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Research Article

Effects of Form of Dietary Trace Mineral Premix on Fertility and Hatchability of Broiler Breeder Hens and Post-Hatch Performance and Carcass Parameters of Their Progenies

Seyyednaeim SABER [1,a] Hasan Rustu KUTLU [1,b] Yusuf UZUN [1,c]
Ladine CELIK [1,d] Ozcan YUCELT [1,e] Mikail BAYLAN [1,f]

[1] Çukurova University, Faculty of Agriculture, Department of Animal Science, TR-01330 Adana - TURKEY
[a] ORCID: 0000-0002-9635-7105; [b] ORCID: 0000-0002-3891-1534; [c] ORCID: 0000-0002-0493-7787; [d] ORCID: 0000-0003-3352-9181
[e] ORCID: 0000-0002-7371-5440; [f] ORCID: 0000-0002-6299-5811

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Abstract

The present study was conducted to investigate the effects of dietary inorganic and/or organic based trace mineral premix in full or half doses in broiler breeders' diet on hatchability, fertility, post hatch performance, and carcass parameters of broiler progeny. A total of 220 Ross-308, 36 wk-old broiler breeders were divided into 4 dietary treatments (100% inorganic, 50% organic + 50% inorganic, 50% organic, and 100% organic trace mineral premix) with 5 replicates of 10 females and 1 male in each pen having similar body weight and egg production. The results of this experiment showed that inclusion of trace minerals source type in broiler breeders' diet did not have a significant effect on hatching egg characteristic. The results, however, showed that diets containing full (100%) or half (50%) doses of organic and/or inorganic minerals in broiler breeder hens' diet have a significant effect on fertility rate (P<0.05). The results also showed that growth performance of offspring was, however, not affected by the trace mineral sources or level used in the maternal diets at the end, while carcass weight and carcass yield were significantly affected. It may be concluded that replacing inorganic based trace mineral premix with half or full dose of organic based trace mineral premix in the broiler breeder hens' diet could improve hatching performance, growth and carcass performances of their progenies.

Keywords: *Broiler breeder hen, Reproduction, Hatchability, Trace minerals, Progeny*

Broyler Dişi Damızlık Rasyonlarında Kullanılan İz Mineral Premiksi Formunun Üreme Performansı, Kuluçka Özellikleri ve Kuluçka Sonrası Civcivlerde Büyüme Performansı ve Karkas Parametreleri Üzerine Etkileri

Öz

Mevcut çalışma, rasyon bileşiminde kullanılan organik ve inorganik iz mineral premikslerinin broyler damızlıklarda döllülük oranı, kuluçka randımanı ve kuluçka sonrası civcivlerde büyüme performansı ve karkas parametreleri üzerine etkisini belirlemek amacıyla yürütülmüştür. Canlı ağırlık, yumurta verimleri benzer olan 36 haftalık yaşta toplam 220 adet Ross-308 broyler damızlık tavuk 4 muamele grubuna %100 inorganik, %50 organik + %50 inorganik, %50 organik ve %100 organik iz mineral premiks) her bir grup, her birinde 10 dişi ve 1 erkek bulunan 5 alt gruptan oluşturulmuştur. Rasyonda organik ve/veya inorganik premikslerin broyler damızlıkların beslenmesinde kullanımının kuluçkalık yumurta kalitesi üzerine önemli etkiye sahip olduğu saptanmıştır. Öte yandan, damızlık tavukların rasyonlarında %100 veya %50 oranında organik ve inorganik kaynaklı minerallerin kullanımının döllülük oranı üzerine olan etkisi önemli (P<0.05) bulunmuştur. Denemeden elde edilen sonuçlara göre dişi ebeveyinleri organik ve/veya inorganik iz mineral kaynakları ile beslenen civcivlerin performanslarının benzer; ancak rasyon organik iz mineral kaynağının civcivlerin karkas ağırlığı ve karkas randımanı üzerinde etkisinin olumlu olduğu saptanmıştır. Sonuç olarak broyler damızlık tavuk rasyonlarında inorganik iz mineral yerine %100 veya %50 organik iz mineral premiksi kullanımının broyler damızlıklarda kuluçka randımanı ve civcivlerinde büyüme performansı ve karkas verimini iyileştirdiği gözlenmiştir.

