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Effect of Feeding Management on Thermoregulation, Production Performance and Immunological Response of Broilers During Summer

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ABSTRACT

Three feeding methods i.e. continuous feeding (CF, 24 h feeding), intermittent feeding (IF, 1 h feed & 3 h off) and feed withdrawal (FW, no feed from 9:00 am to 5:00 pm) were used for the study. Under each feeding system, birds were fed a ration with 3% supplemented fat or without fat supplementation. Respiration rate during afternoon and evening was significantly lower ($P < 0.05$) in birds kept under IF system and FW system than those kept under CF system. Live weight and dressed weight was higher in birds kept under CF and FW system than those fed intermittently. However, the effect due to the addition of fat was found to be non significant on the parameters mentioned above. Higher values of antibody titers against Newcastle (ND) and Infectious Bursal Disease (IBD) vaccines were found in the birds kept under IF system than those kept under FW and CF system. Antibody titre of the birds kept under FW system was slightly higher than those fed continuously. Birds fed ration with out fat supplementation showed lower antibody titre against ND and IBD vaccine.

Key Words: Feeding; Thermoregulation; Immunological response, Broilers

INTRODUCTION

Heat stress has been reported to affect various physiological parameters of birds like increase in rectal temperature (Ching & Ching, 1992; Deyhim & Teeter, 1994; Salvador *et al.*, 1999) and increase in respiration rate (Arieli *et al.*, 1980; Raup & Bottje 1990; Inoue *et al.*, 1995). Measures such as running automatic feeders more frequently or physical shaking of feeders, slow walking in the flock, continuous lighting and use of high nutrient density rations have been used by the farmers (Wiernusz, 1998) to combat these physiological stresses in broilers. These practices are supposed to enhance feed intake during summer, which may increase heat production and thus mortality. Feed restriction has been reported as a measure to reduce the mortality during summer (Gonzales *et al.*, 1998). Therefore, the objective may change from more weight gain to the survival of birds during the period of heat stress.

To alleviate the effects of heat stress, various feeding practices, like intermittent feeding or short term feed withdrawals or addition of fat in ration during the hottest hours of the day may be the best technique to be used. Latshaw (1991), however, observed that feed restriction causes higher plasma corticosterone levels, which are known to decrease the immune response, possibly through effects on cytokines. Zouelfakar and Moubarak (1998) studied the effect of nutrition on the immune response of broilers. They found that sustainability of maternal immunity against Newcastle disease and Infectious Bursal disease virus was not affected by different energy levels in the diet. Immune response of birds is not clear under different feeding practices. Therefore, this project was conducted to find out best suited feeding method for optimum performance as well as immune response of broilers mentioned above during hot and humid climatic conditions.

MATERIALS AND METHODS

Three hundred, day-old chicks were purchased from a hatchery and reared in a group for one week (adaptation period). After the adaptation period, all the birds were weighed individually and 180 chicks of middle-weight range ($\mu \pm 1\sigma$) were selected to be used as experimental birds. The chicks were randomly divided into 18 replicates having 10 chicks each. These replicates were further allotted to six treatments (A, B, C, D, E & F) i.e. 3 replicates per treatment at random. Three feeding methods i.e. continuous feeding (CF, 24 h feeding), intermittent feeding (IF, 1 h feed & 3 h off feed) and feed withdrawal (FW, no feed from 9:00 am to 5:00 pm) were used for the study. Under each feeding system, birds were fed a ration either without supplemented fat (0%) or the ration with 3% supplemented fat. During the adaptation period of one week, the birds were fed a commercial broiler starter mash. After this, the birds were given experimental rations. All the experimental birds were vaccinated according to the following vaccination schedule:

Vaccination schedule

Age	Vaccine	Rout of vaccination
7 days	ND Mukteswar	Intra ocular
13 days	IBD (Gumboro) D78	Intra ocular
21 days	ND Lasota	Intra ocular
27 days	IBD (Gumboro) D78	Intra ocular

Data regarding temperature and relative humidity inside the experimental room were recorded by using thermometers and hygrometer, respectively. Respiration rate of three birds per replicate was recorded three times a day throughout the experimental period by observing the expansion and contraction of the rib-cage exactly during one minute time. Stop watch was used for this purpose (Wiernusz & Teeter, 1993). At the end of the experiment, two birds from each replicate were picked up and their live weight and dressed weight was recorded. The data thus collected were analyzed by analysis of variance technique using Completely Randomized Design with 3 × 2 factorial arrangement of treatments (Steel *et al.*, 1997). The differences in means of the treatments were compared by Duncan's Multiple Range test (Duncan, 1955).

