RESEARCH ARTICLE Indian Journal of Animal Research, Volume 60 Issue 5: 839-845 (May 2026)

Effect of Supplementation of Different Levels of Trace Mineral Mixture on the Performance of White Pekin Ducks for Meat Production Purpose

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10.18805/IJAR.B-5510

ABSTRACT

Background: Duck meat consumption has been popularized and augmented during the past few decades and the better growth necessitates optimal mineral requirements. Over the past few decades, the consumption of duck meat has increased and become more popular and its improved growth requires the right minerals. Therefore, the present study was carried out conducted to find out the effect of supplementation of different levels of trace mineral mixture on the performance of White Pekin ducks for meat production purpose.

Methods: 180 day-old White Pekin ducks (180; day-old) were divided into three groups; with each group consist of four replicates; and each replicate had 15 ducklings. Three experimental diets feeds were prepared by supplementing a standard starter feed with TMM @ of 100 g (TMM-100), 200 g (TMM-200) and 300 g (TMM-300) per 100 kg diet and were offered randomly to the above three groups for eight weeks of age.

Result: The day-old body weight (51.67-52.02, g) and 8th week body weight (2155.02-2176.17, g) of the ducklings were similar among the groups. The daily feed intake at the 8th week of age in TMM-100 group (156.62 g) was similar to both TMM-200 group (154.77 g) and TMM-300 group (160.31 g). However, the cumulative feed intake up to 8 weeks in TMM-100 group (6.83 kg) was similar to TMM-200 group (6.83 kg) and both the groups were recorded higher feed intake than the TMM-300 group (6.60 kg). The feed conversion ratio up to 8 weeks (3.07-3.17) was similar among all the experimental groups. The eviscerated weight percentage (68.98-70.27) was similar among all the treatment groups. There is were no significant differences in various body parts as percentage of eviscerated weight *i.e.* legs (19.89-20.51), breast (27.99-29.11) and wings (15.57-17.08) among the experimental groups. However, the back expressed as percentage of eviscerated weight in TMM-100 group (23.11) was similar to TMM-200 group (24.23), but lower than TMM-300 group (24.69) recorded higher weight than other two groups. It can be concluded that trace mineral mixture can be supplemented @ 100- 200 g per 100 kg feed in the diet of White Pekin ducks up to 8 weeks of age for resulted better growth rate and meat production.

Key words: Ducks, Growth, Meat, Mineral, Supplementation, Trace, White Pekin.

INTRODUCTION

Duck meat consumption has been popularized and augmented during the past few decades owing to the high nutritional value packed with essential amino acids, fatty acids composed more of polyunsaturated fatty acids with a balanced proportion of omega-6 and omega-3 (Pingel and Germany, 2011; Naik *et al.,* 2022a; 2022b). The continuous selection pressure on the birds for better growth has further necessitated more mineral requirements for bone health (Swain *et al.,* 2023). recorded. In ducks, rapid bone growth and mineralization due to intensive selection for growth rate in ducks. Minerals have a significant role in bone mineralization and the growth of meat ducks (Zhang *et al.,* 2019). Minerals are essential to support several enzymatic systems enhancing antioxidant ability and immunity (Wang *et al.,* 2020). Micro minerals like manganese, copper, zinc, selenium and iron play significant roles in growth, reproduction, egg production and egg quality in ducks. Till dates, research have mostly concentrated on macro-nutrients (amino acids, crude protein, metabolizable energy). Therefore, the literature on duck mineral nutrition is comparatively scarce quite limited. Furthermore, among the minerals, macro-minerals have dragged most attention of the researchers, with scarce scanty literature on the micro-minerals (Cu, Fe, Mn, Zn and Se). To add on, most mineral nutrition studies have focused on requirements in chicken. Chicken and ducks differ in terms of digestion physiology (Jamroz *et al.,* 2002), digestibility of minerals (Adeola, 2006) and mineral deposition (Rodehutscord and Dieckmann, 2005). Compared to chickens, ducks possess a spindle-

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How to cite this article: Naik, P.K., Swain, B.K., Behera, R., Kumar, D., Beura, C.K., Sahoo, S.K. and Mishra, S.K. (2026). Effect of Supplementation of Different Levels of Trace Mineral Mixture on the Performance of White Pekin Ducks for Meat Production Purpose. *Indian Journal of Animal Research*. **60(5):** 839-845. doi: 10.18805/IJAR.B-5510.

