all other single supplement groups.

Twelfth week of age

During 12th week of age, CFI of C_2Cr_2 (4831.5g±6.50) and $C_2E_1Cr_2$ (4843.0g±7.00) were non-significantly different and these were significantly higher in feed intake than control and all other treatment groups. Following higher FI was recorded for C_2Cr_1 than C_2E_2 with significant difference from C_2E_1 and all single supplement groups. Among single supplement group Cr_2 feed intake was non-significant from E_2 and significantly higher than C_0 and all other single supplement groups. Feed intake of control group C_0 was lower and non-significantly different from C_1, C_2, E_1, Cr_1 and C_2E_1.

Table 5: Effect of vitamin C, E, organic chromium and its combination on bi-weekly cumulative feed intake and feed efficiency of Narmadanidhi birds in winter season

Treatments	Bi-weekly cumulative feed intake (g)		Bi-weekly cumulative feed efficiency	
	6th Week	12th Week	6th Week	12th Week
C_0	1515.50^{f}±3.50	4685.50^{ef}±5.50	2.60^{ab}±0.01	3.77^{a}±0.01
C_1	1531.50^{ef}±1.50	4674.00^{ef}±6.00	2.60^{ab}±0.01	3.75^{ab}±0.00
C_2	1539.50^{ef}±0.50	4681.00^{ef}±5.00	2.61^{ab}±0.01	3.75^{ab}±0.00
E_1	1553.50^{de}±6.50	4662.50^{f}±11.50	2.61^{ab}±0.00	3.75^{ab}±0.02
E_2	1570.50^{cd}±1.50	4712.50^{cd}±12.50	2.56^{c}±0.02	3.72^{c}±0.01
Cr_1	1542.50^{ef}±2.50	4695.00^{de}±12.00	2.61^{ab}±0.00	3.75^{ab}±0.00
Cr_2	1517.50^{f}±1.50	4737.00^{c}±6.00	2.58^{bc}±0.01	3.73^{bc}±0.01
C_2E_1	1538.50^{ef}±27.50	4694.50^{de}±7.50	2.63^{a}±0.00	3.75^{ab}±0.00
C_2E_2	1573.00^{cd}±13.00	4727.00^{c}±5.00	2.58^{bc}±0.00	3.73^{bc}±0.00
C_2Cr_1	1595.50^{abc}±4.50	4766.00^{b}±4.00	2.60^{ab}±0.01	3.75^{ab}±0.00
C_2Cr_2	1612.50^{ab}±3.50	4831.50^{a}±6.50	2.56^{c}±0.01	3.72^{c}±0.01
$C_2E_1Cr_2$	1623.00^{a}±9.00	4843.00^{a}±7.00	2.56^{c}±0.01	3.72^{c}±0.01

a,b,c Means bearing different superscripts in a column differ significantly (P<0.05).

Table 6: Means sum of squares for bi-weekly cumulative feed intake of Narmadanidhi birds in winter season (pooled sex)

Source	DF	Bi-weekly cumulative feed intake (g)		Bi-weekly cumulative feed efficiency	
		6th Week	12th Week	6th Week	12th Week
Treatment	11	2604.68**	8658.92**	0.00**	0.00**
Error	12	184.42	110.04	0.00	0.00
Total	**23**				

Bi- weekly cumulative feed efficiency

Sixth week of age

During sixth week of age CFE in C_0, C_1, C_2, E_1, Cr_1, Cr_2, C_2E_1, C_2E_2, C_2Cr_1 were non-significantly different and ranged between 2.58 to 2.61. All these treatments were significantly inferior FE than E_2, C_2Cr_2 and $C_2E_1Cr_2$ which were similar in FE (2.56). Among single supplement groups, E_2 was superior in FE with non-significant difference from Cr_2 and significant from C_0 and all single supplement groups.

Twelfth week of age

Cumulative feed efficiency of control C_0 was non-significantly different from C_1, C_2, E_1, Cr_1, C_2E_1, C_2Cr_1 and significantly inferior than E_2, C_2E_2, C_2Cr_2 and $C_2E_1Cr_2$ treatment groups. Among single supplement groups FE of E_2 (3.72±0.01) was significantly superior. Among all treatment groups FE of E_2, C_2Cr_2 and $C_2E_1Cr_2$ was superior and similar (3.72±0.01) with non-significant difference from Cr_2 (3.73±0.01), C_2E_2 (3.73±0.10) and significantly better than all other treatment groups.