Blood samples at 21, 28, 35 and 42 days were collected from two birds per replicate for immunological response. Haemagglutination inhibition (HI) titer and antibody titers against Infectious Bursal Disease virus (IBD) were measured (Cunningham, 1966; Buxton & Fraser, 1977) and calculation of geometric mean titers (GMT) was conducted as described by Thrusfield (1999). Cumulative mean titers of the birds kept under different feeding managements were calculated by calculating the geometric mean titre values taken at 21, 28, 35 and 42 days of age.

RESULTS AND DISCUSSION

Temperature and relative humidity. Environmental temperature and relative humidity both remained high during the experimental period. Average temperature during the experimental period ranged between 28.8 to 34.99°C and the relative humidity ranged from 62.32 to 82.54%. High temperature (35°C) and cyclic temperature (25 - 35°C) has also been reported to have adverse affect on broiler performance (Acar *et al.*, 1995; Plavnik & Yahav, 1998; Gu *et al.*, 1999). It can, therefore, be envisaged that the temperature and relative humidity during the experimental period was high enough to alter the performance of the broilers.

Respiration rate. Feeding method significantly affected the respiration rate of the birds at afternoon ($P < 0.01$) and evening ($P < 0.05$) time. In both the cases, significantly higher values were obtained from the birds kept under continuous feeding system followed by those fed intermittently and kept under feed withdrawal system,

Table I. Respiration rate (No./Min) of broilers kept under different feeding management practices

Feeding method	Respiration (morning)	Respiration (afternoon)	Respiration (evening)
CF	69.97±1.62	84.55±2.16^{A}	69.99±1.87^{A}
IF	66.29±0.78	79.83±1.30^{B}	66.31±0.53^{B}
FW	67.34±0.52	76.31±1.23^{B}	64.58±1.32^{B}
Fat Supplement			
0%	68.17±0.87	81.61±1.87	67.96±1.36
3%	67.56±1.13	78.86±1.47	65.96±1.22
Interaction			
CF x 0%	71.03±0.80	87.69±2.85	70.74±3.62
CF x 3%	68.92±3.38	81.41±2.30	69.25±1.94
IF x 0%	65.89±1.21	80.69±1.19	66.92±0.33
IF x 3%	66.69±1.19	78.98±2.51	65.70±0.95
FW x 0%	67.60±0.44	76.44±0.51	66.22±1.72
FW x 3%	67.08±1.04	76.18±2.70	62.94±1.77

CF = Continuous feed; IF = Intermittent feed; FW = Feed withdraw; 3% = Fat supplementation; 0% = Ration without fat supplementation
Means sharing similar letters in a column are statistically non-significant.
Capital alphabets (A, B) are used for feeding methods.

respectively (Table I). However, the respiration rate at afternoon and evening time did not differ in the birds maintained under intermittent feeding or feed withdrawal system. Feeding methods did not exert any effect on the respiration rate of the birds in the morning time. As expected, the mean values of respiration rate of broilers maintained under different feeding management systems were higher at afternoon time than those recorded at morning or evening. The reason for higher respiration rate may be the high ambient temperature at afternoon as compared to morning or evening. The birds might have started panting, because at high ambient temperature evaporative cooling through panting is the most effective method to get rid of increased body temperature (Wiernusz & Teeter, 1993; Daghir, 1995; Wirnusz, 1998). Similar findings were reported by Arad *et al.* (1975) and Anjum (2000), who found increased respiration rate in fowls due to increase in ambient temperature.

Intermittent feeding and feed withdrawal systems influenced the respiration rate of the broilers and kept it significantly lower than those kept under continuous feeding system. Probable explanation of lower respiration rate of the birds may be less heat increment in the body of the birds as a result of lower feed intake. This may have resulted in to decreased body heat load and less panting of the birds. However, Garcia *et al.* (1992) did not find any noticeable change in the respiration rate of the birds due to feed deprivation. Probable explanation of this contradictory finding may be the difference in the duration of feed restriction and/or environmental conditions during the experimental period.

