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Evaluation of Broiler Health Status Through Flock Health Monitoring Program in Bangladesh

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Abstract

Flock health monitoring program is an important system, used in the poultry industry worldwide to minimize the production cost, detect clinical and subclinical diseases and acquire data to make comparisons among the farms and identify the future research area. The present study was aimed to investigate the broiler health status through a flock health monitoring program using the lesion scoring method. For this purpose, a total of 540 broiler birds were collected from four different places from January to December 2017 and necropsied. Five body systems including gastrointestinal, respiratory, immune, skeletal, and integumentary were monitored with their 33 parameters during the study period. All the scores obtained from different parameters were analyzed and summarized. Among the body systems, lesion scores percentages were more prevalent in the parameters of the gastrointestinal, respiratory, and immune systems. Regarding age groups, 2nd (0-84.4%) and 3rd weeks (0-78.3%) had most of lesion scores percentage compared to 4th weeks (0-70.6%). With respect to season, lesion scores percentages were highest in summer (0-87.2%) and winter season (0-76.7%) respectively than monsoon season (0-68.3%). Based on different scores, zero was scored by the most number of birds ranged from 22.6-100%, while one was scored in 0-66.9%, two in 0-15.2%, three in 0-5.9%, and four in 0-0.4% of birds, respectively. Flock health monitoring program is a mirror of flock health status that can be a great alternative for the poultry industry and manager. Thus, the flock monitoring program mainly emphasizes poultry health which can be a good approach for future disease prevention.

Introduction

The poultry industry is an important sub-sector playing a significant role in the national economy and agricultural growth in Bangladesh (Hamid *et al.,* 2017). About 6 million people in Bangladesh are directly or indirectly employed through this sector (Ansarey, 2012). Among the total livestock value, this poultry sub-sector occupies 14% and is growing continuously (Raihan and Mahmud, 2008). This sector has provided great nutritional support which contributes 22-27% of total protein supply in the country (Hamid *et al.,* 2017). Poultry rearing in Bangladesh first started through traditional backyard farming (Ali, 2018). However, commercial poultry farming began in the early 80s and after that, it is growing rapidly especially in the private sector (Begum, 2005). But significant progress was noted in the early 90s when lots of private company involved in poultry farming (Hamid *et al.,* 2017). The total number of poultry farms in the government sector is 36 with 15 poultry and 21 duck farm (DLS, 2018). Privately, there are 16 grand-parent stock farms and 206 small and large scale parent stock farms in Bangladesh (www.wpsa-bb.com). About 65-70 thousand commercial farms are available in Bangladesh and now,150 feed manufacturing companies are operating throughout the country (DLS, 2018). An adult person requires 120 gm of meat/day/head and 108 numbers of eggs/year/head

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and at present, availability of meat overcome the required demand, is 122 gm/day/head but in case of the egg, the amount is slightly lower than desired demand, is 95 numbers/year/head (DLS, 2018).

Health monitoring program is an important tool used in poultry farms where lots of factors related to health status are monitored for over a period of time through a systemic approach and analyzing the degree of images (Keirs *et al.,* 1991). This program can be used as a disease preventive tool as well as permitted to identify the future research area. This program first initiated at the co-operative poultry industries of Mississippi in 1982 and till the year it has developed remarkably as a poultry health monitoring program (Keirs *et al.,* 1991).

This program can assist poultry Production Company by minimizing production cost through enhancing feed utilization and detection of clinical and subclinical diseases. It helps the producer to detect the early disease outbreak, identify the new disease or problems as well as the unnoticed production losses. It also allows the producer and companies to compare the poultry performance between flock and farm to farm or company to company (Keirs *et al.,* 1991; De Gussem, 2010).

It consists of a regular and representative sampling of a live chicken, postmortem, and scoring of gross observation of different body systems, along with regular storage of data in a computerized program. This computerized program was first developed in 1982 by Mcilroy *et al.* (1988) where 29 production data were entered such as stocking density, mortality, disease prevalence, amount of feed consumed, preventive measures, etc. Later, a macroscopic evaluation system combining coccidiosis and dysbacteriosis or bacterial enteritis was developed by De Gussem (2010). Nowadays, this system is widely used throughout the world at the field level to differentiate the feed or anticoccidial drug to evaluate intestinal health programs (De Gussem, 2010). To best of our knowledge, this is the first study in Bangladesh conducted on broiler health based on the flock health monitoring program. So, the present study was aimed to monitor broiler health status though a flock health monitoring program using a lesion scoring system with special emphasis on five body systems.

Materials and Methods

Study area

The present study was conducted in four Upazilas(Bogura Sadar, Valuka, Sreepur, and Trishal) of three different districts (Bogura, Gazipur, Mymensingh) of Bangladesh from January to December 2017. During the selection of study areas, the selection criteria were considered likes density of poultry population, climatic condition, and geographical location as they represent the actual scenario of poultry flock health status.

Sampling procedure

A total of 36 commercial broiler farms from four locations were selected for monitoring health status where each of them contributed 9 farms. Regarding age groups, the broiler was divided into three distinct groups at 14 days (2 weeks), 21 days (3 weeks), and 28 days (4 weeks). From each selected farm, a total of 15 birds were collected (five birds in each of three weeks). Therefore, a total of 540 birds were investigated throughout the year from selected farms and 135 birds from each location. During sampling, farm service personnel were instructed to collect representative samples based on sex, weight, and health to avoid biases. Three seasons were considered during sample collection as Bangladesh has three distinct seasons namely summer from March to June, monsoon from July to October, and winter from November to February. After that, birds selected for monitoring health status were subjected to necropsy.