Anahtar sözcükler: *Broyler dişi damızlık, Üreme, Kuluçka Randımanı, İz Mineral, Civciv*

INTRODUCTION

Producing fertile eggs for gaining the highest hatchability is one of the important needs of having profitable chicken breeding. In poultry, many factors such as parents and environment may influence on production of egg characteristics [1] and its fertility [2]. In poultry, diets trace minerals are essential as they play important roles on

İletişim (Correspondence)
+90 531 3296266
naeim_saber@yahoo.com

male and female breeders' reproduction performance, biochemical processes required and embryo development [3-5]. It has been reported that good nutritional condition of the parents is vital for transferring of required nutrients for development of the embryo [6,7]. Some important interrelationships between several micronutrients and other nutrients have been reported and these interrelationships may affect the reproduction and production of hens, especially during the last period of production [8]. Zinc is one of the most important essential trace minerals for the growth, immune system function, reproduction, biochemical processes, and also is a cofactor for many metalloenzymes. During embryogenesis, zinc is reported to be a very important nutrient for embryo as utilizing of zinc during 11th to 17th days decreases from 0.99 mg to 0.01 [9]. Source of this mineral could also be an important factor as the inclusion of organic zinc (80 ppm zinc-methionine) in broiler breeders' diet improves cellular immune response [10]. It was reported that Cu has an influence on 17 beta-estradiol and enzymes involved in carbohydrate, lipid, and amino acid metabolism in mature laying hens [11]. Replacements of 30% inorganic sources of Zn, Mn, and Cu with organic sources of this micro-element in broiler breeders' diet have been reported to improve humoral immune responses [12] and gastro intestinal development of their offspring's [13]. It has also been reported that supplementation of broiler breeder hen's diets with simultaneous inorganic and organic forms of Zn, Mn, and Cu had significant effects on egg shell quality, embryo mortality, some bone mineralization parameters, tibia calcification, and thickness [14,15]. Iron (Fe) is also known an essential trace mineral for all living organisms, and it is required for several metabolic processes, including oxygen and electron transport as well as DNA synthesis [16]. Selenium is normally provided in the diet in the form of inorganic sodium selenite. An organic form can be provided, which is selenium-enriched yeast. Yeast, like plants, form selenoamino acids and other organic selenocompounds that exist in very reduced form in comparison to the highly oxidized inorganic selenium forms (selenite and selenate). The protective effects of organic selenium are reported to be especially apparent during the highly oxidative state of late incubation and the first few days after hatch [17,18]. Although some advantages have been obtained in recent years, inclusion of organic-based trace minerals in poultry diets could not be a common practice as they are expensive. It has been speculated that as the digestibility and bio-availability of organic based trace minerals are high, half dose of inorganic sources could be used in the premixes and then the cost could be reduced. The present experiment was conducted to determine if dietary inorganic vs. organic based trace mineral premix used in half (50%) or full (100%) or doses would affect fertility and hatching performance of broiler breeder hens and post-hatch performance and carcass parameters of their progenies.

MATERIAL and METHODS

The present study was carried out in the Broiler Unit of Experimental Farm of the Department of Animal Science, Faculty of Agriculture, University of Cukurova-Turkey. All the protocols used in this experiment were approved by the Animal Experiments Local Ethics Committee of Cukurova University, Adana-Turkey.

General Experimental Procedure and Trial Groups

In this experiment, two hundred and twenty, aging 36 weeks Ross-308 broiler breeders (200 female + 20 male) were used for 10 weeks. During pre-feeding period (36th to 39th weeks), all broiler breeder hens *(Table 1)* or cocks *(Table 2)* were fed with standard breeder hen's or cock's diets based on corn and soybean which were formulated according to the recommendation of Ross Breeding Company [19].

All birds after pre-feeding period were divided into four treatment groups according to mean body weight and mean egg production in a complete randomized design. The treatment groups were differ in dietary trace mineral premixes (A: 100% inorganic, B: 50% organic + 50% inorganic, C: 50% organic, and D: 100% organic) with five replicate pens. The contents of organic and inorganic trace minerals in premixes were shown in *Table 3*.

The birds were accomodated in 20 pens, each (2×1.5×2 m) included ten females and one male, wood shaving litter (7-8 cm height), female tubular feeder, one individual male feeder, and nipple drinkers. A 16:8 light:dark photoperiod program was applied and feeds were given to breeders (female: 163 g/day, male: 130 g/day) according to the recommendation of Ross Breeding Company [19] with ad libitum access to drinking water. During the experiment, environmental temperature (18-22°C) and humidity (55-60% RH) were maintained within the animal comfort zone using foggers and tunnel ventilation. Throughout the experiment, males' mating performances were watched every day. The male with low mating performance was replaced with a spare one.

