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The effect of spraying vegetable oil and elevating relative humidity during incubation on the hatchability of Rhode Island Red (RIR) eggs

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Abstract – In Ethiopia, Rhode Island Red (RIR) breed of chickens acclimatize very well to the existing production environment with fairly reasonable level of production. Unfortunately however, there is a serious complaint about the poor hatchability of their eggs. This study was conducted at Debre Zeit Agricultural Research Center (DZARC) to study the effect of oil spraying and elevated Relative Humidity (RH) on hatchability of RIR eggs. Five treatments comprising of 80-85%RH, 80-85%RH plus oil spraying, 90%RH, 90%RH starting from 12th day of incubation and 90%RH during hatching were studied in CRD with four replications. The results obtained revealed that there was no statistically significant difference ($P<0.05$) between the treatments in percent fertility and hatchability. Spraying with vegetable oil negatively affected fertility, whereas, oil spraying as well as elevated relative humidity of 90% during the larger segment of the incubation period were found to be equally depressive in hatchability. More over the weight loss recorded from the eggs sprayed with oil was lower than the others indicating that oil spraying prevented the recommended level of weight loss through water evaporation, which in turn resulted in lower hatchability. On the contrary increasing of relative humidity from 80-85% to 90% during hatching period seem to increase hatchability of RIR eggs.

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The effect of spraying vegetable oil and elevating relative humidity during incubation on the hatchability of Rhode Island Red (RIR) eggs

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Abstract - In Ethiopia, Rhode Island Red **(RIR)** breed of chickens acclimatize very well to the existing production environment with fairly reasonable level of production. Unfortunately however, there is a serious complaint about the poor hatchability of their eggs. This study was conducted at Debre Zeit Agricultural Research Center **(DZARC)** to study the effect of oil spraying and elevated Relative Humidity **(RH)** on hatchability of RIR eggs. Five treatments comprising of 80-85%RH, 80-85%RH plus oil spraying, 90%RH, 90%RH starting from 12th day of incubation and 90%RH during hatching were studied in CRD with four replications. The results obtained revealed that there was no statistically significant difference ($P<0.05$) between the treatments in percent fertility and hatchability. Spraying with vegetable oil negatively affected fertility, whereas, oil spraying as well as elevated relative humidity of 90% during the larger segment of the incubation period were found to be equally depressive in hatchability. More over the weight loss recorded from the eggs sprayed with oil was lower than the others indicating that oil spraying prevented the recommended level of weight loss through water evaporation, which in turn resulted in lower hatchability. On the contrary increasing of relative humidity from 80-85% to 90% during hatching period seem to increase hatchability of RIR eggs.

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I. Introduction

Chicken population of Ethiopia is estimated to be 56.5 million (4), which is about 60% of the total chicken population of east Africa subcontinent (6). To exploit this national genetic resource in the development process Ethiopia launched a short and long-term plans of food self-sufficiency and poverty reduction program starting from 1995, placing special emphasis on the introduction of exotic chickens. The extension service of the Ministry of Agriculture and Rural Development **(MoARD)** promoted a scheme in which cockerels and pullets from selected strains mainly Rhode Island Red and to some extent White Leghorn are distributed from the government Poultry Breeding and Multiplication Centers **(PBMC)** to subsistence farmers in order to "upgrade" the genetic potential of the local breeds (15) and benefit from increased productivity of exotic birds. These extension approaches have been practiced for more than forty-five years (1). However, the impact of this strategy on the genetic makeup of indigenous birds has not been assessed carefully. Some empirical evidences, however, suggest that these approaches did not meet the desired target due to high mortality rate of exotic breeds (15). A study report by (16) in the central highlands of Ethiopia revealed that there has been an introduction of exotic breeds to three study villages at various times and in different forms through the introduction of cockerels, pullets, and fertile eggs, but their impact in upgrading the genetic potential of local chickens found to be less significant.