Scoring system and interpretation

Before necropsy, the weight and sex of each bird were recorded. A total of 33 parameters were investigated and scored under five different body systems viz. gastrointestinal, respiratory, immune, skeletal and integumentary following the methods (Keirs *et al.,* 1991; De Gussem 2010). The scoring based on different parameters described in Table 1.

Statistical analysis

All the data were incorporated into the SPSS program Version 25 (IBM Corp, 2017) for analysis. The significant association among the variables was calculated using Pearson's Chi-square test and a *p*-value less than 0.05 was considered as significant. The mean score value and percentages of birds with abnormal scores were calculated.

Table 1. Experimental body system and scoring parameter

Item scored	Score	Description
Gastrointestinal system		
Gizzard erosion	0	Normal smooth lining without roughing of lining surfaces
	1	Rough appearance with no ulceration or hemorrhages
	2	Erosion in gizzard lining not extending to the mucosal surface
	3	Erosion extending to the mucosal surface
Proventiculitis	0	Normal size and shape of proventriculus, glands and mucosal surfaces

Item scored	Score	Description
	1	Mid edema of the tissue with hypertrophy of the gland
	2	Marked enlargement of proventriculus with edema of glands and loss of normal pattern of glandular alignment occurs
	3	Severe enlargement of the proventriculus to 2X or more normal size
Litter eater	0	Minimal litter in gizzard contents
	1	50% of total gizzard contents filled with litter materials
Water content	0	Absence of the condition
	1	Presence of excessive fluid in the intestinal tract, or noticeably increased content in dropping
Mucus content	0	Absence of the condition
	1	Presence excessive mucus in the intestine
Thick intestine	0	Normal intestine
	1	Marked thickening of the epithelial layer of the intestinal tract
Thin intestine	0	No gross lesions
	1	Marked loss of entire intestinal wall thickness
Cellular sloughing	0	Absence of the condition
	1	Presence of excessive cellular debris in proximal intestine, possibly mixed with excessive mucus
Hyperemia	0	Absence of the condition
	1	Uniform rosy pink to the red color mucosal surface of the intestine
Enteritis	0	Absence of the condition
	1	Inflammation of small intestine with watery content in the intestine
Feed passage	0	Absence of undigested feed at the end of the GI tract
	1	The presence of undigested feed in large intestine or feces, comprising greater than 25% content
Necrotic enteritis	0	Small intestine grossly normal
	1	Severe extensive necrosis in the small intestine
Intestinal tone	0	Absence of the condition
	1	Loss of folding and muscular function of the intestine
Intestinal hemorrhage	0	Normal intestine with no hemorrhage
	1	Petechial hemorrhage
	2	Ecchymotic hemorrhage
	3	Diffuse hemorrhage
Eimeria maxima	0	No gross lesion
	1	Small red petechiae appear on the serosal side of the intestine with no ballooning or thickening
	2	Presence of numerous red petechiae in serosal surface with orange mucous
	3	Ballooning, roughened mucosal surface and a significant amount of orange or brown mucus content in the intestine
	4	The severally ballooned intestinal wall along with large quantities of mucus in the intestinal tract
Eimeria tenella	0	No gross lesion
	1	Few scattered petechiae on the cecal wall
	2	Increased petechiae hemorrhage on the cecal wall and streak blood in ceca
	3	Thickened ceca wall with scattered petechiae and the ceca contain blood and white caseous material
	4	Cecal wall with distended blood and lacking normal debris
Eimeria acervulina	0	No gross lesion
	1	Scattered plaque-like lesions either the serosal or mucosal surfaces
	2	Lesions are much closer together and more numerous
	3	Thickened coated appearance intestinal wall with watery content
	4	The entire intestine is pale and is filled with creamy or watery exudates
Retained yolk	0	Absence of the condition
	1	Any portion of yolk sac present on Meckel's diverticulum, or remaining in the abdominal cavity after seven days of age
Respiratory system		
Tracheitis	0	No tracheitis
	1	Mild tracheitis with slight rosy color to the mucosal surface of trachea due to petechial hemorrhage
	2	Similar to mild tracheitis with extending farther down the trachea
	3	Necrotic debris and/or blood accumulates in the lumen of the trachea
Airsaculitis	0	Normal air sac
	1	Air sacs with light studs commonly seen after post-vaccination

Item scored	Score	Description
	2	Heavy studs in air sacs
	3	Milky to cheesy exudate in the air sac confined to one air sac
	4	More than one air sac fills with exudate
Ammonia burn	0	Normal cornea
	1	Bilateral or unilateral damage to the eye characterized by cloudiness and/or ulceration of the cornea
Swollen head	0	No clinical signs
	1	Swelling of peri and infra-orbital sinuses
		Immune system
Bursa standard size	0	Normal size
	1	Abnormal size
Bursa atrophy	0	Absence of the condition
	1	Mild bursal atrophy with a reduction of 5% total bursa size
	2	Reduce to 50% of normal size
	3	Reduce more than 55% of normal size
Bursa damage	0	Normal
	1	Yellow edematous in serosa mainly due to classic strains
	2	Obvious hemorrhage internally
	3	Cherry like bursa
Thymus atrophy	0	Normal
	1	Marked atrophy
		Skeletal system
Femoral head necrosis	0	Absence of the condition
	1	Shattering of femoral head or fracturing of the neck of the femoral head
Rickets	0	Normal presentation of the bone
	1	Folding without fracturing or slight breaking of the long bones, widening of the growth plate in long bones
Tibial dyschondroplasia	0	Normal
	1	A slight increase in thickness from normal on the anterior edge to 3 to 4 times the normal thickness of the growth plate on the posterior edge
	2	Greater than 3 to 4 times the normal thickness of the growth plate
	3	Little or no normal plate growth
		Integumentary system
Burned feet	0	No lesions
	1	Discoloration of the footpad, superficial lesions and dark papillae
	2	Lesion like scabs or ulcers, the sign of hemorrhages or swollen foot pads
Scratches	0	No cuts or lacerations on the skin
	1	Cuts or lacerations on the skin
Pale legs	0	Absence of the condition
	1	Bilateral loss of color
Inflammatory process	0	Absence of the condition
	1	Presence of white-to-yellow material underneath the skin