The above discussion provides a strong indication that there may be a positive correlation between environmental temperature and respiration rate. Continuous feeding at high ambient temperature may increase respiration rate of the birds. Hence, feed restriction could be an effective practice to reduce thermal load of the birds to keep them within comfortable physiological conditions.

Production performance. Live weight and dressed weight varied significantly due to the feeding methods used in the study (Table II). Significantly higher values of live weight and dressed weight ($P < 0.01$) were observed in the birds kept under continuous feeding and feed withdrawal system than those kept under intermittent feeding. The difference in the parameters was found to be non-significant between the birds kept under continuous feeding and feed withdrawal system. These results are in line with Savic *et al.* (1993) and Zakia *et al.* (1995); whereas, Fontana *et al.* (1992) found that early feed restriction in broilers resulted in significantly ($P < 0.05$) lower mean body weight than controls. Results of present study indicated that all the methods of feed restriction are not associated with reduced body weight. Higher body weight in the birds is not recommended during hot environmental conditions. Therefore, it can be concluded that intermittent feeding is more efficient feed restriction system to combat heat stress as compared to feed withdrawal during summer.

Fat supplementation did not affect live weight, dressed weight or dressing percentage of broilers. Whereas, Oliveira *et al.* (2000) reported that carcass yield of broilers maintained under thermo-neutral environment (23.2 ± 0.74°C) linearly reduced according to levels of metabolizable energy in the rations. These contradictory findings may be due either to difference in climatic conditions or level of metabolizable energy in the ration used for the study or both. In present study, although, addition of fat did not alter production performance yet it resulted in better immune response.

Immune response. The highest values of cumulative mean titre (CMT) for Newcastle Disease (ND) were observed in the birds kept under intermittent feeding followed by those kept under feed withdrawal and continuous feeding system (Table III). High ambient temperature has been known to affect immune response of birds (Suba Rao & Glick, 1977). El-Gendy *et al.* (1995) and Zhang *et al.* (1998) reported that high ambient temperature resulted in reduced immunological response. It is, therefore, possible that additional thermic effect of feed in hot climate may reduce antibody titre of the birds kept under continuous feeding system. Results of present study indicated that both the methods of feed restriction resulted in higher antibody titre than continuous fed birds.

Contrary to the findings of present study, Ben Nathen *et al.* (1976) found that feed withdrawal resulted in lower antibody titre against viral diseases. Difference in the results may be due to the methods used for feed restriction, which may have caused fasting stress and increased corticosterone level (Latshaw, 1991), resulting into decreased antibody titre possibly through effects on cytokines. In case of IBD maximum value for CMT was found in the birds kept under intermittent feeding followed by those maintained on feed withdrawal and continuous feeding system (Table III). The results of present study are in line with the findings of Zulkifli *et al.* (1997), who observed that feed-restricted (9 am to 5 pm) chicks had a higher antibody response to IBD vaccination than those fed *ad libitum* at 42 days of age.

Fat supplementation also resulted in higher CMT in the broilers than those maintained on ration without fat supplementation, indicating that antibody titre was positively correlated with energy level of ration. These results are in agreement with the findings of Friedman and Sklan (1995), who observed that addition of fat resulted in to higher antibody titre than those provided ration without fat supplementation, which indicated that efficient use of energy have positive affect on immune response of birds. Whereas, interaction presented a different scenario, the birds kept under intermittent feeding showed better immune response when provided ration with out fat supplementation. This may be because birds kept under intermittent feeding system were lighter and their energy requirements were less than those kept in other systems. Zouelfakar and Moubarak

Table II. Live weight (g) and dressed weight (g) of broilers kept under different feeding management practices

Feeding method	Live Weight	Dressed Weight
CF	1952.80±35.82 A	1322.70±20.26 A
IF	1789.00±41.86 B	1200.30±27.10 B
FW	1913.30±26.16 A	1295.70±24.64 A
Fat Supplement		
0%	1898.10±24.70	1288.00±23.25
3%	1872.00±46.10	1257.80±28.65
Interaction		
CF x 0%	1922.00±12.34	1313.30±36.81
CF x 3%	1984.00±72.92	1332.00±24.68
IF x 0%	1812.3 0±26.59	1217.00±8.390
IF x 3%	1765.70±86.66	1183.70±57.65
FW x 0%	1960.00±24.13	1333.70±34.28
FW x 3%	1866.70±27.88	1257.70±20.41

CF = Continuous feed IF = Intermittent feed FW = Feed withdraw
3% = Fat supplementation 0% = Ration without fat supplementation 111
Means sharing similar letters in a column are statistically non-significant.
Capital alphabets (A, B) are used for feeding methods.

