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Feasibility of household broiler production with the use of hay box brooder in Ethiopia

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In Ethiopia, chicks are raised by broody hen, the success of which depends on the prevalence of predators. Hay box brooder was successfully used to raise layer type chicks. In this study, a total of 270 cobb, 500 broiler chicks were used to evaluate the brooding performance of electric, modified and existing hay-box brooders of 30 chick's capacity, in completely randomized design. Chick mortality, growth, economic return and weight of internal organs were used as evaluation parameters. The results showed that, 98% of each of the electric and modified hay box groups survived to an age of 56 days. The electric, modified and existing hay box groups attained body weight of 2.3, 2.1, and 1.6 kg/head, respectively at an age of 56 days. It was calculated that Birr 74, 71 and 96 was required to raise day old broiler chicks to an age of 56 days with the use of electric, modified and existing hay box brooder respectively. The in-put and out-put analysis indicated net profit/head of Birr 51, 37 and 2.6 for the electric, modified and existing hay box groups respectively at an age of 56 days. The results obtained clearly showed that modified hay box brooder is equally productive as an electric brooder in raising broilers in Ethiopia where there is no electric power. However, study into setting up of proper input supply system (feed, vaccination, market linkage etc) is the future direction of research in the area of initiation of household broiler production with the use of hay box brooder.

Key words: Broilers, brooding performance, survival rate, hay box brooder.

INTRODUCTION

Unlike most small animals, baby chicks are unable to live for any length of time without an additional source of heat other than their own bodies. Chick brooding refers to the early periods of growth (0 to 8 weeks), when young chicks are unable to maintain their normal body temperature without the aid of supplementary heat. It is by natural brooding that day old chicks are raised all over rural Ethiopia. The broody hen rearing and protecting few chicks ceases laying egg during the entire incubation and brooding periods of up to 81 days. Yet the success of the brooding process depends on the maternal instinct of the broody hen and the prevalence of predators such as birds of prey, pets and some wild animals, all of which are listed as the major causes of premature death ofchicks in Ethiopia. The hay-box chick brooder, developed at Jimma University College of Agriculture and Veterinary Medicine (JUCAVM) is an appropriate and simple techniques that could be used to raise day-old

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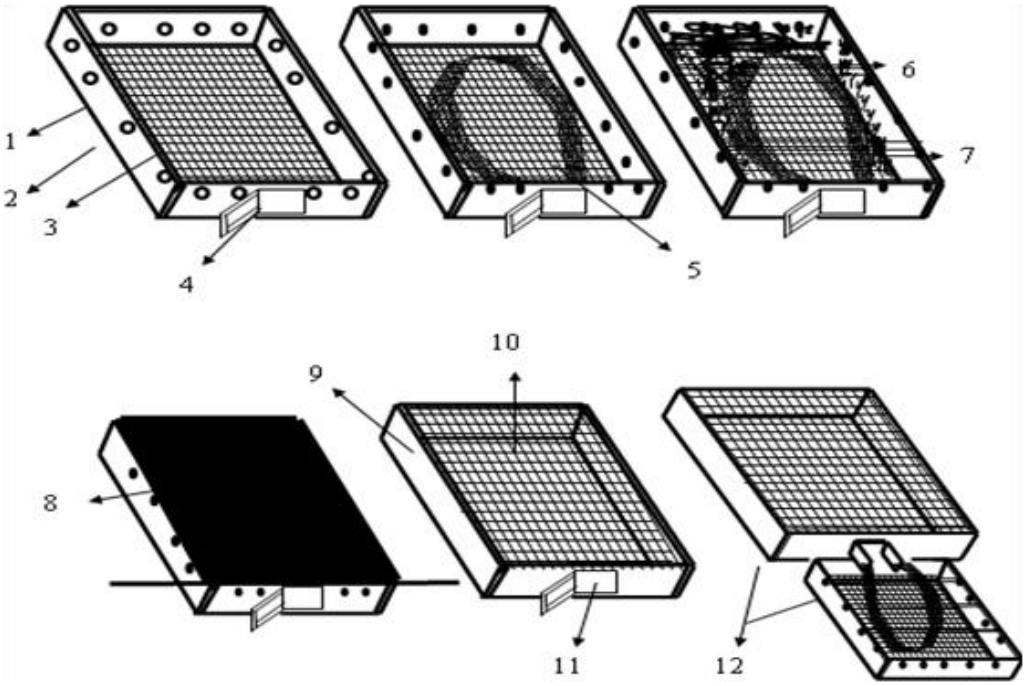