Results

Week wise broiler flock health status monitoring

Table 2 presents the results of broiler flock health status on the week. Gizzard erosion was recorded a higher percentage of birds (84.4%) during early ages (2nd week) but it decreased significantly with the advancement of ages such as 3rd (78.3%) and 4th weeks (70.6%). Retain yolk sac, another important parameter, was recorded also a higher number of birds at the 2nd week of ages (83.3%) and significantly reduced at 3rd (59.4%) and 4th week (57.8%) of ages. Mucous content was increased significantly with the advancement of ages where 18.9% at 2nd, 26.1% at 3rd, and 32.2% at the 4th week of ages. Out of three different weeks, watery content was highest at 3rd week of ages (15%) but lowest at the 2nd week of ages. Proventiculitis was 3.9%, 9.4%, and 20% birds at 2nd, 3rdand 4th week of respectively ($P < 0.05$). On the contrary, litter eater percentage was lowest in the 4th week (5%) but highest in the 2nd week of ages (7.2%). Birds at the 2nd week of ages had lower intestinal hemorrhage compared to the 3rd and 4th week of ages (6.7% vs. 10%). The hyperemic lesion in the intestinal tract was found 19.4% birds at the 4th week of ages but their percentage was significantly lower at 2nd (6.1%) and 3rd (11.7%) weeks. Three coccidial parasites were observed in each bird based on macroscopic lesions, where *E. maximum* was the most prevalent one compared to *E. tenella* and *E. acervulina*. The lesion of *E. maxima* was found highest at the 3rd week of ages (33.3%) but lowest at 2nd (30%) and 4th (21.7%) week of ages. Other parameters like thick intestine, thin intestine, cellular sloughing, enteritis, feed passage, necrotic enteritis, and intestinal tone were observed in the lower number of birds in all three weeks.

Airsacculitis and tracheitis of the respiratory system were found more frequently in birds of all three weeks of age. Airsacculitis was observed highest at the 2nd week of ages (70%) compared to 3rd (69.4%) and 4th (58.8%) weeks of ages. About 18.9% of birds were observed with tracheitis at the age of 14 days where it was comparatively lower at 2nd (11.7%) and 3rd (17.2%) weeks. Another two parameters, ammonia burn, and swollen head were merely found in all three weeks. Bursa size, bursa atrophy, bursa damage, and thymus, these four items belong to the immune system were investigated, of where bursa damage and thymus were found in the most number of birds. Among them, bursa damage and thymus atrophy were highest at 3rd week (27.2% and 24.4%) and lowest at 2nd and 4th week consequently. The percentage of bursa standard size was highest in the 2nd week (32.2%) and lowest in the 3rd week (5.6%) but it was increased significantly in the 4th week of ages. Similar findings were also observed in the case of bursa atrophy. Among the three parameters of the skeletal system, femoral head necrosis and tibial dyschondroplasia were observed in few occasions which were quite low (0.6-6.1%) and no birds were found positive for rickets. Burned feet and scratches are the two parameters of the integumentary system, were frequently observed in the birds of all ages. Burned feet were highest at 2nd week of ages (45.6%) in relation to 3rd (39.4%) and 4th (41.1%) week of ages. About 38.3% of birds at the 3rd and 4th week of ages were found with scratches lesions where 22.8% of birds at 2nd week and they were statistically significant (P <0.05). Only 3.3-5.6% of birds of all ages were observed with an inflammatory process where pale leg lesion was almost absent in the birds of all three weeks.