Effect of vit-C on feed intake and feed efficiency

During winter season, effect of ascorbic acid on feed intake of birds was non-significant during initial and later age growth period. Puron *et al.* (1994) supplemented 200 mg Vit C/kg diet of broilers reared at temperature of 26 ^{o}C. They reported non-significant effect on body weight, FI and FE of broiler between treatment and control group. Non-significant effect of vit-C on performance of birds in absence of heat stress was also reported by Elkheir *et al.* (2008). The result was in agreement to these authors. Since the vit-C synthesized in birds during normal season, its dietary supplementation may not be beneficial during winter season except in high depression of environment temperature stress.

During winter season, effect of vitamin C supplementation on feed efficiency of birds was non-significantly different from control group. Mahmoud *et al.* (2004) reared broiler at 30 ^{o}C (3.5 hrs for 3 days/wk) and supplemented 500 mg vit C/ kg diet. They reported non-significant effect on body weight, FI and FE of broiler. The result was in collaboration to these authors (Puron *et al*., 1994) who observed non-significant effect of vit C on body weight and feed efficiency of birds during winter season.

Effect of vitamin E on feed intake and feed efficiency

During winter season dietary vit-E supplementation at E_1 lower level did not exert effect on feed intake whereas E_2 higher level significantly improved FI during 6 to 12 week growth period. Guo *et al*. (2003) reported non-significant effect of 100 mg vit-E/kg diet on FI and significant effect on FCR and body weight. Kant *et al.* (2015) supplemented 200 mg vit-E /kg diet during winter season and found improved FCR and body wt but FI was not affected. In the present study non-significant effect on FI of birds at lower level of vit-E supplementation was in line with the result of Guo *et al*. (2003) and Kant *et al*. (2015) but did not supported their finding for higher level of vit-E supplementation, whereas in this study significantly higher FI was observed with 200 mg vit-E /kg diet during winter season. This difference may be due to diet composition, variation in environmental temperature and micro environment in the house.

During winter season feed efficiency of birds at 6 and 12 week significantly improved FE was recorded with E_2 higher level. E_1 was non-significantly different from control. Kant *et al.* (2015) reported significantly improved FCR of broiler supplemented 200 mg vit-E/kg of diet during winter season. In normal climatic condition, Rebole *et al.* (2006) reported significantly better FE in dietary Vit E Supplementation. In the present study positive effect of vit-E supplementation on FE of birds during winter season was in agreement with Rebole *et al.* (2006) and Kant *et al*. (2015). However, study result did not observed significant effect in lower level of supplementation (125 mg /kg diet). This was in contrary to Guo *et al.* (2003), who reported significantly better FE in 100 mg /kg vit-E supplementation during cooler climate.

Effect of chromium propionate on feed intake and feed efficiency

During winter season effect of Cr-propionate on feed intake of birds was not observed during 6, 12 week of age supplemented at Cr_1 (1.2 mg/kg) and Cr_2 (2.0 mg/kg) levels in diet except Cr_2 at 12 week noted higher in feed

Table 7: Treatment wise per kg feed cost and feeding cost of birds during different growth period under winter season

Treatments	Per kg cost of Starter feed (₹)	Per kg cost of Finisher feed (₹)	Feeding cost 0-6 week (₹)	Feeding cost 7-12 Week (₹)	Feeding cost 0-12 week (₹)
C_0	47.90	44.59	72.59	141.37	213.96
C_1	48.02	44.59	73.54	140.14	213.68
C_2	48.09	44.68	74.04	140.36	214.40
E_1	48.11	44.69	74.74	138.96	213.70
E_2	48.24	44.82	75.73	140.85	216.58
Cr_1	47.91	44.49	73.87	140.27	214.14
Cr_2	47.94	44.52	72.72	147.45	220.21
C_2E_1	48.30	44.89	74.32	141.67	215.98
C_2E_2	48.43	45.01	76.18	141.97	218.15
C_2Cr_1	48.10	44.68	76.74	141.66	218.41
C_2Cr_2	48.10	44.69	77.56	143.84	221.41
$C_2E_1Cr_2$	48.31	44.90	78.41	144.56	222.97

intake. Rajalekshmi *et al*. (2014) reported non-significant effect on feed intake, feed efficiency, supplemented 100 and 3200 µg/kg organic chromium in the diet of broiler in winter season. Similar observation was also reported by Kutlu and Forbes (1994). Arif *et al*. (2019) supplemented 400 and 1600 ppb Cr picolinate /kg diet of broiler reared under normal environment temperature. They reported improved body weight and FE in 400 ppb cr / kg diet but feed intake was not affected due to chromium supplementation. The present results were in harmony with the finding of Rajalekshmi *et al.* (2014) and Arif *et al*. (2019) for non-significant effect of chromium on FI and body weight of birds.