Table III. Antibody titer for Newcastle Disease (ND) and Infectious Bursal Disease (IBD) virus in broilers kept under different feeding management practices

Feeding Method	ND (CMT)	IBD (CMT)
CF	96.05	42.0
IF	170.5	57.5
FW	143.9	43.1
Fat Supplement		
0%	134.7	45
3%	141.1	50
Interaction		
CF 0%	80.0	41.0
CF 3%	112.1	42.8
IF 0%	185.3	62.4
IF 3%	156.7	52.6
FW 0%	133.7	31.6
FW 3%	154.25	53.8

CMT= Cumulative mean titre

(1998) reported no effect of energy levels on immune response, while present study indicated that boosting energy where less energy is required may decrease immunity, due to less intake of protein caused by high fat contents in diet.

CONCLUSION

Based upon findings of the study, it may be concluded that production performance, thermoregulation and immune response of broilers against Newcastle disease and Infectious Bursal disease may be improved through feeding management practices during summer.

REFERENCES

Acar, N., F.G. Sizemore, G.R. Leach, R.F.J. Wideman, R.L. Owen and G.F. Barbato, 1995. Growth of broiler chickens in response to feed restriction regimens to reduce ascites. *Poultry Sci*., 74: 833–43

Arad, Z., E. Moskovits and J. Marder, 1975. A preliminary study of egg production and heat tolerance in a new breed of fowl (Leghorn x Bedouin). *Poultry Sci*., 54: 780–3

Arieli, A., A. Meltzer and A. Berman, 1980. The thermoneutral temperature zone and seasonal acclimation in the hens. *British Poultry Sci*., 21: 471–8

Anjum, M.S., 2000. Productive performance and physiological behavior of White Leghorn caged layers under different heat combating practices during summer. *Ph.D. Thesis,* University of Agriculture Faisalabad, Pakistan

Ben Nathan, D., E.D. Heller and M. Perek, 1976. The effect of short heat stress upon leucocyte count, plasma corticosterone level, plasma and leucocyte ascorbic acid content of chickens. *British Poultry Sci*., 17: 481–5

Buxton, A. and G. Fraser, 1977. *Animal Microbiology,* 1st Ed. 2: 526–8. Blackwell Science Publication, Oxford

Ching, C.Y. and C.Y. Ching, 1992. Effects of acute heat stress on the blood characteristics of Taiwan country chickens and broilers. *J. Chinese Soc. Anim. Sci*., 21: 57–66

Cunningham, C.H., 1966. *A Laboratory Guide in Virology, 6th Ed*. Bugess Publishing Co., Minneapolis, Minnesota

Daghir, N.J., 1995. *Poultry Production in Hot Climates.* CAB International. Wallingford, Oxon OX10 8DE, UK

Deyhim, F. and R.G. Teeter, 1994. Effect of heat stress and drinking water salt supplements on plasma electrolytes and aldosterone concentration in broiler chickens. *Int J. Biometeorol*., 38: 216–7

Duncan, B.D., 1955. *Multiple Range and Multiple F-biometrics,* 11: 1–42

El-Gendy, E.A., A.A. Atallah, F.R. Mohamed, A.M. Atta and N.E. Goher. 1995. Strain variation in young chickens in response to chronic heat stress conditions. *Egypt J. Anim. Prod.,* 32: 237-251

Fontana, E.A., W.D. Weaver, B.A. Watkins and D.M. Denbow, 1992. Effect of early feed restriction on growth, feed conversion and mortality in broiler chickens. *Poultry Sci*., 71: 1296–305

Friedman, A. and D. Sklan, 1995. Effect of dietary fatty acids on antibody production and fatty acid composition of lymphoid organs in broiler chicks. *Poultry Sci*., 74: 1463–9