Table 2. Week wise broiler health status monitoring

Body system	Item scored	2nd week (14 days) (%)	3rd week (21 days) (%)	4th week (28 days) (%)	P-value
Gastrointestinal	Gizzard erosion	84.4	78.3	70.6	0.006
	Proventiculitis	3.9	9.4	20	<0.0001
	Litter eater	7.2	5.6	5	0.649
	Water content	10.6	15	13.9	0.430
	Mucous content	18.9	26.1	32.2	0.015
	Thick intestine	0.6	2.2	3.9	0.100
	Thin intestine	0	1.7	1.7	0.219
	Cellular sloughing	2.2	2.8	7.8	0.016
	Hyperemia	6.1	11.7	19.4	0.001
	Enteritis	1.1	7.8	7.8	0.006
	Feed passage	1.7	0.6	1.7	0.560
	Necrotic enteritis	0	0	0.6	0.367
	Intestinal tone	2.8	2.2	1.1	0.522
	Intestinal hemorrhage	6.7	10	10	0.439
	Eimeria maxima	30	33.3	21.7	0.041
	Eimeria tenella	2.2	5.6	4.4	0.265
	Eimeria acervulina	0	2.2	0	0.018
Respiratory	Retained yolk	83.3	59.4	57.8	0.000
	Tracheitis	11.7	18.9	17.2	0.146
	Airsaculitis	70	69.4	57.8	0.022
	Ammonia burn	2.2	1.1	1.7	0.712
	Swollen head	0.6	0	0	0.367
Immune	Bursa standard size	32.2	5.6	15	<0.0001
	Bursa atrophy	32.2	5.6	15	<0.0001
	Bursa damage	26.1	27.2	18.9	0.133
	Thymus atrophy	17.8	24.4	20.6	0.295
Skeletal	Femoral head necrosis	6.1	0.6	5.6	0.013
	Rickets	0	0	0	-
	Tibial dyschondroplasia	2.2	0	2.8	0.093
Integumentary	Burned feet	45.6	39.4	41.1	0.478
	Scratches	22.8	38.3	38.3	0.001
	Pale legs	0.6	0.6	0.6	1.000
	Inflammatory process	5.6	3.3	5.0	0.580

P-value less than 0.05 considered as significant.

Season wise broiler flock health status monitoring

Table 3 presents the results of broiler flock health status monitoring based on different seasons. In the case of the gastrointestinal system, most of the parameter percentage was highest during summer and winter seasons compared to monsoon. Gizzard erosion, the most abundantly observed parameter in birds was highest in summer (87.2%) and winter

(76.7%) seasons than monsoon (68.3%) which was statistically significant ($P < 0.05$). A similar observation was also noted in the case of retaining yolk sac was 69.4% and 66.1% of birds associated with the lesion were in summer and winter seasons respectively. But opposite results were observed in mucous content where the highest one was recorded in monsoon season compared to summer and winter (33.9% vs. 23.9% and 19.4%). The lesion of watery content in the intestinal tract was almost the same at summer and monsoon which was comparatively high (13.3% and 13.9%) than winter (11.7%) season. The condition, litter eater was mostly found in the summer season (7.8%). The hyperemic lesion was also highest in the summer season (18.9%) which was significantly reduced at monsoon (8.9%) but slightly increased in winter (9.4%) season. In the winter season, intestinal hemorrhage was highest (13.9%) and in monsoon, it was lowest (3.9%) and their association was statistically significant ($P < 0.05$). Although the percentage of thick and thin intestine was quite low in all the season compared to other items within the season the prevalence was highest in summer and winter seasons. On the other hand, cellular sloughing, enteritis, feed passage, and intestinal tone were highest in monsoon season (6.7%, 2.8%, 2.8%, and 5.6%). Necrotic enteritis was found in one bird out of 540 birds, and interestingly that was also in the summer period. *E. maxima* and coccidia parasite were found frequently throughout the season especially in summer (33.9%) and in winter (25.6%). Similar results were also recorded in the case of *E. tenella* where the percentage was lowest in monsoon (3.3%) and *E. acervulina* was rarely found in the tested birds in all three seasons. Airsacculitis, item of the respiratory system, was frequently noted in summer (71.1%) and winter (68.9%) seasons than monsoon (62.2%). Trachea inflammation (tracheitis), another important indicator of the respiratory system, was mostly observed in summer (23.9%) and winter (13.9%) the same as airsacculitis.

Table 3. Season wise broiler health status monitoring

Body system	Item scored	Summer (Mar-Jun) (%)	Monson (Jul-Oct) (%)	Winter (Nov-Feb) (%)	P-value
Gastrointestinal	Gizzard erosion	87.2	68.3	76.7	<0.0001
	Proventiculitis	11.1	8.9	13.3	0.407
	Litter eater	7.8	5.6	4.4	0.395
	Water content	13.3	13.9	11.7	0.808
	Mucous content	23.9	33.9	19.4	0.006
	Thick intestine	3.3	1.1	2.2	0.360
	Thin intestine	1.7	1.1	0.6	0.603
	Cellular sloughing	5.6	6.7	0.6	0.009
	Hyperemia	18.9	8.9	9.4	0.005
	Enteritis	4.4	11.7	0.6	0.000
	Feed passage	1.1	2.8	0	0.064
	Necrotic enteritis	0.6	0	0	0.367
	Intestinal tone	0.6	5.6	0	0.000
	Intestinal hemorrhage	8.9	3.9	13.9	0.004
	Eimeria maxima	33.9	25	25.6	0.110
	Eimeria tenella	3.9	3.3	5.0	0.718
	Eimeria acervulina	0.6	1.1	0.6	0.777
Respiratory	Retained yolk	69.4	65	66.1	0.648
	Tracheitis	23.9	11.7	13.9	0.004
	Airsaculitis	71.1	62.2	68.9	0.173
	Ammonia burn	3.3	0	1.7	0.047
	Swollen head	0	0	0.6	0.367
Immune	Bursa standard size	16.1	17.8	17.2	0.912
	Bursa atrophy	16.1	17.8	17.2	0.912
	Bursa damage	34.4	14.4	24.4	<0.0001
	Thymus atrophy	27.8	25	11.7	<0.0001
Skeletal	Femoral head necrosis	3.3	3.3	6.1	0.321
	Rickets	0	0	0	-
	Tibial dyschondroplasia	3.3	1.7	1.7	0.464
Integumentary	Burned feet	46.1	33.3	52.2	0.001
	Scratches	32.2	22.2	49.4	0.000
	Pale legs	1.1	1.1	0.6	0.603
	Inflammatory process	8.9	3.9	3.3	0.036

P-value less than 0.05 considered as significant.