A study report based on the averages of five years fertility and hatchability of RIR chickens of the Poultry Breeding and Multiplication Centers was found to be 88% and 69% at Nazareth, 86.6% and 54.4% at Kombolcha and 82.89% and 62.36% at Andassa, respectively, which is below the recommended level. The information obtained from Amhara Rural Development Bureau of Agriculture **(BoARD)** in association with RIR breeding performance also indicated that the farming community by and large facing problems as a result of poor fertility and hatchability levels (5). However, (2) indicated that the fertility and hatchability percentage of commercial layers is recommended to be around 97% and 90%, respectively.

In Ethiopia, it was reported that RIR breed acclimatize well to the existing production environment with a reasonable level of production under smallholder management systems. Unfortunately however, there is a serious complaint about the poor hatchability of RIR egg under natural incubation. This is a very critical issue for sustainability and multiplication of the breed in the rural farming system. (5) reported fertility level of RIR is influenced by both male and female whereas, poor hatchability performance is primarily due to higher egg weight, weight loss during incubation and high embryonic mortality. The best hatchability results were obtained when egg weight loss is 12 percent of their fresh weight from the time of lay to the time of embryo pipe out of the shell. Weight loss smaller than 10 percent and greater than 15 percent of their fresh weight decreases hatchability (13); (7) and (17). Excess moisture loss of up to 20% was reported from RIR eggs incubated, during the first 18 days of incubation by (5), who recommended minimizing the loss to the normal level to improve the hatchability. (8) reported that the coating of the eggshell with mineral oil results in the

sealing of the majority of the pores aimed at reducing moisture loss from the eggs. Improving fertility and hatchability of any breeding stock is essential factor to determine success of poultry operation, as fertility and hatchability are the most important determinant factors in the reproductive efficiency of poultry. The objectives of the study were to determine the effect of spraying vegetable oil and elevating relative humidity during incubation on the hatchability of RIR eggs.

II. Materials and Methods

a) Experimental site

The experiment was conducted at Debre Zeit Agricultural Research Center (DZARC) located at 45 km south east of Addis Ababa, at an altitude of 1900 m.a.s.l and between 8.44°N latitude and 39.02°E l ongitude. The average annual rainfall is 845 mm and the annual minimum and maximum temperatures are 10°C and 22°C, respectively (11).

b) Management of the experimental eggs

A total of 1500 RIR eggs were obtained from Kombolcha Poultry Breeding and Multiplication Center (PBMC), which is 385 km North East of the capital Addis Ababa. The eggs were collected from RIR flock kept under intensive management system and kept on floor and large spacious shed surrounded by half wall in lower portion and above it was surrounded by solid wall up to door level, above which mesh wire is fitted. Complete feed was supplied in circular type feeder with sufficient feeding space. Adequate clean drinking water also supplied to the flock. The flocks were vaccinated against New Castle Disease (NCD) and Fowl Pox. Hatching eggs were collected, fumigated and stored in cold-humid storage for five days at 12-18°C and 75% RH, with small end down position until transportation. The hatching eggs reached DZARC poultry farm after 12 hrs of transportation. Soon after arrival (before setting), the eggs were allowed to rest for 36 h. The eggs were fumigated aimed at minimizing the introduction of disease to the DZARC poultry farm. They were also fumigated before incubation at DZARC poultry farm.

c) Incubation of eggs

The incubators were cleaned, disinfected and fumigated properly and the incubation temperature, ventilation and turning devices were checked and adjusted according to the recommendation of the manufacturer in advance of setting the eggs. The eggs were selected against large and small size, abnormal shape, undesirable shell structure and broken eggs during transportation in each treatments. The remaining eggs in five treatment groups were further sub-divided in to 4 groups each with average 72 to 74 eggs and individually weighed. Finally each group were randomly allocated to the five treatments shown in below in completely randomized Design with four replications

Trt-1 = 80-85% RH through out the incubation period with a total number of 298 eggs.

Trt-2 = Trt-1 + spraying vegetable oil on the surface eggs with a total number of 298 eggs.

Trt-3 = 90% RH through out the incubation period with a total number of 291 eggs.

Trt-4 = 80-85% RH from the 1st day incubation to 11th day and 90% RH from 12th day to the hatching period with a total number of 292 eggs.