Garcia, J.A., A. Sutirin, P. Taboada and M. Gutierrez, 1992. The use of food-deprivation to protect broiler from heat stress. *Revista Cubana-de-Ciencia Avicola,* 19: 14–9

Gonzales, E., J. Buyse, M.M. Loddi, T.S. Takita, N. Buys and E. Decuypere, 1998. Performance, incidence of metabolic disturbances and endocrine variables of food-restricted male broiler chickens. *British Poultry Sci*., 39: 671–8

Gu, X.H., R. Du and L. Fang, 1999. Effect of humidity on rectal temperature, plasma T_3 and insulin level in broilers under high ambient temperature. *Scientia-Agricultura-Sinica,* 32: 105–7

Inoue, Y., W. Zhou and S. Yamamoto, 1995. Effects of short time heat exposure on thermoregulating physiological responses and heat acclimation in broilers. *Japanese Poultry Sci*., 32: 289–95

Latshaw, J.D., 1991. Nutrition - mechanisms of immunosuppression. *Vet. Immunol. Immunopathol.,* 30: 111–20

Oliveira, de N.A.R., R.F.M. de Oliveira, J.L. Donzele, H.S. Rostagno, R.A. Ferreira, H.M. do Carmo, N.A.R. de-Oliveira, R.F.M. de-Oliveira and H.M. do-Carmo, 2000. Metabolizable energy level for broilers from 22 to 42 days of age maintained under thermoneutral environment. *Revista Brasileira-de-Zootecnia,* 29: 1132–40

Plavnik, I. and S. Yahav, 1998. Effect of environmental temperature on broiler chickens subjected to growth restriction at an early age. *Poultry Sci*., 77: 870–2

Raup, T.J. and W.G. Bottje, 1990. Effect of carbonated water on arterial pH, PCO_2 and plasma lactate in heat-stressed broilers. *British Poultry Sci*., 31: 377–84

Salvador, D., J. Ariki, S.A. Borges, A.A. Pedroso and V.M.B. Moraes, 1999. Sodium bicarbonate supplementation in ration and drinking water of heat stressed broilers. *Ars-Veterinaria,* 15: 144–8

Savic, V., M. Mikec, P. Pavicic and M. Tisljar, 1993. Effect of repeated heat stress on the humoral immune response and productivity of broiler chicks. *Vet. Stanica*., 24: 195–202

Steel, R.G.D., G.H. Torrie and D.A. Dickey, 1997. *Principal and Procedures of Statistics: A Biometerical Approach*. (3rd Ed.) McGraw Hill, New York

Suba Rao, D.S.V. and B. Glick, 1977. Effect of cold exposure on the immune response of chicken. *Poultry Sci.,* 56: 992–6

Thrusfield, M., 1999. *Veterinary Epidemiology, 2nd Ed.* P: 267. Blackwell Science UK

Wiernusz, C., 1998. Nutritional therapies to optimize poultry during high humidity and ambient temperature exposure. Technical News, Cobb-Vantress Inc. *Siloam Springs, Arkansas,* 6: 1–6

Wiernusz, C.J. and R.G. Teeter, 1993. Feeding effects on broiler thermobalance during thermoneutral and high ambient temperature exposure. *Poultry Sci*., 72: 1917–24

Zakia, A.M.A., E. El-Khashab, A.M. El-Nabarawi and J. El-Jaky, 1995. Effect of light and food withdrawal on the broiler responses to heat stress and/or *Salmonella typhimurium* infection at early growing stage. *Vet. Med. J. Giza,* 43: 461–8

Zhang, L.C., S.H. Liu, S.B. Wang, S.Z. Hou, Y.Q. Liu, L.C. Zhang, S.H. Liu, S.B. Wang, S.Z. Hou and Y.Q. Liu, 1998. Study on the effect of heat stress on the morphology of immune organs of broilers. *Chinese J. Vet. Med*., 24: 24–5

Zouelfakar, S.A. and S.T. Moubarak, 1998. Effect of high-energy diet (using 2% Ultrakeal R) on broiler performance, litter quality and immune response. *Vet. Med. J. Giza,* 46: 199–208

Zulkifli, I., M.B. Hair and A.M. Fauzi, 1997. Antibody response to infectious bursal disease vaccinations in fasted broilers under high temperature and humidity. *J. Vet. Malaysia,* 9: 29–31

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