The number of birds associated with ammonia burn was quite low in all three seasons. Another parameter, swollen head syndrome, was merely present in the birds. Bursa damage was highest in summer (34.4%) and winter (24.4%) and lowest in monsoon (14.4%). About 27.8% of birds had thymus problems in the summer season, where it was significantly (P <0.05) lower in monsoon (25%) and winter (11.7%) season. The parameter bursa standard size and bursa atrophy were highest at monsoon season (17.8%) and lowest in summer season (16.1%) which was opposite to the bursa damage and thymus. Among the three parameters of the skeletal system, femoral head necrosis and tibial dyschondroplasia were found in a few numbers of birds compared to parameters of other body systems. Above mentioned parameters were highest in summer (3.3% and 3.3%) and winter (6.1% and 1.7%). Another item, rickets was absent in all the examined birds. Burned feet and scratches were more frequently noted parameters in the integumentary system. Both of them was recorded the highest number of birds during summer (46.1% and 32.2%) and winter (52.2% and 49.4%) seasons and lowest (33.3% and 22.2%) in monsoon. The inflammatory process was decreased in monsoon (3.9%) and winter (3.3%) season and an increase in summer (8.9%) season. The number of birds associated with pale legs was quite low in all three seasons.

Table 4. Place wise broiler flock health status

Body system	Items scored	Valuka	Trishal	Mawna	Bogura	P-value
Gastrointestinal	Gizzard erosion	77.8	77.8	83	71.1	0.141
	Proventiculitis	13.3	8.1	9.6	13.3	0.415
	Litter eater	1.5	3	0.7	18.5	<0.0001
	Water content	11.1	10.4	13.3	17	0.359
	Mucous content	22.2	22.2	23.7	34.8	0.049
	Thick intestine	0.7	0.7	3	4.4	0.105
	Thin intestine	2.2	1.5	0	0.7	0.338
	Cellular sloughing	1.5	5.2	0.7	9.6	0.001
	Hyperemia	5.9	3	8.1	32.6	<0.0001
	Enteritis	1.5	3.7	3	14.1	<0.0001
	Feed passage	0	5.2	0	0	<0.0001
	Necrotic enteritis	0.7	0	0	0	0.391
	Intestinal tone	1.5	3	3.7	0	0.14
	Intestinal hemorrhage	7.4	5.9	7.4	14.8	0.045
	Eimeria maxima	24.4	16.3	22.2	49.6	<0.0001
	Eimeria tenella	3	4.4	8.1	0.7	0.018
	Eimeria acervulina	1.5	0	0.7	0.7	0.569
Respiratory	Retained yolk	65.2	64.4	80	57.8	0.001
	Tracheitis	15.6	15.6	18.5	16.3	0.901
	Airsaculitis	69.6	64.4	71.9	63.7	0.407
	Ammonia burn	1.5	3.7	1.5	0	0.124
	Swollen head	0	0	0.7	0	0.391
Immunity	Bursa standard size	21.5	21.5	16.3	8.9	0.017
	Bursa atrophy	21.5	21.5	16.3	8.9	0.017
	Bursa damage	24.4	15.6	14.1	43.7	<0.0001
	Thymus atrophy	16.3	20	11.1	38.5	<0.0001
Skeletal	Femoral head necrosis	4.4	3.7	5.9	3	0.662
	Rickets	0	0	0	0	-
	Tibial dyschondroplasia	2.2	2.2	2.2	2.2	1
Integumentary	Burned feet	27.4	20	58.5	69.6	<0.0001
	Scratches	25.2	27.4	43	43	0.001
	Pale legs	0	3	0	1.5	0.06
	Inflammatory process	0.7	2.2	5.9	12.6	<0.0001

P-value less than 0.05 considered as significant.

Place wise broiler flock health status monitoring

Among the 33 tested parameters, 17 of them were significantly associated with places (Table 4). Regarding places, gizzard erosion was highest (83%) in Mawna followed by Trishal (77.8%), Valuka (77.8%), and Bogura (71.1%) respectively. A similar finding was also observed in retain yolk sac, where the highest number was in Mawna (80%) and lowest in Bogura (57.8%). But mucous content was found highest in Bogura (34.8%) and the lowest in Valuka and Trishal (22.2%). Watery content in the intestinal tract was observed with the highest number of birds in Bogura (17%) and the lowest number in Valuka (11.1%), Trishal (10.4%), and Mawna (13.3%) respectively. Proventiculitis, another important parameter of the gastrointestinal system, was noted

