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Effect of dietary manipulation on production, reproduction and immunocompetence traits in turkey breeder hens

A BHATTACHARYYA[1], S MAJUMDAR[2], S K BHANJA[3], A B MANDAL[4], B B DASH[5] and M M KADAM[6]

Central Avian Research Institute, Izatnagar, Uttar Pradesh 243122 India

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ABSTRACT

Turkey breeder hens (200) and viable toms (24) of 30–35 weeks of age of small white variety were distributed into 2 treatment groups having 4 replicates of 25 hens and 3 toms in each treatment. First four replicates were offered turkey breeder diet (diet A) (NRC 1994) and other 4 replicates were offered high immune diet (diet B) having 115% amino acids, 1% each omega-6 and omega-3 fatty acids, retinol- 4.95 mg, DL-α-tocopherol- 199.86 mg, ascorbic acid –150 mg, selenium- 0.5 mg and zinc–118 mg / kg diet for 8 week duration. After 6 weeks of experimental feeding, 2 replicates from each treatment groups were vaccinated with ND (R_2B) vaccine. Average egg weight of birds fed diet B was significantly higher after 6 weeks of experimental feeding than diet A. Per cent fertility and per cent hatchability on total egg set basis was better in the birds fed diet B than diet A. Chicks hatched from the birds fed diet B were heavier than the birds fed diet A. Total immunoglobulins, IgG and IgM response to sheep red blood cells were also higher in the diet B than diet A. Birds fed diet B had better cell-mediated immune response than birds fed diet A. Birds fed diet B had significantly higher HI titer against R_2B vaccination than those fed diet A at 7 days post vaccination. Hence, it may be concluded that turkey breeders may be fed high immune diet to enhance egg weight, chick weight, fertility, hatchability and immune response.

Key words: Diet, Fertility, Hatchability, Immunity, Turkey breeder hens

Nutrition plays a pivotal role in the development and function of the immune system both *in ovo* and post-hatch. Activation of the immune system reduces bird performance because of decreased food intake and changes in nutrient metabolism (Humphrey 2010). Hence, studies on interactions between the immune signaling pathways and productivity signaling could provide the basis for the formulation of diets that optimize disease resistance (Kogut and Klasing 2009). While amino acids act as substrates for the immune system and branched chain amino acids being most potent among them; fatty acids bind to intracellular receptors or modify the release of secondary messengers. Vitamins like A, D and E supply substrates to the immune system and also bind to intracellular receptors and modify the release of secondary messengers there by regulating the action of leucocytes (Klasing 1998). Besides, nutrient composition of the diet also affects the composition of the yolk and thereby embryonic development. Palmitic acid facilitates increased yolk mobilization by the embryo and thus increases hatchability (Vilchez *et al*. 1992). The present study was undertaken to evaluate the effect of dietary manipulation on the immune response, production and reproduction indices in turkey breeder hens.

MATERIALS AND METHODS

Experimental birds and diets: Two hundred turkey breeder hens and twenty-four viable toms of 30–35 weeks of age of small white variety were distributed into two treatment groups having four replicates of 25 hens and 3 toms in each treatment. First four replicates were offered turkey breeder diet, diet A (NRC 1994) and other four replicates were offered a high immune diet, Diet B having 115% amino acids, 2% higher fatty acid than the basal diet (1% each linoleic acid and linolenic acid), Retinol- 4.95 mg, DL-α-tocopherol–199.86 mg, Ascorbic acid –150 mg, selenium- 0.5 mg and zinc-118 mg per kg diet for 8 week duration (Tables 1 and 2).

Production indices: Hen house egg production and egg weight were determined at fortnightly intervals.

Reproduction indices: The 500 eggs were collected after 8 weeks of experimental feeding and set for hatching of turkey poults. The hatchability indices were determined.

General immune response: After six weeks of

Present address: [1]Assistant Professor (amitav16 @rediffmail.com), Department of Poultry Science, College of Veterinary Science and Animal Husbandry, Mathura, [2,3,4]Principal Scientist (samir_cariturk@yahoo.co.in, skbhanja @rediffmail.com, abmcari@rediffmail.com). [5]Senior Scientist (bbdash08@gmail.com), Indian Veterinary Research Institute, Mukteshwar. [6] Assistant Professor (mukundkadam@gmail.com), Department of Poultry Science, Nagpur Veterinary College, Nagpur.

Table 1. Gross composition of diets A and B

Feed ingredients	Diet A	Diet B
Maize[1]	636	628
Deoiled rice bran[1]	126	71.5
Soybean meal[1]	75	140
Fish meal[1]	50	50
Sunflower meal[1]	0	11
Linseed oil[1]	0	16.5
Lard[1]	30	0
Dicalcium phosphate[1]	15	15
Limestone[1]	62.5	62.5
Trace mineral premix[1]	0.5	0.5
Vitamin premix[1]	0.7	0.7
Lysine[1]	0.3	0
Retinol[2]	0	2.75
DL-α-tocopherol[2]	0	145
Ascorbic acid[2]	0	150
Zinc Sulphate[2]	0	125
Sodium Selenite[2]	0	1.3
Choline chloride[1]	1	1
Salt[1]	3	3

[1]Expressed as g/kg. [2]Expressed as mg/kg.