Figure 1. Constructional design of the hay-box brooders used in conducting the on-station experiment. 1; frame board; 2, Ventilation hole; 3, mesh-wire floor; 4, door; 5, central nest; 6 , stuffed hay; 7, stick; 8, sack filled with hay; 9, run frame board; 10, mesh-wire; 11, run door; 12, box and run arrangement.

chicks at village level. The technology utilizes simple and locally available materials and involves brooding of chicks by conserving their own metabolic heat to keep them warm. Under village conditions the use of hay-box brooder has the advantages of providing protection against predator attack and reduces risk of exposure to disease through confinement (Nigussie et al., 2003).

The hay- box chick brooder was comprehensively studied using layer type day old chicks in Ethiopia and found to be the brooders of choice for the promotion of day old chick's poultry extension package under the Ethiopian household farming conditions. Mean mortality level of 18.7 and 19.6% were recorded from groups of layer type day-old chicks assigned to the electric and hay-box brooder respectively (Nigussie et al., 2003). Verification trails aimed at field testing of the hay box brooder in Ethiopia, Kenya and Tanzania were conducted with financial support of the Food and Agriculture Organization of the United Nation (FAO). About 92, 96 and 83% of the day-old chicks distributed to the participating farmers with the use of hay box brooder in Ethiopia, Kenya, and Tanzania survived to an age of 8 weeks, respectively (Spore, 2010). In summary, all the available evidences tend to indicate that locally constructed and portable hay-box brooders in which no artificial heat is employed seems to be the brooders of choice for rural household poultry producers under the present Ethiopian conditions. Unfortunately however, there is no research conducted to evaluate the suitability of hay-box brooder in raising broiler type day old chicks. The major objective of this research undertaking was to study the feasibility of initiating household broiler production with the use of hay box brooder in Ethiopia.

MATERIALS AND METHODS

Description of the experimental site

This experiment was conducted during the big rainy season at JUCAVM located in Jimma town at an altitude of 1710 m.a.s.l. Jimma is characterized by two major (dry and rainy) seasons. The rainy season has two segments; small rainy season that occurs between February and April and is characterized by insufficient and erratic rains. Small rainy season is land preparation and planting time. The big rainy season starts in June and extends over mid September, during which time about 80% of the annual rainfall is received. The big rainy season is planting and growing seasons for the major crops grown in the area (BPEDORS, 2000).

Construction of the hay box brooders

A total of 6 hay-box brooders of 30 day-old chick's capacity were constructed. 3 of the hay-box brooders were constructed to measure 30 × 45 × 45 cm with day time running area of 30 × 98 × 98 cm. The remaining three hay-box brooders were modified on the basis of space requirement of modern broilers day old chicks and constructed to have dimensions of 32 cm x 49 cm x 49 cm with day time running area of 32 × 115 × 115 cm (Figure 1). All the hay-box brooders constructed consisted of 4-outer framing boards, each of which is 2 cm thick. Four small ventilation holes of 2.5 cm diameter

Table 1. Treatment allocation to the experimental chicks.

Treatment	Replication/ treatment	Chicks/rep	Dimensions	
			Night box ((cm)	Day run (cm)
Electric brooder of JUCAVM (T_1)	3	30	-	-
Modified hay-box brooders (T_2)	3	30	30 × 49 × 49	32 × 115 ×115
Existing hay-box brooder (T_3)	3	30	30 × 45 × 45	30 × 98 × 98

were drilled at the upper side of each frame board (total of 16) and a door of appropriate dimension were fitted at the center of one of the four frame boards. The floor of the hay-box was made up of half inch wire-mesh nettings tightly stretched to prevent sagging and a central nest was fitted to each of the hay-box constructed. The central nest was made up of a central circle of wire-mesh netting with an opening at the door and is arranged to lead directly into the run, leaving no open space between the nest and door. Hay was stuffed very loosely between the sides of the box and the central nest. The tops of the box were covered with sack. Finally mesh-wire enclosed run of appropriate dimension was fitted to each box.