highest in Valuka and Bogura (13.3%) and lowest in Trishal (8.1%). On the other hand, litter eater was highest in Bogura (18.5%) followed by Trishal (3%), Valuka (1.5%), and Mawna (0.7%) respectively. Similar findings were observed in Bogura in the case of cellular sloughing (9.6%), hyperemia (32.6%), and enteritis (14.1%). Intestinal hemorrhage was also found highest in Bogura (14.8%) followed by Valuka (7.4%), Mawna (7.4%), and Trishal (5.9%) respectively. Parameters like thick intestine, thin intestine, intestinal tone, and necrotic enteritis were found comparatively low in number in all four places. Among the four parameters of the respiratory system, airsacculitis was found in most of the birds of four places. It was recorded highest in Mawna (71.9%) followed by Valuka (69.6%), Trishal (64.4%), and Bogura (63.7%) respectively. A similar result was also noted in the case of tracheitis where the highest one was in Mawna (18.5%) and lowest in Valuka and Trishal (15.6%). The percentage of birds associated with ammonia burn was highest in Trishal (3.7%) compared to other places. Only one bird was found positive for swollen head syndrome and that was in Mawna. In the case of the immune system, bursa damage was highest in number among the other three parameters. It was recorded highest in Bogura (43.7%) and lowest in Mawna (14.1%). A similar observation was also noted in Bogura in the case of thymus where it was 38.5%. Both bursa size and bursa atrophy were highest in Valuka and Trishal (21.5%) and lowest in Bogura (8.9%). Femoral head necrosis of the skeletal system was highest in Mawna (5.9%) and lowest in Bogura (3%). Another parameter, tibial head necrosis was interestingly found the same percentages (2.2%) in all four places. Rickets was absent in all necropsied birds of all the places. Burned feet, one of the indicators of the integumentary system, was found highest in Bogura (69.6%) followed by Mawna (58.5%), Valuka (27.4%), and Trishal (20%) respectively. Scratches lesion was highest in Mawna and Bogura (43%) and lowest in Valuka (25.2%). The inflammatory process was found in a few numbers in all four places, of which the highest one was form Bogura (12.6%). Pale legs lesion was absent in Valuka and Mawna but present in Trishal (3%) and Bogura (1.5%).

Table 5. Overall scores in broiler health monitoring program

Body system	Item scored	Mean value	Percentage of birds per score				
			0	1	2	3	4
Gastrointestinal	Gizzard erosion	0.98	22.6	60.7	12.6	4.1	
	Proventiculitis	0.11	88.9	11.1			
	Litter eater	0.06	94.1	5.9			
	Water content	0.13	87.0	13.0			
	Mucous content	0.26	74.3	25.7			
	Thick intestine	0.02	97.8	2.2			
	Thin intestine	0.01	98.9	1.1			
	Cellular sloughing	0.04	95.7	4.3			
	Hyperemia	0.12	87.6	12.4			
	Enteritis	0.06	94.4	5.6			
	Feed passage	0.01	98.7	1.3			
	Necrotic enteritis	0.00	99.8	0.2			
	Intestinal tone	0.02	98	2			
	Intestinal hemorrhage	0.09	91.1	8.9			
	Eimeria maxima	0.33	72	23.3	4.4	0.2	
	Eimeria tenella	0.04	95.9	3.9	0.2		
	Eimeria acervulina	0.01	99.3	0.7			
Respiratory	Retained yolk	0.67	33.1	66.9			
	Tracheitis	0.17	83.5	16.3			
	Airsaculitis	0.89	32.4	53	8.3	5.9	0.4
	Ammonia burn	0.02	98.3	1.7			
	Swollen head	0.00	99.8	0.2			
Immune	Bursa standard size	0.17	83	17			
	Bursa atrophy	0.18	83	16.1	0.9		
	Bursa damage	0.39	76.1	8.7	15.2		
	Thymus atrophy	0.21	79.1	20.9			
Skeletal	Femoral head necrosis	0.04	95.7	4.3			
	Rickets	0.00	100				
	Tibial dyschondroplasia	0.02	98.3	1.7			
Integumentary	Burned feet	0.46	56.7	40.6	2.8		
	Scratches	0.33	66.7	33.3			
	Pale legs	0.01	99.4	0.6			
	Inflammatory process	0.05	95.2	4.8			

Discussion

Flock health status monitoring, an important program, is being used in poultry industries worldwide to minimize the production cost and to detect the clinical and subclinical diseases. In the present study, a total of 540 birds were sacrificed for the monitoring of 33 health parameters of five body systems from four different places.