Fertility and Hatching Performance

At the 43th week of age, eggs were checked and collected for fertility test (with bright light) to understand male broiler breeders reproduction performance before incubation. Hatching performance of the eggs obtained from the birds was examined at the end of 21 day incubation. For this purpose, at 44th and 45th weeks of age all eggs were selected (removing double yolk eggs, dirty eggs, thin shell eggs, broke eggs, and crack eggs) and stored in a cool room (12°C with 70% RH) until obtaining 700 eggs (35 for each replicate) The eggs were incubated in a single stage incubator (Cimuka Inc., Ankara, Turkey) at 37.2°C and a 10 RH of 55%) according to McQuoid [20]. At the end of 21st day

Table 1. *Ingredient and nutrient compositions of the experimental diets given broiler breeder hens*

Ingredients (%)	Trace Mineral Source of Experimental Diets			
	100% Inorganic	**50% Organic + 50% Inorganic**	**50% Organic**	**100% Organic**
Yellow corn	54.49			
Soybean meal (47.5% CP)	10.00			
Full fat soybean	9.64			
Sunflower meal (36% CP)	7.46			
Corn gluten meal (60% CP)	3.86			
Meat-bone meal (35%CP)	2.48			
DCP (18% P)	1.57			
Soybean oil	2.00			
Limestone	7.61			
Common salt	0.24			
Sodium bicarbonate	0.10			
L-Lysine	0.06			
Choline-60	0.05			
DL-methionine	0.04			
Vitamin premix[1]	0.20			
Trace mineral premix[2]	0.20 Inorganic	0.10 Inorganic + 0.10 Organic	0.10 Organic	0.20 Organic
Limestone	-	-	0.10	-
Total	100.00	100.00	100.00	100.00
Nutrients (%)				
Dry matter	88.52			
Crude protein	19.00			
Crude fiber	3.58			
Ether extract	3.71			
Ash	13.35			
Starch	34.99			
Lysine	0.87			
Methionine	0.37			
Methionine + Cystein	0.70			
Tryptophane	0.20			
Thronine	0.70			
Ca	3.64			
Available phosphorus	0.50			
Sodium	0.16			
Metabolizable energy (kcal/kg)	2680			

[1] Vitamin premix (per 2 kg of diets) 15.000.000 IU Vit. A, 5.000.000 IU Vit. D_3, 100.000 mg Vit. E, 3.000 mg Vit. K_3, 3.000 mg Vit. B_1, 8.000 mg Vit. B_2, 60.000 mg Niasin, 15.000 mg Ca-D-Pantotenat, 5.000 mg Vit. B_6, 20 mg Vit. B_{12}, 2.000 mg Folic Acid, 200 mg D-Biotin, 100.000 mg Vit. C; [2] see Table 3

incubation, all hatched broilers were carefully taken from the pouches and weighted by a digital scale with 0.01g sensitivity. After weighting, the chicks were sexed by wing feathers according to Ross [21] recommendation. Eggs that did not hatch were then broken to determine embryo diagnosis for classification of eggs as infertile or dead embryos. A visual estimation of the age at death stage was carefully performed and embryonic mortality was separated as early (1 to 7 days), intermediate (8 to 14 days) or late (15 to 21 days) dead in shell [22]. The percentage of hatching chicks considered improper for placement as well as pips were calculated. The difference between total eggs set and infertile eggs allowed the calculation of present hatchability of fertile eggs. So, fertility rate (%), total hatchability (%), and hatchability of fertile eggs (%) were calculated [23] as given below;

Table 2. *Ingredient and nutrient compositions of the experimental diets given broiler breeder cocks*

Ingredients	(%)	Nutrients (%)	
Yellow corn	62.44	Dry matter	86.89
Wheat middling	23.76	Crude protein	12
Sunflower meal-36	10.79	Crude fiber	5.96
Limestone (Grn)	1.18	Ether extract	3.30
DCP-18	0.70	Ash	4.80
Sodium bicarbonate	0.22	Starch	45.58
Salt	0.22	Ca	0.70
Carboxylic acid (Salkil)	0.20	TOT-P	0.63
L-Lysine	0.13	Na	0.16
Vitamin premix[1]	0.10	Metabolizable Energy (kcal/kg)	2750
Mineral premix[2]	0.10		
DL-methionine	0.06		
Choline-60	0.05		
Availa Se 1000 (Zinc-L-selenomethionine)	0.05		
Total	100		