Submitted: 28-10-2024 **Accepted:** 01-02-2025 **Online:** 03-03-2025

shaped widening at esophagus and proventriculus is fusi form. Ducks exhibit a faster transit rate of chime, consequentially a lesser mineral availability (Fan, 2003). Copper being a cofactor for many enzymes like pyruvate hydrolase,cytochrome oxidase, phydroxyphenyl, lysyl oxidase, tyrosinase *etc.* is highly essential micro-mineral in poultry nutrition (Leeson, 2009). However, copper requirement in meat duck is not given recommended by NRC (1994). Zinc is an essential mineral for structural and regulatory and catalytic functions. Growing ducks fed Zn-deficient diet exhibited stunted growth and lesions in pedal epidermis (Wight and Dewar, 1976). Severe Zn deficiency resulted in lower hatchability, anomalous embryonic development (Kienholz *et al.,* 1961). Manganese serves as a vital element of pyruvate carboxylase, arginase and superoxide dismutase. Iron is a component of protein heme in the red blood cell and myoglobin protein in muscle cells (Theil, 2004). Selenium is crucial element of selenoproteins needed for regulation of different physiological processes. Se deficiency injured fibroblast membranes and declined collagen synthesis in ducks (Brown *et al.,* 1982). Looking into the availability and role of minerals on duck nutrition, the present study was conducted to find out the effect of supple-mentation of different levels of trace mineral mixture on the performance of White Pekin ducks for meat purpose production.

MATERIALS AND METHODS

The study has been carried out in ICAR-Directorate of Poultry Research Regional Station, Bhubaneswar during 2022 - 2023. 180 day-old White Pekin ducklings (180; day old) were divided into three groups; with each group consists of four replicates and each replicate had 15 ducklings. A basal starter feed diet was prepared by mixing wheat (60 kg), soybean meal (25 kg), fishmeal (5 kg), deoiled rice bran (8 kg), oyster shell (1 kg), dicalcium phosphate (1 kg) and feed supplements (DL-methionine-50 g; lysine-50 g; vit. AD3B2K-20 g; vit E and Se -20 g; vit B Complex-20 g; toxin binder-100 g; choline chloride -100g; Salt-100g). Three experimental diets feeds were prepared by supplementing the above basal starter feed with TMM containing (Mn 11 g; Zn 10 g; Cu 2 g; Fe 11 g; Se 0.15 g; I 0.25 g; Co 0.125 g; Cr 40 mg per 100 kg feed) @ of 100 g (TMM-100), 200g (TMM-200) and 300 g (TMM-300) per 100 kg diet. The three experimental feeds diets were offered randomly to all the above three experimental groups for up to eight 8 weeks of age as per the suggested practical inclusion levels of nutrient requirements for White Pekin ducks 8 weeks (Singh and Panda, 1996). During the experiment, the ducks were reared on deep litter system and the respective diets were fed *ad libitumlib.* following standard management practices. During the feeding trial, a metabolic trial of 4-d collection period was conducted on six birds from each group (two birds from each replicate) in individual cages. The samples of feeds, residues and faeces were analyzed for proximate principles following standard procedures (AOAC, 1997). The metaboliszability of the nutrients was calculated as the difference between nutrient intake and nutrient voided. The data on feed intake was recorded daily, while the live weights were recorded weekly. At the end of eight weeks of age, four male ducks from each group *i.e.* one duck from each replicate was sacrificed following standard procedure for the study of the carcass characteristics. The statistical analysis of the data for any significant differences was conducted as per Snedecor and Cochran (1994).

RESULTS AND DISCUSSION

The chemical compositions (on % DM basis) of the experimental feeds are presented in (Table 1). The CP content and energy content ranged from 22.31-22.70% is maintained in the diets. The day-old body weights of the ducklings (51.67-52.027) were similar among all the treatment groups (Table 2). The mean body weigh at 6th week in TMM-100 group (1821.02 g) was similar to TMM-200 (1833.27 g) and TMM-300 groups (1719.92). Sahoo *et al.* (2014) has reported similar findings at 6th week of age body weight in White Pekin ducklings, while higher body weight was recorded by Farhat and Chavez (2000) and lower body weight than the present study was reported by Bhuyan *et al.* (2005). However, the mean body weight at 8th week (2155.02-2176.17, g) was similar among the experimental groups. The body weight gain during 4-6 weeks (673.60-736.44, g) was higher than 6-8 weeks (335.16-435.10, g). Many of the researchers have recorded a higher 8th week body weight at 8th week of age in Pekin ducks compared to our present study (Solomon *et al.,* 2006; Solomon *et al.,* 2007; Kuzniacka and Adamski, 2019) while a lower body weight was observed by many researchers (Ghosh *et al.,* 202; Rabbani *et al.,* 2019). In contrary to our present study, Yin *et al.* (2022) observed more body weight gain with greater supplementation of trace minerals. Baltic *et al.* (2016) recommended that trace mineral selenium supplementation @ 4 mg/kg feed imparted better growth rate in ducklings.