Management of the experimental chicks

A total of 300 day old chicks of modern breeds of broilers (cobb 500) were purchased from Alema commercial poultry farm located in Debre Ziet. The chicks were transported to JUCAVM and placed on commercial broilers ration purchased from Alema farm for two consecutive days. At the end of the two days, a total of 270 chicks were randomly selected from the total of the 300 and divided into nine groups of 30 chicks each. Each group was randomly assigned to the electric, modified hay-box and the existing hay- box brooders in completely randomized design with 3 replicates for a study period of 2 months (Table 1). The electric treatment groups were fed to appetite with commercial broilers starters ration and clean water was made available all the times. In contrast the hay box groups were fed to appetite with the same broilers ration and offered clean water during day times in the run and closed into the box during night time. At the end of the first month of brooding all the treatment groups were switched over to commercial broilers finishers ration purchased from Alema commercial poultry farm. All the hay box groups were gently pushed out of the box for several times for feeding and watering in the run during the first week of brooding. Data on body weight gain, feed intake and survival rate were collected throughout the entire study period.

Carcass yield and weight of internal organs

At the end of the feeding trial, 6 chicks were randomly taken from each treatment, weighed and slaughtered to measure carcass yield and weight of internal organs. The dressing percentage was determined after de-feathering by hand plucking and re-weighing. The carcass was eviscerated by removing the viscera, head, shank, trachea, and lungs excluding the giblets (heart, liver and gizzard) in order to calculate the eviscerated percentage. The crop, liver, gizzard, proventriculus, duodenum, jejunum and ileum, combined caecum and large intestine, adrenal gland and bursa of Fabricius were weighed with and without contents using sensitive balance. Finally the relative weights of the carcass and internal organs were calculated.

Statistical analysis

The data collected were analyzed using SAS computer package and the replication-wise mean values of different entries were subjected to analysis of variance techniques according to completely randomized design (CRD). Appropriate mean separation procedures (least significant difference (LSD) were used to determine differences between treatment means whenever the treatment effects was found to be significant.

RESULTS

Chick mortality

The results of this study showed that about 98% of each of the treatment groups assigned to electric and modified hay box brooders survived to an age of 56 days (Table 2), the value of which is very high by the Ethiopian standard as reported elsewhere from egg type chicks subjected to natural brooding. Comparatively, high rate of mortality (46.7%) was recorded from the treatment groups assigned to the existing hay box brooder to an age of 56 days, again the value of which is significantly($P < 0.05$) higher than the others. About 95% of the total mortality recorded from the groups assigned to the existing hay box brooders occurred during the first 28 days of the feeding trial. Mean mortality rate of 2.2% was recorded from each of the treatment group's assigned to the electric and modified hay box brooder during the first 28 days of the trail. There has been no mortality recorded from the electric and modified hay box treatment groups during the second 28 days of the feeding trial.

Growth performance

According to the data presented in Table 2, the mean daily body weight gain recorded during the first 28 days of the feeding trial was 29.8, 25.2 and 18.9 g/chick for the electric, modified hay box and existing hay box brooders respectively, indicating that the daily body weight gain of the electric groups was significantly higher than the others ($P < 0.05$). On the other side the mean daily body weight gain of the groups assigned to electric, modified and existing hay box brooders during the second 28 days of rearing was 54.0, 51.0 and 39.3 g/chick, respectively, showing that comparatively faster growth rate was obtained by the modified hay box groups during the finishing phase. There was no statistically significant difference ($P > 0.05$) between the electric and modified hay-box groups in mean daily weight gain during the

Table 2. Weight gain, fed efficiency and mortality of the experimental chicks.

Parameter	T1	T2	T3	SE	Cv (%)
Initial B. weight(g/head)	50.42	50.43	48.35	0.76	4.5
Weight gain at an age of 28 days(g/head)	833.72[a]	705.64[b]	528.9[c]	46	5.12
Weight gain at an age of 56 days(g/head)	2347.81[a]	2130.05[a]	1627.61[b]	114.1	6.69
Daily gain during the 1st 28 days(g/head)	29.8[a]	25.2[b]	18.9[c]	0.37	1.57
Daily gain during the 2nd 28 days (g/head)	54.0[a]	51.0[a]	39.3[b]	3.40	2.27
Daily gain during the entire rearing(g/head)	41.92[a]	38.03[ab]	29.06[b]	2.04	6.7
Feed intake during the 1st 28 days(g/h/day)	61.85[a]	52.18[b]	42.13[c]	8.46	3.04
Feed intake during the 2nd 28 days(g/h/ day)	145.01[a]	154.46[a]	132.74[b]	0.57	3.20
Feed intake of the entire period(g/h/ day)	103.43[a]	101.71[a]	87.44[b]	2.53	1.45
Feed conversion E. during the 1st 28 days	0.48	0.48	0.44	Ns	5.49
Feed conversion E. during the 2nd 28 days	0.37	0.36	0.29	Ns	8.41
Feed conversion E. during the entire period	0.40[a]	0.37[ab]	0.33[b]	0.015	6.46
Mortality during the 1st 28 days (%)	2.22[a]	2.22[a]	44.44[b]	0.56	75
Mortality during the 2nd 28 days (%)	0	0	2.22	Ns	252
Mortality to an age of 56 days (%)	2.22[a]	2.22[a]	46.66[b]	0.54	62