Table 2. Nutrient composition of diets A and B of turkey breeders

Nutriments	Unit	Diet A	Diet B
ME[1]	kcal/ kg	2903.18	2904.49
CP[2]	%	14.04	16.13
Linoleic acid[1]	g/kg	12.4	22.6
Linolenic acid[1]	g/kg	0.8	10.2
Retinol[1]	mg/kg	2.2	4.95
DL-α-tocopherol[1]	mg/kg	35.17	199.86
Ascorbic acid[1]	mg/kg	0	150
Zinc[1]	mg/kg	59.52	118.06
Selenium[1]	mg/kg	0.2	0.52
Calcium[2]	g/kg	30.8	31
Available Phosphorous[1]	g/kg	5.5	5.5
Lysine[1]	g/kg	6.2	7.4
Methionine[1]	g/kg	2.7	2.9
Arginine[1]	g/kg	8.1	9.8
Threonine[1]	g/kg	5.1	5.9
Tryptophan[1]	g/kg	1.4	1.8
Isoleucine[1]	g/kg	5.5	6.6
Leucine[1]	g/kg	14.2	15.8
Phenylalanine[1]	g/kg	6.9	8.0
Valine[1]	g/kg	6.9	7.9
Histidine[1]	g/kg	3.8	4.4
Glycine[1]	g/kg	5.9	6.2

[1]Calculated values. [2]Analysed values.

experimental feeding, two replicates from each treatment groups were vaccinated with ND (R_2B). The other two replicates in each group were used to study the general immunocompetence traits. The antibody response to 1% SRBC was determined using a standard haemagglutination assay (Siegel and Gross 1980, Van der Zijpp 1983). Further, 2-mercaptoethanol resistant antibody response (MER or IgG) and mercaptoethanol sensitive antibody response (MES or IgM) to SRBC was determined using a standard procedure (Martin *et al*. 1989). The cellular immune response was assessed in 25 birds from each of the non-vaccinated groups using the *in vivo* cutaneous basophilic hypersensitivity response to lectin phytohaemagglutinin from *Phaseolus vulgaris* (PHA-P) (Corrier and DeLoach 1990).

Hemagglutination inhibition titer: A blood sample (2 ml) was obtained from the jugular vein of 15 birds from each of the vaccinated replicates at 7 and 14 days post vaccination to determine the haemagglutination inhibition response ($\log_2$) to ND vaccine (R_2B) as described by Allan and Gough (1974).

Reproduction indices: The 500 eggs were collected after 8 weeks of experimental feeding and set for hatching of turkey poults. The hatchability indices were determined.

Statistical analysis: Data obtained from above experiment were analysed as per the standard statistical procedure (Snedecor and Cochran 1980). Significant differences among treatment means were calculated as per Duncan's multiple range test (Duncan 1955).

RESULTS AND DISCUSSION

Production indices: There was no significant difference in egg production per hen day among the birds fed either diet A or diet B during the experimental feeding. Further, the average egg weight of birds fed diet B was higher than those fed diet A throughout the experiment. However, there was no significant difference in feed conversion ratio among treatment groups during the experimental feeding (Table 3). In the present experiment, the birds were offered a high immune diet having amino acids 115% of NRC. Kaur (2005) also reported that eggs of Japanese quails fed 115% essential amino acid were heavier when compared with the control group. Kingori *et al*. (2010) noted that an increased maternal dietary protein level resulted in an increase in egg weight in indigenous chickens. Similarly, Jennifer *et al*. (2005) also reported that layers fed a low protein diet laid eggs having weight significantly lower ($P<0.01$) than the control diet.

Reproduction indices: Per cent fertility and percent hatchability on total egg set basis was better in the birds fed diet B than that of diet A. However, per cent hatchability on fertile egg set basis did not differ between the two groups (Table 4). Vilchez *et al*. (1992) also reported that adding corn oil, palmitic acid, oleic acid or linoleic acid to basal diet increased hatchability and decreased late embryonic mortality. Chicks hatched from the birds fed diet B were numerically heavier than the birds fed diet A. This is in corroboration with the results of Kaur (2005), who also observed that weight of chicks were numerically higher hatched from eggs of Japanese quails fed 115% essential amino acid. Ng'ambi *et al*. (2013) reported that heavier eggs hatched heavier chicks in Venda chicken. Similar observations were also made in the present study.