Out of 17 health parameters of the gastrointestinal system, the gizzard erosion was observed in the highest percentages of birds throughout the study period which supports the findings of previous research (Kaldhusdal *et al.,* 2012). The cause of gizzard erosion mainly related to feeding quality as a toxic compound in feed can erode the lining of gizzard (Gjevre *et al.,* 2013). For preventing gizzard erosion, the focus should be given on feed quality because coarse feed particles increase gizzard function (Kiarieand Mills, 2019). Proventiculits, inflammation of proventriculus, were found mainly in the later stage of broiler bird ages such as the 4th week. The present findings are in agreement with the results of previous research (Dormitorio *et al.,*2007) who also reported that proventiculitis affects the broiler at the age of 3-6 weeks. Several factors are responsible for proventiculitis including microbial pathogens, feed quality and fiber level, high amount of dietary copper sulfate, and mycotoxin (Kutkat *et al.,* 2010). It is also associated with intestinal fragility, poor feed conversion ratio, retard growth, undigested feed passage, and stunning syndrome (Pantin-Jackwood and Brown, 2003; Smialek *et al.,* 2017).The present study reveals that young birds were more prone to litter eating. Excessive litter consumption causes enteritis and also increases pathogen exposure (Ritz *et al.,* 2017). The lesion watery content is found when the intestinal tract fills up with excessive watery fluid. The present finding reveals that the lesion was comparatively found at the 4th-week ages and monsoon period. Excessive watery content in the intestinal tract is normally related to electrolyte imbalance especially salt content (Mushtaq *et al.,* 2013). So, the necessary steps should be taken during feed formulation with appropriate mineral levels (Balos *et al.,* 2016).Regarding age and season, the highest intestinal mucous content was recorded in the 4th week of ages and monsoon season. Although mucous production is normal digestive phenomena certain pathogenic organisms and feed toxins could enhance its production in the broiler (Awad *et al.,* 2017). Control strategies fully depend on proper feed quality, intestinal disease prevention, anticoccidial program, and also acidified water treatment. Thin intestine refers to a marked loss of intestinal wall thickness and it is rarely found in the current study. The main reason for its occurrence is pathogens such as viruses, bacteria, or protozoa and therefore proper intervention should be taken to reduce the microbial population (Day *et al.,* 2015). In the case of the thickened intestine, score one denotes the thickening of the epithelial mucus layer of the intestinal tract, and their prevalence in necropsied birds was quite low in all study areas. However, intestinal thickening is the normal response to a threat like a virus, bacteria, or other physical trauma that results in immunity to birds but attention should be given to that threat rather than controlling thickened intestine (Lilburn and Loeffler, 2014). The lesion cellular sloughing (presence of excessive cellular debris in the proximal intestine) was absent in most of the tested birds. Infectious agents such as bacteria, virus, and protozoa cause intestinal damage that leads to excessive mucus production and cell death which mix with each other (Lilburn and Loeffler, 2014).The hyperemic lesion in the bird intestine was mostly found in 4th week and summer season in the study. There is no real clinical significance related to hyperemia in broiler if it is found particularly in the intestine. It is not wise to make a quick decision regarding hyperemia in the intestine as it may happen due to abnormal irritation and sometimes due to pathogenic microorganisms (Cooper *et al.,* 2013). Therefore, there are no definite control strategies required for hyperemia in the intestine rather than finding another associated cause with it. The presence of undigested feed in the large intestine or feces greater than 25% of total content, the condition is then designated as feed passage (Butcher *et al.,* 2002) which was commonly absent in the examined birds. Feed quality including toxin, various pathogens, and also stress-induced factors are closely associated with the feed passage (Roto *et al.,* 2015). So, these incite factors should be identified to minimize the condition. Necrotic enteritis is a result of bacterial toxin produced by *Clostridium perfringens* (Flores-Diaz *et al.,* 2016). The control strategies mainly used to control necrotic enteritis is antibiotics but few other alternative treatments are closely related to necrotic enteritis prevention including improved hygienic condition, anticoccidial program, and diet modification (Caly *et al.,* 2015). Luckily, in the present study, only a bird had a necrotic enteritis lesion although the birds had few coccidian lesions. The lesion intestinal tone was hardly observed in birds of study areas. Insufficient intestinal integrity or tenacity reduces digestive mixing and movement of chickens which further cause microbial imbalance and enteritis (Shang *et al.,* 2018). A good feed formulation with proper particle size is the main prerequisite for maintaining intestinal tone. Based on age and season, intestinal hemorrhage in the broiler intestinal tract was notably observed in the 3rd and 4th week and monsoon season. Sometimes it is quite difficult to figure out which types of hemorrhage are occurred. Petechial and ecchymotic hemorrhage are comparatively easy to diagnosis but diffuse

hemorrhage can be confused with hyperemia. Earlier two may be occurred by coccidian parasite, bacteria, virus, toxin, and round and tapeworms and later one may be caused by physical trauma or any type of intestinal tract irritations (Yegani and Korver, 2008). The initial cause has to be identified to prevent the intestinal hemorrhage. Coccidial parasitic lesions are measured according to the method described by Johnson and Reid (1970). Among the three coccidial parasites, *E.maxima* was found more frequently in the tested birds compared to the other two parasites such as *E. tenella* and *E. acervulina*. For the untrained people, it is most difficult to identify *E. maxima* grossly as lesion similar to other variety of conditions (Brito *et al.,* 2014). *E. tenella* is mostly confined on caeca which filled with blood and *E. acervulina* invades the upper intestinal tract characterized by white elongated lesions on the inner intestinal lining (De Gussem, 2007). Coccidiosis may cause decrease nutrient absorption, poor weight gain, pigmentation, and death may occur rarely unless secondary bacterial infection happens (Gyorke *et al.,* 2016). Vaccination, anticoccidial drug along with good husbandry practices could minimize the coccidial risk in broiler chickens (Quiroz-Castañeda and Dantán-González, 2015). The retained yolk sac, one of the most frequently observed parameters in the tested birds, recorded the highest percentage at an early stage of birds' life especially the 2nd week of ages. The main reason for the retained yolk sac may be the bacterial infection during hatching which serves as a source of other infections that indicates the chick quality (Khan *et al.,* 2004). Therefore, attention should be given to hatchery and egg sanitation as well as temperature and humidity.

In the respiratory system, tracheitis and air saculitis were noted in most of the birds compared to ammonia burn and swollen head. The most common cause of tracheitis is air quality. During tracheitis, the trachea loses its protective mechanism which makes birds susceptible to viral and bacterial diseases (Samy and Naguib, 2018). Almost all the respiratory conditions could appear early on as tracheitis. Air sacculitis, inflammation of air sac, was observed in the highest percentages of birds in all places. Similar findings were also found by a previous study (Keirs *et al.,* 1991). It is associated with excessive vaccination reactions, pathogenic microorganism especially viruses and bacteria (Russell, 2003). Significant air sacculitis could impact overall bird health, performance, morbidity, and even could cause death (El-Sukhon *et al.,* 2002). Good quality litter and air along with proper administration of vaccine could minimize its prevalence. Ammonia burn and swollen head were almost absent in the birds. Ammonia burn is associated with litter quality and ventilation that impact on health and performance of broiler (Mesa *et al.,* 2017). On the contrary, swollen head in broiler may be caused by trauma or disease lesion includes infectious bronchitis, infectious coryza, cholera, pox, etc. (Lu *et al.,* 1994). Maintaining proper ventilation and litter quality as well as disease control strategies could minimize the ammonia burn and swollen head lesion.