[a, b, c]Means in a column having different superscript are statistically different at p<0.05.

Figure 2. The existing hay box groups at an age of 1 day and 20 days in the run.

second 28 days of the feeding trial. The daily body weight gain of the existing hay box groups was significantly lower than the others (P<0.05) throughout the entire experimental period.

Feed consumption and conversion

The mean daily feed consumed/head was significantly higher (P < 0.05) for the treatment groups assigned to the electric brooder during the first 28 days of the experiment (Table 2). The higher feed consumption recorded from the electric groups during the starters phase could be attributed to the fact that the hay box groups were fed to appetite during day times and closed behind into the box at night as compared to the electric groups, which were fed to appetite both during day and night times. The hay box groups were left in the run both during day and night times starting from the 16th day of brooding (Figure 2) and there was significant increase in feed consumption of all the hay box groups thereafter.

As shown in Table 2, there was no statistically significant difference (P > 0.05) between the treatment groups assigned to electric and modified hay box brooders on one side and between the treatment groups assigned to the modified and existing hay box brooders on the other side in feed conversion efficiency expressed as mean body weight gain (gram) of the experimental

chicks per unit feed consumed.

Carcass and internal organs

The carcass yield and weight of the internal organs of the experimental chicks are shown in Table 4. There was no significant difference between the electric and modified hay box groups in dressing percentage (P>0.05), whereas the dressing percentage of the existing hay box groups was significantly lower than the others. The dressing percentage of all the treatment groups of this study ranged between 74 and 78%.

DISCUSSION

Chick mortality

There was no statistically significant difference between the groups assigned to electric and modified hay box brooder in mortality (P > 0.05) indicating that the electric and modified hay box brooders are equally productive in broilers rearing as measured by the percentage mortality of the experimental chicks. Mean mortality to an age of 56 days of 2.2% was recorded from the electric as well as modified hay box groups, all of which occurred during the first 28 days of the feeding trial. It is generally agreed that the first two weeks comprise the most critical phase of artificial chick brooding (Flavio, 2012). According to Tadelle (1996), chick mortality recorded from natural brooding under village conditions in the central highlands of Ethiopia was about 60% during the first 8 weeks of age. The results of a survey conducted by Hoyle (1992) on small scale poultry keeping in Wolayta, North Omo region also indicated that, the most challenging period for indigenous baby chicks kept under natural brooding condition in Ethiopia is from 2 to 4 weeks after hatching. The results of this study showed that about 98% of each of the treatment groups assigned to electric and modified hay box brooder survived to an age of 56 days, the value of which is very high by the Ethiopian standard as reported elsewhere from egg type chicks subjected to natural brooding.

The mean mortality to an age of 56 days (46.7%) recorded from the existing hay box groups was significantly higher than the others (P < 0.05). It was also higher than the mortality to an age of 2 months (5 to 20%) reported elsewhere from the egg type chicks reared with the use of the existing hay box brooder. The higher rate of mortality obtained from the existing hay-box brooder could be attributed to the lack of adequate floor space that could comfortably accommodate the relatively fast growing broiler as compared to the egg type chicks. Moreover, the existing hay box groups experienced wetting and soiling with droppings accompanied by overcrowding and smothering. One of the replicates of the existing hay box groups was also attacked by ants during night time which in turn confounded the result of the feeding trial. The results of this study clearly showed that the existing hay box brooder could not be used to rear broiler type chicks as measured by rate of mortality to an age of 56 days.