During winter season feed efficiency was non-significantly different from control group up to 6-week of age, thereafter Cr_2 level of Cr-propionate in diet improved FE during 7-12 week of age. The present finding was in agreement for significant effect in feed efficiency. In-contrary, Rajalekshmi *et al*. (2014) reported non-significant effect on FE of broiler supplemented chromium in diet during winter season.

Combined effect of Vitamin C, chromium and vitamin E on FI and FE

During winter season at 12 week of age C_2E_1 feed intake was significantly higher from E_1 whereas C_2E_2 shown significantly higher feed intake than C_2. Feed efficiency during initial and later age growth period in combined and separate supplement groups were non-significantly different and significant from control group. C_2Cr_2, $C_2E_1Cr_2$ combined supplemented group were non-significantly different from Cr_2 and significantly better than C_2 at 12 week of age. C_2Cr_1 was non-significant from control and individual supplement groups during initial and later age. However, FI of C_2Cr_1, C_2Cr_2 and $C_2E_1Cr_2$ were significantly higher than control and their individual supplement group at 6 and 12 week of age.

In absence of stress factor particularly heat stress, combination of ascorbic acid with vit-E or chromium had no advantage in FE over its individual supplement groups. However, feed intake of birds in ascorbic acid and chromium combination was significantly higher than their separate treatment groups at 6 and 12 week of age. Higher body weight in combined supplement groups might be the reason for increased feed intake. As chromium and vitamin E play vital role in many physiological and metabolic processes in birds and has beneficial effect in digestion and utilization of nutrients of birds, may attributed for increased feed intake and body weight in combined supplement groups.

Economics of rearing Narmadanidhi birds

Treatment wise per kg feed cost & feeding cost and Income on sale of birds & gross profit over feeding cost during winter season presented in table 7 and 8.

Table 8: Income on sale of birds and gross profit over feeding cost in winter season

Treatments	Body wt at 12 week age (Kg)	Income on sale of bird (₹ 200/Kg live wt) (₹)	Feeding cost up to 12 weeks of age (₹)	Gross profit/ bird over feed cost (₹)	Gross profit per kg body wt over feed cost (₹)
C_0	1.24	248.00	215.00	33.00	26.61
C_1	1.25	250.00	213.60	36.40	29.12
C_2	1.25	250.00	214.31	35.69	28.55
E_1	1.24	248.00	213.65	34.35	27.70
E_2	1.26	252.00	214.97	37.03	29.39
Cr_1	1.26	252.00	214.14	37.86	30.04
Cr_2	1.29	258.00	220.06	37.94	29.41
C_2E_1	1.25	250.00	215.92	34.08	27.26
C_2E_2	1.26	252.00	218.12	33.88	26.89
C_2Cr_1	1.27	254.00	218.33	35.67	28.09
C_2Cr_2	1.30	260.00	221.35	38.65	29.73
$C_2E_1Cr_2$	1.30	260.00	222.94	37.06	28.51

Effect of treatments on economics of rearing Narmadanidhi birds upto 12 weeks of age

During winter season, treatment C_2Cr_2 has highest gross profit/bird (₹ 38.65) and Cr_1 has highest gross profit/kg live weight (₹ 30.04) than control and all other treatment groups. In compared to C_0 control group, C_2Cr_2 birds fetched higher gross profit / bird by ₹ 5.65 and Cr_1 birds fetched higher profit/kg live weight by ₹ 3.43. and C_2Cr_2 by 3.12. Considering the single supplement groups profit per kg live weight was higher in Cr_1 and C_1 lower supplement compared to Cr_2 and C_2 respectively, whereas E_2 were higher in profit compared to E_1 lower concentration in diet.

CONCLUSION

It may be concluded that in winter season combined supplement C_2Cr_2, $C_2E_1Cr_2$ had superior performance and Cr_1 had better economy with significantly better performance than control.

ACKNOWLEDGEMENTS

Authors are thankful to the AICRP on Poultry Breeding (ICAR), Jabalpur and NDVSU, Jabalpur for financial support for conducting field trial.

REFERENCES

Abedayo, F.B., Adu, D.A., Chineke, C.A., Oloruntola, O.D., Omoley, O.S., Adeyeye, S.A. and Ayodele, S.O. 2020. The performance and haematological indices of broiler chicken feed chromium picolinate and vit C supplement diets. *Asian J. Res. Anim. Vet. Sci.*, **6**(4): 54-61.