The daily feed intake at 6th week of age (158.44-162.59 g) was similar among the treatment groups (Table 3). However, the daily feed intake at 8th week of age in TMM-100 group (156.62 g) was similar to both TMM-200 group (154.77 g) and TMM-300 group (160.31 g). The cumulative feed intake up to 6 weeks and 8 weeks in TMM-100 group (4.55 and 6.83, kg) was similar to TMM-200 group (4.61 and 6.83) and both were higher than the TMM-300 group (4.33 and 6.60) (Table 4). The feed conversion ratio (FCR) up to 6 weeks (2.58-2.60) and 8 weeks (3.14-3.25) were similar among the experimental groups (Fig 1). The present our findings have been supported by Yin *et al.* (2022) who reported non-significant influence of dietary mineral supplementation on average daily feed intake and FCR. The data on metabolisability of various nutrients and nitrogen balances is presented in (Table 5). The metabolisability

(%) of dry matter (72.03-75.86), organic matter (73.24-76.86), crude protein (76.82-79.87), ether extract (83.74-85.16) and crude fibre (60.22-63.93) were similar among the treatment groups. Attia *et al.* (2013) recommended that supplementation of trace mineral zinc in Pekin duck diet can prevent clinical deficiencies and help the ducks to achieve their full genetic growth potential. Inorganic Zn supplemented @ 30 ppm exhibited positive impact on growth rate and Zn excretion in male White Pekin ducklings.

The slaughter body weight (2165.75 - 2234.00 g) and various body parts expressed as percentage of body weight *viz.* blood (4.80-5.63), feather (11.65-13.30), head (5.23-5.85), shank (2.85-2.98), heart (0.56-0.64), liver (1.69-1.74), gizzard (2.84-3.20), intestine (3.51-3.60) and eviscerated weight (68.98-70.27) was similar among the experimental groups (Table 6). There were no significant differences in various body parts as percentage of eviscerated weight *i.e.* legs (19.89-20.51), breast (27.99-29.11) and wings (15.57-17.08) among the treatment groups. However, the back as percentage of eviscerated weight in TMM-100 group (23.11) was similar to TMM-200 group (24.23), but lower than TMM-300 group (24.69). Our findings The observations of the present study being supported by findings of Attia *et al.* (2013) who observed supplementation of trace mineral copper at different concentrations exhibited non-significant influence on dressing percentage of the carcass and the feather, giblets or intestine. The researchers advocated

Table 1: Chemical composition (on % DM basis) of feeds.

Parameters	Feed		
	TMM-100	TMM-200	TMM-300
Nutrient content (% DM)			
Crude protein	22.70	22.31	22.62
Ether extract	1.56	1.61	1.54
Crude fibre	6.87	6.13	6.26
Nitrogen free extract	61.07	62.29	61.73
Total ash	11.80	11.66	11.85
Calculated			
Energy (ME, kcal/kg)	2811	2811	2811
Lysine (%)	1.22	1.22	1.22
Methionine (%)	0.46	0.46	0.46
Ca (%)	1.20	1.20	1.20
Available P (%)	0.92	0.92	0.92
Trace minerals (mg/kg feed)			
Mn (mg/kg)	155.12	265.12	375.12
Zn (mg/kg)	109.36	209.36	309.36
Cu (mg/kg)	32.57	52.57	72.57
Fe (mg/kg)	179.10	289.10	399.10
Se (mg/kg)	1.50	3.0	4.50
I (mg/kg)	2.5	5.0	7.5
Co (mg/kg)	1.25	2.50	3.75
Cr (mg/kg)	0.40	0.80	1.20

TMM-100: Diets without total mineral mixture 100 g/100 kg feed; TMM-200: Diets without total mineral mixture 200g/100kg feed; TMM-300: Diets without total mineral mixture 300 g/100 kg feed.

Table 2: Effect on weekly body weight (g) of ducks.