Growth performance

There was statistically significant difference (P < 0.05) between the treatment groups in body weight attained during the first month of the study period. As sown in Table 2, the mean body weight attained by the existing hay box groups was significantly lower than the others (P<0.05). The highest mean body weight to an age of one month was recorded from the treatment groups assigned to the electric brooder house, the value of which is significantly higher than the others. The better growth performance of the electric groups could be attributed to the fact that the box groups were fed to appetite during day times only and closed behind in the box at night as compared to the electric groups, which were fed to appetite both day and night. In contrast, there was no statistically significant difference (p < 0.05) between the groups assigned to the electric and modified hay-box brooder in growth performance to an age of 56 days. This is attributed to the fact that, there was comparatively fast and significant increase in feed consumption and growth performance of the modified hay box groups, when left in the run both during day and night times starting from the 16th day of the feeding trail.

The results of this study agree to that of previous works which reported significantly slower (P < 0.05) growth performance from the groups of layer type chicks assigned to the hay box brooder as compared to the electric groups. Nevertheless comparatively faster growth rate were obtained from the hay-box groups after the first four weeks of brooding during which they doubled their body weight. When all the treatment groups were transferred to their respective rearing corners,(after the brooding period), the hay-box groups rapidly compensated the slow growth they experienced at the early phase of brooding and acclimatized quickly than the electric groups (Solomon, 1999).

The electric, modified hay box and existing hay box groups attained body weight of 2.3 and 2.1 and 1.6 kg/head respectively at an age of 56 days indicating that modified hay box brooder is equally productive as an electric brooder in raising broiler type chicks to an age of 2 months. The result of this study clearly showed that, the existing hay box brooder is inferior to modified hay box brooder in raising broiler type chicks as measured by mean daily weight gain of the experimental chicks. High mortality, low feed consumption and slow growth rate were recorded from the treatment groups assigned to the existing hay box brooder during the first 28 days of the

Table 3. Economic evaluations of the performance of the experimental chicks.

Variable cost (Birr)	T_1	T_2	T_3
Fuel/electricity	772.56	-	-
Hay box brooder (Dep.cost) 30%	-	525	504
Labor	400	400	400
Feed cost	3,273.42	3,204.00	1,444.32
Feed cost of dead birds	1.30	.50	75.29
Transportation of feed and chicks	833.33	833.33	833.33
Vaccination price	71.30	71.30	71.30
Price of day-old chick	1,260.00	1,260.00	1,260.00
Total cost/chick	74	71	96
Total input price	6,611.91	6,294.13	4,588.24
Edible carcass weight (kg)	1.92	1.66	1.51
Price of finished chicken (edible meat)	124.8	107.9	98.15
No of chicken survived	89	89	48
Income generated (chick survive × chick price)	11,107.2	9,603.1	4,711.2
Net profit /chick	50.51a	37.18b	2.56c

feeding trail. Improvement in performance of these treatment groups has also been observed during the second phase of the feeding trail. However, the improvement brought was not to an economically acceptable level as compared to the others indicating that the existing hay box groups were not fast enough to recuperate during the second phase of the feeding trail as compared to the groups assigned to the modified hay box.

Traditionally broilers were raised in well equipped, large and open structures (deep litter system). The floor space requirement of broiler depends on their body weight, housing system and climatic condition. Approximately 540 cm^2/1kg broiler weight is required under tropical condition. When broilers are reared in cages, half the space suggested (0.03 m^2/head) is sufficient (Prabakarahn, 2003). Floor space of 0.01m^2/head in the night time box and 0.03 m^2/head in the day time run was provided by the existing hay box brooder, while floor space of 0.012/head of night time box and 0.04m^2/head of day time run was provided by the modified hay box brooder. The better performance of the modified hay box groups as compared to the existing hay box seems to be attributed to the availability of relatively adequate floor space within the modified hay box brooders, particularly during day time in the run. Thus the results of this study clearly indicated that there is strong need to modify the existing hay box brooder if it is aimed at raising broiler type chicken of cobb500 breeds.

Feed consumption and conversion

There was no statistically significant difference (P>0.05) between the electric and modified hay box groups in mean daily feed consumption to an age of 56 days. The mean daily feed consumption of the existing hay box groups during the entire experimental period of 56 days was significantly (P < 0.05) lower than the others, which might be attributed to the comparatively insufficient floor and feeding space of the run as the chicks increase in size. The modified hay box groups exhibited increased (compensatory) feed consumption after being left in the run during night times. These groups were found to be active and free of being soiled with droppings in the run.