Ali, N., Akram, M., Fahim, A., Singh, B. and Imran, M. 2018. Effect of dietary supplementation of vitamin E, zinc and chromium supplementation on growth performance and hematological characteristics of broiler chickens. *Ind. J. Anim. Res.*, **52**: 574-578.

Alm-El-Dein, A.K.A., Soliman, M.M. and El-Aziz, S.A. 2013. Effect of dietary vitamin E supplementation on some productive, reproductive and immunological traits of Inshas chickens strain. *Egy. Poult. Sci. J.*, **33**: 939-955.

Arif, M., Hussain, I., Mahmood, M.A., Abd-EL-Hack, M.E., Swelum, A.A., Alagawany M., Mahmoud, A.H., Ebaid, H. and Komany, A. 2019. Effect of varying levels of chromium propionate on growth performance and blood biochemistry of broiler. *Animals*, **9**(11): 935.

Attia, K.M., Tawfeek, F.A., Mady, M.S. and Assar, A.H. 2015. Effect of chromium, selenium and vitamin C on productive performance and blood parameters of local strain dokki-4 in Egypt summer conditions. *Egy. Poult. Sci. J.*, **35**: 311-329.

Attia, Y.A., Al-Harthi, M.A., El-Shafey, A.S., Rehab, Y.A. and Kim, W.K. 2017. Enhancing tolerance of broiler chickens to heat stress by supplementation with vitamin E, vitamin C and/or probiotics. *Annals Anim. Sci.,* **17**(4): 1155-1169.

Campbell, J., Donald, J., Simpson, G. and Macklin, K. 2008. Get ready for winter! The five-step program. The Poultry Engineering, Economics & Management Newsletter. National Poultry Technology Center, Auburn Univ. No.55. September.

Dhanalakshmi, S., Devi, R.S., Srikumar, R., Manikandan, S. and Thangaraj, R. 2007. Protective effect of Triphala on cold stress-induced behavioral and biochemical abnormalities in rats. *Yakugaku Zasshi,* **127**(11): 1863-7.

EL-Gogary, M.R., Ismail, F.S.A. and EL-Nadi, M.I. 2015. Effect of vitamin E supplementation and stocking density on broiler performance, carcass traits and histological responses of lymphoid organs. *Asian J. Poult. Sci.*, **9**: 70-84.

Elkheir, S., Mohhamed, M.K., Ahmed, M.M. and Abdelgadir, S.M. 2008. Effect of feed restriction and ascorbic acid supplementaton on performance of broiler chicks, reared under heat stress. *Res. J. Anim. Vet. Sci.,* **3**: 1-8.

Gous, R.M. and Morris, T.R. 2005. Nutritional interventions in alleviating the effects of high temperatures in broiler production. *World. Poult. Sci. J.*, **61**: 463-475.

Guo, Y.M., Zhang, G.M., Yuan, H.M. and Nie, W. 2003. Effect of source and level of magnesium and vit-E on prevention of hepatic peroxidation and oxidative deterioration of broiler meat. *Anim. Feed Sci. Tech.*, **107**: 143-50.

Haq, Z., Jain, R., Farooq, J., Ganai, I.A., Gull, G. and Khan, N. 2017. Effect of dietary supplementation of chromium yeast alone and in combination with antioxidants on performance of broilers. *J. Anim. Health Prod.*, **5**(4): 159-164.

Haq, Z., Jain, R.K., Khan, N., Dar, M.Y., Ali, S., Gupta, M. and Varun, T.K. 2016. Recent advances in role of chromium and its antioxidant combinations in poultry nutrition (A review). *Vet. World*, **9**: 1392-1399.

Ipek, A. and Sahin, U. 2007. Effect of cold stress on broiler performance and ascites susceptibility. *Asia. Austra. J. Anim. Sci.*, **19**(5): 734-738.

Kant, S., Ali, N., Chandra, G., Siddique, R.A. and Imran, M. 2015. Effect of Shatavari and Vit-E on growth performance, biochemical profile and dressing percentage on broiler during winter season. *Ind. J. Poult. Sci.,* **50**(2): 158-162.

Khan, R.U. 2011. Antioxidants and poultry semen quality. *World. Poult. Sci. J.*, **67**: 297-308.