Immune response: Total immunoglobulins, mercaptoethanol resistant (IgG) and mercaptoethanol sensitive (IgM) antibody titer ($\log_2$) values in response to

Table 3. Effect of breeder diets on production performance of turkey hens

Diet	2nd wk	4th wk	6th wk	8th wk
Egg production per hen day				
Diet A	0.37	0.35	0.30	0.29
Diet B	0.38	0.33	0.28	0.27
Pooled SEM	1.41	1.90	2.09	2.05
Sig level	NS	NS	NS	NS
Average egg weight (g)				
Diet A	79.35	79.49	79.34^a	82.62
Diet B	79.47	79.84	82.02^b	83.95
Pooled SEM	0.46	0.51	0.66	0.87
Sig level	NS	NS	p<0.05	NS
FCR as per dozen eggs				
Diet A	7.07	7.34	9.08	8.76
Diet B	6.24	7.83	10.00	10.77
Pooled SEM	0.27	0.43	0.69	0.88
Sig level	NS	NS	NS	NS
FCR as per kg egg mass				
Diet				
Diet A	7.42	7.68	9.54	8.84
Diet B	7.07	8.18	10.14	10.66
Pooled SEM	0.28	0.44	0.67	0.84
Sig level	NS	NS	NS	NS

FCR, Feed conversion ratio; means bearing different superscripts in a column differ significantly (P<0.05); NS, non-significant (P>0.05).

Table 5. Effect of breeder diets on immune response parameters of turkey hens

Diet	Total Immunoglobulin	IgG	IgM
Humoral immune response to 1% SRBC (log_2 titer)			
Diet A	7.0	2.2	4.8
Diet B	7.52	2.28	5.24
Pooled SEM	0.24	0.13	0.16
Sig level	NS	NS	NS
Cell mediated immune response (Response to PHA-P)			
Diet	Foot pad index		
Diet A	0.29		
Diet B	0.36		
Pooled SEM	0.044		
Sig level	NS		

NS, Non-significant (P>0.05); foot web index (mm) = (thickness after 24 h injection of PHA-P of right foot- thickness before injection of the same foot) - (thickness after 24 h of injection of PBS of left foot - thickness before 24 h of injection of PBS of the same foot).

1% SRBC were higher in the diet B fed groups than diet A groups. Further, birds fed diet B had comparatively better *in vivo* PHA-P cell-mediated immune response than the birds fed diet A (Table 5). In addition, birds maintained on a higher plane of nutrition had significantly higher (P<0.01) haemagglutination inhibition titer (log_2) values (HI) against ND, R_2B vaccination at 7 day-post-vaccination. However, no such difference was observed at 14 days post vaccination

Table 6. Effect of breeder diets and breeder vaccination on HI titer (log $_2$) at 7 and 14 days post ND vaccination in turkey hen serum

Group	7 days	14 days
Diet A	2.75	3.0^a
Diet A Vaccinated	6.17	7.5^c
Diet B	4.88	5.1^b
Diet B Vaccinated	6.97	6.83^c
Diet		
Diet A	4.46^a	5.25
Diet B	5.93^b	5.97
Vaccination		
Non-vaccinated	3.82^a	4.05^a
Vaccinated	6.57^b	7.17^b
Pooled SEM	0.24	0.24
Sig level		
Diet	P<0.01	NS
Vaccination	P<0.01	P<0.01
Diet X Vaccination	NS	P<0.01

Means bearing different superscripts in a column differ significantly (P<0.01); NS, nonsignificant (P>0.05).

Table 4. Effect of breeder diets on hatchability indices of turkey hens

Diet	Egg weight (g)	Chick weight (g)	Fertility (%)	Hatchability on total egg set (%)	Hatchability on fertile egg set (%)
Diet A	78.4	49.5	71.83	47.22	65.8
Diet B	79.2	50.1	79.44	51.61	65
Pooled SEM	0.21	0.24			
Sig level	P<0.05	NS			

Means bearing different superscripts in a column differ significantly (P<0.05); NS, nonsignificant (P>0.05).

(Table 6). Others who noted that nutrition plays a pivotal role in modulating immune response also reported similar findings (Torki *et al*. 2003, Xia *et al*. 2003, Gonzalez *et al*. 1995, Bertuzzi *et al*. 1998). Torki *et al*. (2003) reported that antibody production against sheep red blood cells in chicks fed a diet with a higher ratio of n-3: n-6 PUFA was higher among the dietary groups where as moderate dietary ratio of n-3: n-6 PUFA improved antibody production against New Castle disease virus. Similarly Xia *et al*. (2003) found that antibody titres in fish oil and linseed oil supplemented diets were higher than that of laying hens fed corn oil. In the present study 1.65% linseed oil was supplemented to increase the linolenic acid (omega-3) content of the diet which might have influenced the antibody production against SRBC. Further, in the present study, the vaccinated birds had significantly higher (P<0.01) HI titer both at 7 and 14 days post-vaccination. Diet A and diet B vaccinated groups had significantly higher (P<0.01) HI titer compared to the other treatment groups at 14 days post-vaccination.

These results lead us to conclude that turkey breeders fed a high immune diet may enhance egg weight, chick weight, fertility, hatchability and also elicit better immune response.

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