Age (weeks)	Groups			SEM
	TMM-100	TMM-200	TMM-300	
Day Old	52.02±1.04	51.98±0.30	51.67±0.87	0.47
1st week	158.35±4.28[b]	140.92±1.19[a]	130.42±7.19[a]	4.31
2nd week	349.77±5.07[b]	320.15±2.59[a]	323.94±10.90[a]	5.43
3rd week	674.30±20.60	627.62±16.99	655.02±14.40	10.82
4th week	1084.58±40.58	1115.68±16.35	1046.32±16.76	16.51
5th week	1464.50±49.13	1519.57±13.97	1423.63±15.56	19.96
6th week	1821.02±43.70[ab]	1833.27±17.15[b]	1719.92±29.44[a]	22.66
7th week	1986.52±51.73	1995.00±29.92	1969.40±82.57	30.90
8th week	2156.18±30.23	2176.17±34.67	2155.02±53.49	21.48

the dose as 8 mg/kg feed of inorganic Cu for male White Pekin ducklings (0-8 weeks) for optimal growth. However, Cu @ 150 mg/ kg feed significantly enhanced meat quality (more meat protein, lesser meat lipids and cholesterol). In another study, Zhang *et al.* (2020) recorded that trace mineral manganese when supplemented in layer duck breeder diet (up to 160 mg/kg of feed), influenced their tibial characteristics, overall production, serum biochemical and antioxidant status. In another study, Baltic *et al.* (2016) observed that ducks fed high-selenium diets (0.4 mg/kg

Table 3: Effect on daily feed consumption (g) (under DM basis).

Age (weeks)	Groups			SEM
	TMM-100	TMM-200	TMM-300	
1st week	35.59±0.22[c]	33.12±0.54[b]	31.01±0.55[a]	0.61
2nd week	76.95±0.62[c]	68.34±1.43[b]	62.35±0.53[a]	1.87
3rd week	114.85±2.75[b]	107.39±1.94[ab]	102.97±2.43[a]	1.94
4th week	136.38±1.10[b]	135.00±1.20[b]	127.20±1.45[a]	1.38
5th week	124.00±1.22[a]	156.50±0.96[c]	136.00±1.29[b]	4.09
6th week	162.50±1.55	158.50±1.32	159.00±0.71	0.84
7th week	168.62±1.78[b]	161.64±2.38[a]	163.81±2.06[ab]	1.40
8th week	156.50±1.04[ab]	154.75±1.55[a]	160.50±1.50[b]	1.02

Table 4: Effect on cumulative feed intake (g) (under DM basis).

Age (Up to)	Groups			SEM
	TMM-100	TMM-200	TMM-300	
1st week	249.10±1.56[c]	231.81±3.78[b]	217.07±3.83[a]	4.29
2nd weeks	787.76±4.82[c]	710.19±10.85[b]	653.50±7.09[a]	17.11
3rd weeks	1591.71±23.31[c]	1461.92±21.65[b]	1374.29±18.23[a]	29.11
4th weeks	2546.37±29.40[c]	2406.88±21.03[b]	2264.71±23.92[a]	37.05
5th weeks	3412.89±37.21[b]	3502.75±20.14[b]	3216.17±29.50[a]	39.29
6th weeks	4550.98±48.12[b]	4611.79±24.07[b]	4327.56±24.70[a]	40.94
7th weeks	5731.32±60.O9[b]	5743.26±36.50[b]	5474.23±31.19[a]	44.02
8th weeks	6827.64±60.91[b]	6826.61±35.46[b]	6596.38±29.5[a]	40.08

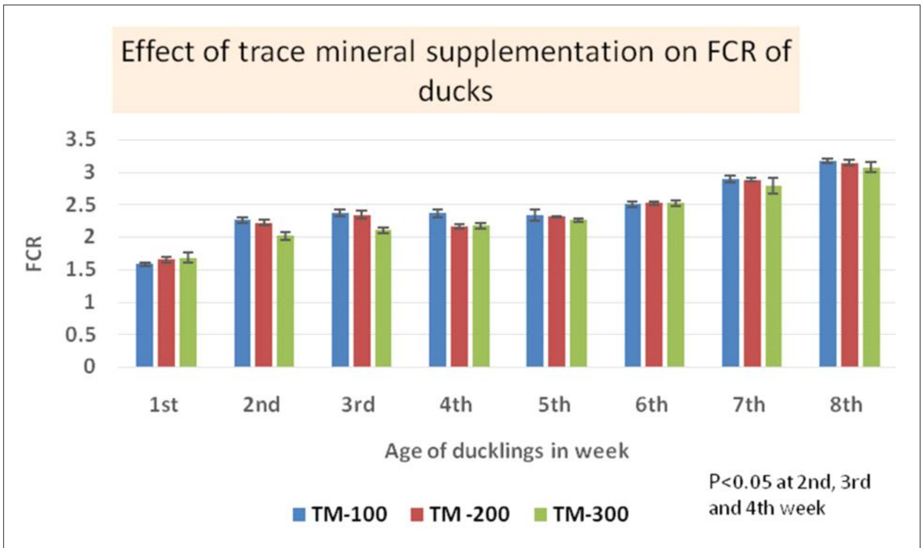
Table 5: Effect on metabolisability of various nutrients and nitrogen balances.