The results of this study showed that the feed conversion efficiency of the existing hay box groups was significantly lower (P < 0.05) than the electric groups. Attempts were made to consider input-output analysis aimed at evaluating the economic feasibility of raising broilers type chicks with the use of hay-box brooder. The expected life of the hay box brooding technology was based on the information provided by Solomon (1999) who reported that, the technology could be reused with minor repair and cleaning. It was calculated that about Birr 74, 71 and 96 (1USD = Birr 17.5) was invested to raise day old broiler chicks to an age of 56 days with the use of electric, modified hay box and existing hay box brooder respectively. Mean final body weight of 2.3, 2.1 and 1.6 kg/head was attained at an age of 56 days by the electric, modified hay box and existing hay box groups respectively, with the corresponding net profit of Birr 51, 37 and 2.56/head respectively (Table 3). Thus the results of this study clearly showed that modified hay-box brooder in which no supplementary artificial heat is employed seems to be brooder of choice of small scale broiler production under the present Ethiopian rural condition.

In summary the results of this study clearly showed that, modified hay-box brooder in which no supplementary artificial heat is employed seems to be brooder of choice of small scale broiler production under

Table 4. Carcass and internal organs characteristics of the experimental chicks.

Parameter	T1	T2	T3	SE	CV (%)
Crop	7.3[a]	7.33[a]	7.00[a]	0.08	2.71
Proventriculus	8.9[a]	8.3[a]	8.5[a]	0.18	6.22
Liver	44.83[b]	48.83[a]	50.50[a]	0.99	3.08
Gizzard	40.3[a]	39.5[a]	38.6[a]	0.44	2.44
Doudonal loop	10.3a	10.5[a]	11.25[a]	0.18	3.74
Jejunum	19.3[a]	19.00[a]	19[a]	0.38	6.30
Ileum	19.00a	21.00a	23.00a	1.07	15.23
Ceca	2.63[a]	2.61[a]	2.62[a]	0.007	0.88
Large intestine	12.8[a]	13.33[a]	13.5[a]	0.16	3.33
Adrenal gland	0.49[a]	0.49[a]	0.67[b]	0.03	1.52
Bursa of fabricus	1.17b	1.23[b]	1.50[a]	0.05	1.49
Life weight data	2.46[a]	2.18[b]	2.06[c]	0.062	0.90
Carcass weight	1.92[a]	1.66b	1.51b	0.062	0.84
Dressing percentage	78.1[a]	76.2[b]	73.44[c]	0.046	0.34

[a, b, c]Means in a column having different superscript are statistically different at $p<0.05$.

the present Ethiopian objective rural condition. Moreover the modified hay-box brooder seems to better fits market oriented production system, since batches of up to 30 broiler type chicks could safely and economically be raised at a time compared to natural brooding.

Carcass and internal organs

The dressing percentage of all the treatment groups of this study ranged between 74 and 78% and found to be higher than the results reported by Kassa et al. (2010) from cobb 500 breeds of broiler placed on meat and bone and soya bean meal based ration at Debre Zeit research station. There was no significant difference between all the treatment groups in weight of the internal organs (Crop, Proventriculus, and Gizzard, Duodenal loop, Jejunum, Ileum, Ceca and Large intestine). There have been neither gross morphological changes nor histopathological manifestation in the internal organs of all the treatment groups.

The mean weight of Adrenal gland and Bursa of fabricus recorded from the existing hay groups was significantly ($p < 0.05$) higher than the others. It is reported that increased stress load, stimulates the Hyperplasia and hypertrophy of adrenal gland (Etches, 1995), which in turn leads to increase weight of adrenal gland. Larger the size of adrenal gland more synthesis of corticosterone hormone which might have suppressed the immune system of the chicks as measured by the weight of Bursa Fabricus. The result of this study tends to indicate that the electric and modified hay box groups were more comfortable than the existing hay box groups. Similarly mean liver weight of the treatment groups assigned to the existing hay box brooder was higher than the mean liver weight of the others ($P < 0.05$). The higher mean liver weight of the existing hay box groups might be attributed to either stress or comparatively lower brooding temperature. This result seems to agree with that of Plavnik and Yahar (1998) who reported lower weight of liver in chickens raised at 35°C as compared to those raised at 20 to 25°C and increased weight of liver from broilers exposed to low environmental temperature.

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