Khukhodziinai, S., Ayub Ali, M., Lallianchhunga, M.C., Goswami, R., Tolenkhomba T.C. and Mayengbam, P. 2021. Supplementation of chromium and vitamin C to alleviate cold stress in white leghorn chicken. *J. Entomo. Zoo. Stud.,* **9**(1): 1295-1298.

Kutlu, H.R. and Forbes, J.M. 1994. Effect of feeding ascorbic acid (Vit. C) and corticosteroneon performance and metabolism of broiler chicks. *Turk. J. Vet. Ani. Sci.,* **18**, 117-124

Mahmoud, K.Z., Edens, F.W., Eisen, E.J. and Havenstein, G.B. 2004. Ascorbic acid decreases heat shock protein 70 and plasma corticosterone response in broilers (*Gallus gallus domesticus*) subjected to cyclic heat stress. *Comp. Biochem. Physio. Part B Biochem. Mole. Biol.,* **137**, 35-42.

Mohammed, H.H., El-Sayed, B.M., Abd El-Razik, W.M., Ali, M.A. and Abd El-Aziz, R.M. 2014. The influence of chromium sources on growth performance, economic efficiency, some maintenance behaviour, blood metabolites and carcass traits in broiler chickens. *Glob. Vet. J.*, **12**: 599–605.

Olfati, A., Mojtahedin, A., Sadeghi, T. and Akbari. M. 2018. Comparison of growth performance and immune responses of broiler chicks reared under heat stress, cold stress and thermoneutral conditions. *Span. J. Agri. Res*., **16**(2): 1-7.

Perai, A.H., Kermanshahi, H., Nassiri, H. and Zarban, A. 2014. Effects of supplemental vitamin C and chromium on metabolicand hormonal responses, antioxidant status, and tonic immobility reactions of transported broiler chickens. *Biol. Trace Elem. Res.,* **157**(3): 224–233.

Phuong, H., Nguyen, M.S., Greene, E., Donoghue, A., Huff, G., Clark, D. and Dridi, S. 2016. A new insight into cold stress in poultry production. *Adv. Food Tech. Nutri. Sci.*, **2**(1): 1-2.

Puron, D., Santamaria, P. and Segura, J.C. 1994. Effect of sodium bicarbonate, acetylsalicylic and ascorbic acid on broiler performance in a tropical environment, *J. Appl. Poult. Res.*, **3**: 141-145.

Rajalekshmi, M., Sugumar, C., Chirakkal, H., Ramarao, S.V. 2014. Influence of chromium propionate on the carcass characteristics and immune response of commercial broiler birds under normal rearing conditions. *Poult. Sci.*, **93**(3): 574–580.

Rao, S.V.R., Raju, M.V.L.N., Panda, A.K., Poonam, N.S. and Sunder, G.S. 2009. Effect of vitamin E supplementation on performance, immununity and oxidative parameters in broiler starter chicks fed different sources of vegetable oil. *Ind. J. Poult. Sci.*, **44**(3).

Rebole, A., Rodriguez, M.L., Ortiz, M.L., Alzueta, L.J., Centerio, C., Vivros, C., Branes, A. and Ariza, I. 2006. Effect of dietary high oleic acid sunflower seed, Palm oil and vit-E supplementation on broiler performance, fatty acid composition and oxidative susceptibility of meat. *Brit. Poult. Sci.*, **47**: 581-91.

Sahin, K. and Sahin, N. 2002. Effects of chromium picolinate and ascorbic acid dietary supplementation on nitrogen and mineral excretion of laying hens reared in a low ambient temperature (7 °C). *Acta Vet. Brno*, **71**: 183-189.

Sahin, K., Sahin, N. and Ondercin, M. 2002b. Vitamin E supplementation can alleviate negative effects of heat stress on egg production, egg quality, digestibility of nutrients and egg yolk mineral concentrations of Japanese quails. *Res. Vet. Sci.*, **73**: 307–312.

Sahin, N. and Sahin, K. 2001. Optimal dietary concentrations of vitamin C and chromium picolinate for alleviating the effect of low ambient temperature (6.2°C) on egg production, some egg characteristics and nutrient digestibility in laying hens. *Vet. Med. J.*, **46**: 229-236.

Snedecor, G.W. and Cochran, W.G. 1994. Statistical methods, 7th Edn., Oxford and IBH publishing Co., New Delhi, 312-317.

Toghyani, M., Shivazad, M., Gheisari, A.A., Zarkesh, S.H. 2006. Performance, carcass traits and hematological parameters of heat stressed broiler chicks in response to dietary levels of chromium picolinate. *Int. J. Poult. Sci.*, **5**(1): 65-69.