[1] Vitamin premix (per 2 kg of diet): Vit. A, 16.000 IU; Vit. D_3, 3.000 IU; Vit. E, 40 IU; Vit. K_3, 2.5 mg; Vit. B_1, 2.5 mg; Vit. B_2, 10 mg; Nicotinamide, 50 mg; Calcium D-pantothenate, 15 mg; Vit. B_6, 6.25 mg; Vit. B_{12}, 0.035 mg; Folic acid, 15 mg; D-biotin, 0.045 mg; Choline chloride, 150 mg; [2] Mineral premix (mg/kg of diet): Mn, 80; Fe, 80; Zn, 60; Cu, 8; Co, 0.2; I, 0.5; Se, 0.15

Fertility rate (%) = (No of fertile eggs/No of eggs placed in hatchery) ×100

Total hatchability (%) = (No of chicks hatched/No of eggs placed in hatchery) × 100

Hatchability of fertile eggs (%) = (No of chicks hatched/No of fertile eggs placed in hatchery) × 100

Growth Performance of Progeny

At the end of the incubation, all chicks obtained from the eggs were carefully taken and divided into 20 pens by name of the maternal group/subgroup number to follow on the same axis to maternal to its chicks. Each treatment group had five pens sized 2×3 m that were equipped with a tube feeder, an automatic water-bowl on litter, and wood shaving litter with 7-8 cm height. During the experiment, all chicks were fed with starter (0-10 days of age), grower

***Table 3.** Sources and contents of trace mineral premixes in organic or inorganic forms used in the experiment*

Trace Mineral		Source	Source Amount in Mix	Trace Mineral Amount in Mix
Inorganic form (per 2 kg)	Manganese	$MnSO_4$ (32%)	250.000 mg	80.000 mg
	Iron	$FeSO_4$ (30%)	200.000 mg	60.000 mg
	Zinc	ZnO (72%)	83.333 mg	60.000 mg
	Copper	$CuSO_4$ (77%)	6.494 mg	5.000 mg
	Selenium	Na_2SeO_3 (4.5%)	4.444 mg	0.200mg
	Cobalt	$CoSO_4$ (20%)	1.000 mg	0.200 mg
	Iodine	Ca $(IO_3)_2$ (62%)	1.613 mg	1.000 mg
	Filling material	Limestone	1.453.116 mg	
	Total		2.000.000 mg	
Organic form (per 2 kg)	Manganese	Mintrex Mn (Metionin-Hid. Analog Mn Chelate 15.5%)	516.129 mg	80.000 mg
	Iron	Mintrex Fe (Methionine-Hid. Analog Fe Chelate 16.0%)	375.000 mg	60.000 mg
	Zinc	Mintrex Zn (Metionin-Hid. Analog Zn Chelate 17.5%)	342.857 mg	60.000 mg
	Copper	Mintrex Cu (Metionin-Hid. Analog Cu Chelate 18.0%)	27.777 mg	5.000 mg
	Selenium	ZORIEN SeY, 2% Se)	10 mg	0.200 mg
	Cobalt *	$CoSO_4$ (20%)	1.000 mg	0.200 mg
	Iodine *	$Ca(IO_3)_2$ (62%)	1.613 mg	1.000 mg
	Filling material	Limestone	735.614 mg	
	Total		2.000.000 mg	

** They have no organic form*

(11-21 days of age), finisher (22-35 days of age), and withdrawal (36-42 days of age) diets *(Table 4)* that they were formulated by Ross [21] recommendation.

During the experiment (42 days) all chicks were fed ad libitum under 23:1 light: dark photoperiod. Environmental temperature in animal house was controlled by heating and tunnel ventilation system starting from 33°C in the first week and gradually decreased by 3°C per week until the fourth week then it fluctuated between 22-24°C. During the experiment, live weight, feed intake, and feed efficiency were recorded weekly.

Carcass Parameters of Progeny

In order to determine the carcass weight, abdominal fat and carcass yield, at 42nd day of age all chicks were weighted and 6 chicks (3 males + 3 females) from each subgroup were selected according to the average body weight and then slaughtered.

Statistical Analysis

The data obtained in the study were analyzed using GLM (General Linear Model) procedure of the Statistical Analysis System [24] to obtain the effect of trace mineral source. Duncan's New Multiple Range Test in SAS was used to identify significant differences among treatments means [24]. Results obtained in this study were presented as means per bird with standard errors of the difference between means [SED; √(S^2/n)] with P values, except for feed intake of breeders as feeds were given to the them in equal amounts according to the recommendation of the Breeding Company [19].