Parameters	Groups			SEM
	TMM-100	TMM-200	TMM-300	
DM Intake (g/d)	168.51±6.09[a]	193.04±5.90[b]	184.17±4.67[ab]	3.90
Metabolisability (%) of nutrients				
Dry matter*	74.94±1.22	75.86±1.60	72.03±2.00	0.97
Organic matter*	76.27±1.12	76.86±1.45	73.24±1.92	0.92
Crude protein*	78.98±1.09	79.87±1.39	76.82±1.67	0.82
Ether extract*	85.10±1.27	85.16±1.45	83.74±1.47	0.78
Crude fibre*	62.46±1.70	63.93±2.33	60.22±2.81	1.31
Nitrogen balances				
N intake (g/d)*	6.61±0.12[b]	6.83±0.21[b]	6.15±0.07[a]	0.11
N out go (g/d)*	1.36±0.07[ab]	1.50±0.09[b]	1.22±0.03[a]	0.05
N Balance (g/d)*	5.25±0.16	5.33±0.25	4.93±0.08	0.10
N balance as % of N intake*	79.43±1.15	78.04±1.63	80.16±0.53	0.69
Economics				
Cost of feed (Rs./kg)	36.47±0.00	36.61±0.00	36.76±0.00	0.04
Cost (Rs.)/kg live bird	115.57±0.93	114.91±1.46	112.74±2.94	1.09

*Means bearing different superscripts in a row differ significantly (P<0.05).

Table 6: Effect on carcass characteristics.

Parameters	Groups			SEM
	TMM-100	TMM-200	TMM-300	
Body weight (g)	2165.75±96.12	2191.00±65.43	2234.00±71.24	45.21
Body parts as a percentage of body weight				
Blood	5.02±0.60	4.80±0.30	5.63±0.62	0.30
Feather	11.92±1.43	11.65±1.01	13.30±0.56	0.60
Head	5.85±0.26	5.23±0.22	5.70±0.13	0.14
Shank	2.85±0.18	2.98±0.12	2.89±0.02	0.07
Heart	0.60±0.02	0.56±0.02	0.64±0.04	0.02
Liver	1.73±0.08	1.69±0.04	1.74±0.07	0.03
Gizzard	2.84±0.14	3.20±0.10	2.89±0.13	0.08
Giblet (Heart+Liver+Gizzard)	5.16±0.19	5.45±0.12	5.26±0.22	0.10
Intestine	3.51±0.07	3.53±0.11	3.60±0.17	0.07
Eviscerated weight	69.74±1.2	70.27±0.83	68.98±0.51	0.49
Cut off parts as a percentage of eviscerated weight				
Neck	11.22±0.25	10.31±0.57	9.87±0.62	0.31
Legs	19.89±0.25	20.10±0.33	20.51±0.25	0.16
Breast	27.99±0.96	28.81±0.87	29.11±0.61	0.45
Back	23.11±0.45[a]	24.23±0.44[ab]	24.69±0.40[b]	0.30
Wings	17.08±1.26	15.98±0.23	15.57±0.45	0.45
Processing loss (%)	0.71±0.13[b]	0.57±0.12[ab]	0.25±0.06[a]	0.08



TMM-10= Diet with 100 g trace mineral/100 kg feed; TMM-200= Diet with 200 g trace mineral/100 kg feed; TMM-100= Diet with 300 g trace mineral/100 kg feed.

Fig 1: Effect of trace mineral supplementation on feed conversion ratio of white pekin ducklings.

feed) exhibited significantly higher daily weight gain (15 to 49 days) and final bodyweight than the control or the group supplanted with supra-nutritional (0.6 mg/kg) selenium quantities. The effect of selenium supplementation in diet had non-significant effect on weights of the primal cuts.

CONCLUSION

It can Based on the above research findings, it is concluded that trace mineral mixture can be supplemented @ 100 - 200 g per 100 kg feed in the diets of White Pekin ducks up to 8 weeks of age for better growth rate and meat production.

ACKNOWLEDGEMENT

The authors are thankful to Indian Council of Agricultural Research (ICAR), New Delhi, for providing financial support to conduct this study.

Conflict of interest

All authors declared that there is no conflict of interest.

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