Standard bursa size in broiler reflects the bird's health status concerning B-lymphocyte production and the ability to mount the amount system (Schat and Skinner, 2014). In the present study, most birds had standard size bursa throughout the research period. Many things can impact on bursa size including infectious bursal disease virus (IBD) (McMullin, 2004), REO virus (Wang *et al.,* 2007; Ali and Hasan, 2018), chicken infectious anemia virus (CAV) (Hardy *et al.,* 2011) and Marek's disease virus (Chang *et al.,* 2011) as well as feed toxin (Mycotoxin). Monitoring bursa size will tell a producer how the birds are responding to vaccine, stress, and treatment (Cazaban *et al.,* 2015). Bursal atrophy was found in a significant number of birds. It indicates the possibility of reduced immunity and increases the susceptibility to other diseases (Zhai *et al.,* 2014). Infectious bursa disease virus may be a factor of bursa atrophy in broiler chicken (Alkie and Rautenschlein, 2016). Bursa damage also relates to IBD and the percentages were higher in the birds of the study area. IBD normally occurs in young chickens and lesions are more severe in birds of 3-6 weeks of old (Alkie and Rautenschlein, 2016). Therefore, chicken less than 3 weeks may not show clinical signs but will have the destruction of the bursa which leads to immunosuppression (Teshome *et al.,* 2015).Vaccination of birds may be a good alternative for bursal disease prevention.The size of the thymus is closely related to the immune system as it produces T-cell (Hussain *et al.,* 2012). In the current study, thymus atrophy was noted in most of the examined birds. Its size can be affected by several factors such as stress, mycotoxins, malnutrition, and infectious agents including chicken infectious anemia virus (CAV), Marek's disease virus, running stunting syndrome, etc. (Hailemariam *et al.,* 2008; Hoerr, 2010; Omar, 2013). The focus should be given to environmental, nutritional, and infectious factors to minimize the thymus atrophy.

Under the skeletal system, three parameters were investigated of which femoral head necrosis (FHN) and tibial dyschondroplasia were found in few birds and the lesion of rickets was absent in all birds. Femoral head necrosis leads to decrease body weight and uniformity increases leg breakage and sometimes causes mortality of birds (Griffiths *et al.,* 1984; Durairaj *et al.,* 2009). The cause of FHN may be associated with genetic selection in breeder flock or hatchery and sometimes focal cell death and atrophic are likely to be related with head separation from femur and necrosis (McNamee and Smyth, 2000;

Packialakshmi *et al.,* 2015). Tibial dyschondroplasia (TD) is a disease mainly observed in rapidly growing birds in the house (Leach and Monsonego-Ornan, 2007). Scratches, inflammatory processes, and gangrenous dermatitis may increase due to TD (Huang *et al.,* 2017). The disease may be the cause of genetic, poor quality feed with inappropriate calcium phosphorous ratio and electrolyte imbalance (Leach and Monsonego-Ornan, 2007). For the correction of TD, the above-noted cause should be considered. Although rickets was absent in the present study it may occur. It is the cause of calcium deficiencies in diet or imbalance calcium and phosphorus ratio in feed formulation (Hunter *et al.,* 2017).

Burned feet is a condition mainly associated with litter moisture and improper ventilation (Kaukonen *et al.,* 2016). The incidence of burned footpads is also being used as an indicator of animal welfare (Kyvsgaard *et al.,* 2013). In the current study, lots of birds had the lesion of burned feet that indicates selected flock had litter problems. Scratches were found in examined birds but not higher than burned feet. It may indicate competition at the drinker or feeder lines, or heightened activity of the farm (Pilecco *et al.,* 2011). Scratches cause damage to bird skin which enhances the entry of pathogenic organisms (Macklin *et al.,* 1999). So, constant and consistent feed or water supply should be ensured and maintained lighting programs properly. The lesion of pale legs and inflammatory processes were almost absent in the tested birds. The condition pale legs in the bird are the indicator of intestinal health as color absorbed from the diet through the intestine (Proszkowiec-Weglarz and Angel, 2013). Therefore, the protection of intestinal health is the optimal goal of maintaining performance and pigmentation. The inflammatory process refers to the presence of white to yellow color material underneath skin primarily in the ventral abdomen of birds (Pass, 1989; Eriksson *et al.,* 2008). This condition reduces the market value of poultry carcass. Care should be taken to limit bird overcrowding and also provide an adequate number of feeder or drinker.

However, the study was limited to five body system and less number of flock and places.And it is our limitation and we did not consider another body system along with husbandry practices in the research which are also important for a better understanding of broiler health.

Conclusion

In conclusion, we can say that lesion scoring percentages were higher in the gastrointestinal, respiratory, and immune systems. At the age of 2nd and 3rd week, lesion scoring percentages were found higher in all body systems. During summer and winter, scoring percentages were higher than monsoon. Most of the birds scored the zero score that denotes the absence of the conditions. However, the flock health monitoring program through the lesion scoring system can be a great alternative for disease prevention and cost reduction by identifying the subclinical diseases and utilization of feed properly, maintaining proper management and nutritional program. We believe that this method will increase poultry production with minimum cost thorough out the country.

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