RESULTS

Effects of dietary trace mineral sources on number of hatchable eggs in broiler breeders were given in *Table 5*. The results showed that source or dose of dietary trace minerals did not have any significant effects on number of hatchable eggs (P>0.05). But use of organic based trace minerals in broiler breeder hens' diet numerically increased number of hatchable eggs.

Results related fertility and hatching performance of broiler breeder hens were given in *Table 6*.

The data obtained from this experiment revealed that the inclusion of trace minerals in broiler breeders' diet have significant effects on some hatching performance such as number of fertile eggs, fertility rate, and offspring (female) livability (P<0.05). But inclusion of organic and inorganic trace minerals did have no significant effects on embryonic mortality, number of chicks hatched alive, chicks' weight at hatching, post-hatch mortality, hatchability of fertile eggs, total hatchability, and offspring (male) livability (P>0.05). In broiler breeders, some of hatching performance such as embryonic mortality in late stage, number of chicks hatched alive, hatchability of fertile eggs, post-hatch mortality, total hatchability and offspring (male) livability

Table 4. *Ingredient and nutritional compositions of broiler chicks' diets*

Ingredients (%)	**Starter (0-10 d)**	**Grower (11-21 d)**	**Finisher (22-35 d)**	**Withdrawal (36-42 d)**
Yellow corn	43.17	46.63	50.70	50.76
Soybean meal (47.5% CP)	15.64	7.71	-	-
Full fat soya	14.17	16.68	26.21	26.21
Wheat short (15% CP)	13.03	13.00	11.17	11.17
Maize gluten meal (60% CP)	5.00	3.00	-	-
Poultry offal meal (52% CP)	-	4.00	4.00	4.00
Meat-bone meal (33% CP)	4.00	5.27	4.49	4.49
Soya oil	2.00	2.00	2.00	2.00
DCP (18% P)	0.60	-	-	-
Sodium bicarbonate	0.11	0.08	-	-
Common salt	0.17	0.14	0.21	0.21
Bio-lysine (60%)	0.77	0.60	0.36	0.36
Limestone	0.61	0.28	0.26	0.26
DL-methionine	0.36	0.25	0.24	0.24
Anticoccidial	0.06	0.06	0.06	-
Vitamin Premix*	0.20	0.20	0.20	0.20
Mineral Premix**	0.10	0.10	0.10	0.10
Total	100.00	100.00	100.00	100.00
Nutrients (%)				
Dry matter	88.00	88.00	88.00	88.00
Crude protein	24.00	22.00	21.00	20.00
Ether extract	7.00	8.66	10.13	10.13
Crude fiber	3.20	3.17	3.37	3.37
Crude ash	6.03	5.80	5.48	5.48
Lysine	1.43	1.26	1.09	1.09
Methionine	0.70	0.56	0.50	0.50
Methionine + Cystine	1.07	0.84	0.86	0.86
Calcium	1.00	1.00	0.90	0.90
Available phosphorus	0.45	0.45	0.40	0.40
Sodium	0.16	0.16	0.16	0.16
Metabolizable energy (kcal/kg)	3050	3150	3250	3250

** Each 2 kg of vitamin premix contains 15.500.000 IU Vit. A, 5.000.000 IU Vit. D_3, 100.000 mg Vit. E, 3.000 mg Vit. K_3, 3.000 mg Vit. B_1, 8.000 mg Vit. B_2, 60.000 mg Niacin, 15.000 mg Ca-D-Pantotenate, 5.000 mg Vit. B_6, 20 mg Vit. B_{12}, 2.000 mg Folic acid, 200 mg D-biotin, 100.000 mg Vit. C; ** Each kg of inorganic trace mineral premix contains 80.000 mg Mn, 60.000 mg Fe, 60.000 mg Zn, 5.000 mg Cu, 200 mg Co, 1000 mg I, 200 mg Se (sodium selenite), 500.000 Choline chloride*

were numerically improved in the groups received diets containing organic based trace minerals. According to *Table 5*, the number of fertile eggs, fertility rate, total hatchability, hatchability of fertile eggs, and livability of broiler seemed to be higher in groups which received diets containing organic-based trace minerals than the groups which received 100% inorganic-based trace minerals.

Table 7 summarizes the impacts of dietary organic and inorganic trace minerals used in maternal diet on progeny performance.

The results indicated that source of trace mineral used in maternal diet did not have a significant effect on feed intake, feed conversion ratio, male livability, and male body mass of offspring ($P>0.05$). However, it was seen that source or amount of trace minerals in their female parents' diets had a significant effect on progenies' body weight at 21th days of age ($P<0.05$), while it was disappeared at the 42th days of age. The results also showed that inclusion of organic and inorganic trace minerals in broiler breeders' diet have significant effects on female livability, female body mass, and average body mass in offspring ($P<0.05$).

Table 8 illustrates the data obtained from carcass parameters of offspring. The results indicated that the inclusion of

Table 5. *The effect of maternal dietary trace minerals on hatching egg characteristic (Number/group/2 weeks)*

Parameters	Groups				SED	P
	100% Inorganic	50% Organic + 50% Inorganic	50% Organic	100% Organic		
No of total egg	82.0	85.2	79.6	87.4	2.88	0.784
No of hatchable eggs	70.6	75.6	67.6	75.4	2.32	0.563
No of un-hatchable eggs	11.40	9.60	12.00	12.00	1.02	1.818
Double yolk eggs	-	-	-	-	-	-
Dirty eggs	5.0	5.2	5.8	5.4	0.81	0.987
Thin shell eggs	0.2	0.0	0.0	0.0	0.05	0.418
Broke eggs	1.0	0.8	0.8	1.0	0.17	0.952
Crack eggs	5.0	3.6	5.6	5.6	0.78	0.777

Table 6. *Effect of maternal dietary trace minerals on hatching performance in broiler breeders*

Parameters	Groups					
	100% Inorganic	50% Organic + 50% Inorganic	50% Organic	100% Organic	SED	P
Number of eggs placed hatchery (no/replication)	39	39	39	39	-	-
Number of fertile eggs (number/replication)	33.00^{b}	37.00^{a}	34.60^{ab}	36.00^{ab}	0.48	0.058
Embryonic mortality in early stage	1.66	1.33	1.00	2.00	0.19	0.731
Embryonic mortality in mid stage	-	-	-	-		-
Embryonic mortality in late stage	3.50	3.00	2.20	2.33	0.32	0.509
Number of chicks hatched alive	26.00	31.00	30.20	30.75	1.31	0.542
Male (number)	11.75	15.40	15.80	15.25	0.94	0.452
Female (number)	14.25	15.60	14.40	15.50	0.79	0.892
Chicks' weight at hatching (g/chick)	48.71	48.15	47.50	46.91	0.29	0.174
Post-hatch mortality (number)	2.66	2.20	2.00	2.25	0.38	0.962
Fertility rate (%)	84.62^{b}	94.87^{a}	88.71^{ab}	92.30^{ab}	1.24	0.058
Hatchability of fertile eggs (%)	78.21	83.42	87.03	85.17	2.97	0.763
Total hatchability (%)	66.66	79.48	77.43	78.84	3.35	0.542
Offspring - livability - male (%)	82.69	95.00	84.17	100.00	3.00	0.181
Offspring - livability female (%)	96.87^{a}	95.24^{a}	85.41^{b}	96.65^{a}	1.54	0.051

^{a,b} *Means within a row lacking a common superscript differ significantly (P<0.05)*

different forms and levels of trace minerals in maternal' diet had a significant effect on offspring carcass weight, and carcass yield (P<0.05) without a significant effect on abdominal fat (P>0.05).

DISCUSSION

It is well known that fulfilment of dietary trace mineral needs of poultry is very important to maintain production and product quality. Trace minerals such as iron, manganese, zinc, copper and selenium play many significant roles as enzyme cofactors and as constituents of metalloenzymes, either individually or in combination, in supporting growth, production and maintenance of the structural integrity of tissues. As the efficacy of the use of microelements is an important issue in modern poultry nutrition, various studies on sources and their bioavailability of trace minerals have been under investigation [25]. The availability of minerals from feed materials of plant origin, as well as from traditional inorganic sources, *i.e.*, oxides, sulphates, or carbonates, is relatively low, while the requirements of modern, high-producing lines of laying hens and broiler chickens for microelements are very high. These facts, along with advanced knowledge of the importance of micro-elements in immunological processes and reproduction and the variable content of trace minerals in feed materials, has lead, in commercial practice, to their being added to poultry diets in high amounts, with a large safety margin, often exceeding the birds' requirements [26], leading to soil and water pollution through excrete. In recent years, use of organic based trace minerals in poultry could be of value in terms of fulfilment of trace mineral needs of farm

Table 7. *The effect of maternal dietary trace minerals on growth performance of offspring*

Day	Parameters	Groups				SED	P
		100% Inorganic	50% Organic + 50% Inorganic	50% Organic	100% Organic		
7	Feed intake (g/chicks)	190.9	166.40	192.88	160.91	12.22	0.717
	Body weight (g/chicks)	96.54	111.52	102.79	108.10	2.53	0.213
	Feed Conversion Rate	1.99	1.52	1.87	1.49	0.12	0.414
14	Feed intake (g/chicks)	508.4	506.52	515.33	518.95	11.98	0.980
	Body weight (g/chicks)	383.3	407.93	398.03	404.97	5.17	0.367
	Feed Conversion Rate	1.32	1.24	1.28	1.28	0.02	0.684
21	Feed intake (g/chicks)	1193	1187	1230	1291	31.76	0.645
	Body weight (g/chicks)	789.1^{b}	831.7^{ab}	837.2^{ab}	866.2^{a}	8.23	0.032
	Feed Conversion Rate	1.51	1.42	1.46	1.49	0.03	0.796
28	Feed intake (g/chicks)	2223	2254	2287	2362	49.66	0.781
	Body weight (g/chicks)	1402	1332	1315	1371	21.24	0.482
	Feed Conversion Rate	1.59	1.69	1.73	1.73	0.04	0.618
35	Feed intake (g/chicks)	3225	3444	3570	3569	63.19	0.214
	Body weight (g/chicks)	1940	1969	1973	2046	21.84	0.389
	Feed Conversion Rate	1.66	1.74	1.80	1.74	0.03	0.389
42	Feed intake (g/chicks)	4638	4757	4998	4974	69.78	0.238
	Body weight (g/chicks)	2614	2645	2709	2764	30.11	0.329
	Feed Conversion Rate	1.77	1.80	1.84	1.80	0.02	0.699

^{a,b} *Means within a row lacking a common superscript differ significantly (P<0.05)*

Table 8. *The effect of maternal dietary trace minerals on carcass parameters of offspring at 42 days old*

Parameters	Gender	Groups				SED	P
		100% Inorganic	50% Organic + 50% Inorganic	50% Organic	100% Organic		
Body weight (g/chicks)	Male	2949	2990	3051.	3001	17.07	0.218
	Female	2439^{b}	2428^{b}	2558^{a}	2559^{a*}	16.54	**0.004**
	Average	2645^{b}	2709^{ab}	2804^{a}	2780^{b}	18.01	**0.009**
Carcass weight (g/chicks)	Male	2107^{ab}	2078^{b}	2188^{a}	2109^{ab}	14.25	**0.046**
	Female	1735^{b}	1714^{b}	1817^{a}	1836^{a}	12.22	**0.009**
	Average	1886^{b}	1896^{b}	2003^{a}	1972^{a}	13.28	**0.004**
Abdominal fat (g/chicks)	Male	19.31	19.80	16.64	21.11	0.91	0.375
	Female	17.11	15.24	15.27	17.51	0.88	0.475
	Average	17.53	17.52	15.96	18.89	0.59	0.387
Abdominal fat (%)	Male	0.90	0.94	0.76	1.00	0.04	0.203
	Female	0.98	0.88	0.84	0.96	0.05	0.712
	Average	0.92	0.92	0.79	0.96	0.03	0.230
Carcass yield (%)	Male	71.39^{a}	69.524^{b}	71.71^{a}	70.32^{ab}	0.29	**0.035**
	Female	71.15	70.66	71.06	71.72	0.24	0.475
	Average	71.29^{a}	70.03^{b}	71.39^{a}	70.96^{ab}	0.02	0.067

^{a,b} *Means within a row lacking a common superscript differ significantly (P<0.05)*

animals while having less pollution and health problems as advised to use almost half as its high bioavalilibility. Recommendation for using organic based (chelated) trace minerals, containing a central metal atom (acceptor of electrons) together with ligands *(i.e.*, proteins, amino acids, carbohydrates, or lipids), at relatively low levels in poultry diets has become widespread, especially due their ecological and physiological contributions; however there still is not enough experiment [27]. In fact, supplementing hens with highly bioavailable chelated sources of trace minerals would be expected to support not only the quality of eggs from breeder hens, but also hatching rate and progeny quality. The results obtained from the present study showed that replacing inorganic based trace mineral premix with half or full dose of organic based trace mineral premix in the broiler breeder hens' diet could improve hatching performance, growth and carcass performances of their progenies, as expected. The increments could be attributed to relatively high bioavilability and fulfilment capacity of animal needs for the trace minerals. Zinc is known to be a component of the carbonic anhydrase enzyme, which is crucial for supplying the carbonate ions during eggshell formation [28]; manganese is the metal activator of enzymes that are involved in the synthesis of mucopolysaccharides and glycoproteins that contribute to the formation of the organic matrix of the shell [29], and copper plays the role of cofactor of the lysyl-oxydase enzyme that is important in the formation of collagen cross links present in the egg shell membrane [30]. Not only zinc but also adequate Fe levels are also needed to maintain egg production and as well as hatching chicks' indexes. Taschetto et al.[31] reported that the average of dietary Fe requirement for broiler breeders' hen estimated to be about 100 ppm total. In the present study we provided 60 ppm supplemental Fe, but it is unknown what was the total Fe and other trace minerals in the diet, as no measurements for the trace elements examined in the present study were done for the diet before supplementation. Although we did not measure the contents of the trace minerals in the egg, our results with respect to growth and carcass performances of progenies suggest that organic based trace minerals had positive effects on, not only maternal, also progeny through eggs, as zinc is reported to be a very important nutrient for embryo as utilizing of zinc during 11th to 17th days decreases from 0.99 mg to 0.01 through embryonal development [9]. Sahin and Tasdemir [32] reported that 60 mg/kg organic based zinc (Zn-RedoxMin) supplementation instead of inorganic sources ($ZnSO_4$, ZnO and $ZnCl_2$) to breeder diets improved their chick quality and weight, but not feed conversion rate. Zamani et al.[33] reported that feeding layer hens with a diet containing different levels of manganese and zinc reduced number of crack-broken eggs while increasing egg production. The results of the present experiment revealed that replacing inorganic source with organic based source in half or full dose of trace mineral in broiler breeder hens' diets does not have a significant effect on hatching egg characteristics ($P>0.05$), however, some hatching performance parameters were affected by dietary trace mineral forms. The results obtained from this study were in line with Chen et al.[34] and Attia et al.[35] studies. Chen et al.[34] reported that inclusion of 250 mg copper ($CuSO_4$) in layer hens' diet increased concentration of copper in blood plasma and yolk, induced cholesterol content in yolk and blood plasma, and induced fertility rate but did not have any significant effect on total hatchability ($P>0.05$). On the other hand, it was reported that adding manganese, zinc, copper, and chromium in organic and inorganic form in layer breeders' diet did not have significant effects on laying performance and egg quality ($P>0.05$) but organic form of these minerals improved hatchability and hatching yield parameters [36]. In fact, it has been speculated that inorganic trace element does not fulfill trace element requirements of modern poultry due to their less bioavailability and negative interaction [37,38]. Organic based trace minerals could be of value as many reports have been published on their positive effects in layer, broiler and also turkey performance [14,15,39,40]. Previous studies also revealed that efficacy of organic based trace minerals in broilers could decrease as birds age increased [41,42]. However, no observations have been reported on efficacy of organic based trace minerals in breeders differing in age. Inclusion of inorganic (sulfate) and organic (amino acid chelate) forms on zinc in broiler breeders' diet improved reproduction performance while the immunity was positively affected by amino acid chelate form of zinc [43]. Inclusion of different forms of trace mineral in broiler breeders' diet does not have a significant effect on offspring receiving conventional (inorganic) trace mineral premix feed intake, feed conversion ratio ($P>0.05$), but there was a significant effect on female livability and average body mass ($P<0.05$). Rebel et al.[44] indicated that contents of lymphocyte resistance to various infections in offspring are increased due to feeding of their parents with a diet containing high levels of vitamin and minerals. The results with respect to positive effects of organic based trace elements on fertility and hatching performance of breeder hens and growth performance of progenies could be attributed to their higher bio-efficacy in their physiological roles from egg to hen. Sun et al.[45] reported that adding of organic form of Zn, Mn, and Se (Mintrex) instead of inorganic form of these microelements in broiler breeders' diet protected breeders from lipid peroxidation, increase their retention in the egg, and had a positive effect on growth performance of their offspring. Our results with respect to inclusion level of organic based trace minerals also supported the report of Aksu et al.[46], they concluded that organically complexed trace minerals can be used at a much lower concentration than the current recommended as inorganic based minerals, without a negative impact on performance, while also decreasing the excess mineral excretion.

In could be concluded that use of organic-based trace mineral (50% or 100%) in broiler breeder's diet improve number of total eggs and hatching eggs, fertility rate, total hatchability, hatchability of fertile eggs and also progeny livability. It would also be concluded that using organic-based trace mineral (50% or 100%) in broiler breeder's diet improve body mass and carcass yield of offspring.

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