Trt-5 = 90% RH during the hatching period only (18-21st days) with a total number of 294 eggs.

The eggs were candled on the 18th days of incubation and at the end of each hatch the unhatched eggs were broken to confirm day on which embryos died (break out analysis). Hatchability was calculated on the basis of set and fertile eggs in the incubator and the number of chicks hatched. Moreover, fertility was also calculated during candling using the following formulae:

$$\text{Percent fertility} = \frac{\text{Total fertile eggs}}{\text{Total eggs set}} \times 100$$

Percent hatchability was calculated from two points of view:

i. Percent hatchability on fertile egg basis =

$$\frac{\text{Number of chicks hatched}}{\text{Total fertile eggs}} \times 100$$

ii. Percent hatchability on total eggs set basis =

$$\frac{\text{Number of chiks hatched}}{\text{Total eggs set}} \times 100$$

d) Weight loss of the eggs during incubation

The initial weight of egg from all treatment groups were taken before the eggs were set for incubation and an average individual initial weight of the eggs from each treatment were calculated. On the 18th days of incubation, the final weight of each egg from all treatment groups were taken before the eggs were set in the hatchery and the average individual final weight of the eggs from each treatment were calculated. Finally, percent weight loss was calculated with the following formula:

$$\%\, wt\, loss = \frac{average\ initial\ wt\ of\ x(before\ incubation) - average\ final\ wt\ of\ eggs(on\ 18\ days)}{average\ initial\ wt\ of\ eggs(before\ incubation)} * 100$$

e) Statistical analysis

The collected data were summarized and analyzed using a Statistical Analytical System (SAS) computer software (14)

III. Results and Discussions

Mean percent fertility and hatchability of the experimental eggs are presented in Table 1. There was significant difference ($P<0.05$) between treatments in fertility and hatchability. Treatment 1 and treatment 5 were significantly higher than the others in both fertility and hatchability ($P<0.05$).

Even though there is no significant difference ($P>0.05$) between Treatment 1 and 5 in mean total number of hatched chicks, mean percent hatchability on both total set and fertile eggs, there is a slight increase in mean total number of hatched chicks, mean percent hatchability on both total set and fertile eggs for Treatment 5 compared to Treatment 1. Increasing 5% more RH during the hatching period than Treatment-1 contributed to the observed slight increase in above parameters. High humidity towards hatching time might be necessary for better hatchability of RIR eggs. Similarly (3) reported that high humidity towards hatching time will be necessary if sufficient evaporation from the eggs has occurred previously but detrimental if the humidity was high at all the times. (12) also reported that an increase of the RH by 10% after 18th days of incubation i.e. in the hatchery improved the hatchability of chicken eggs. From Table 1 it can also be seen that the low mean total number of hatched chicks, the low mean percent hatchability on both total set and fertile eggs in Treatment 2 might be due to the addition of vegetable oil on the incubated eggs, which may prevent sufficient evaporation of moisture from the eggs. The optimum levels of weight loss due to dehydration (loss of water from the eggs) during incubation may be important to have optimum hatchability of eggs but from Table 2 it can be clearly seen that only 4% weight loss was observed on the oil treated eggs (Treatment 2) as compared to the other treatments. The smaller weight loss might have resulted in low hatchability of eggs from the oil treated eggs. Different researchers concluded from their research that the best hatchabilities are obtained with poultry species when eggs loss 12% of their fresh weight from the time of lay to the time the embryo pips the shell (10), (7) and hatchability decreases for eggs losing less than 10% or greater than 15% of their fresh egg weight. (5) reported that low hatchability of eggs from RIR might be due the higher loss of the weight eggs during incubation as result of loss of excess water through the pores. However, in this study no much extra loss of weight is observed.

Apart from lower amount of weight loss from the oil treated eggs, the low hatchability of eggs from the oil treated eggs might be related with the closing effect oil on the pores of the shell and reduce exchange of respiratory gasses.

a) Breakout analysis result

Break out analysis result (Table 3) clearly indicates that late embryonic mortality (18-21 days) accounts the major loss of chicks followed by percent infertility, death at middle stage (8-18 days) and death at early stage. (9) reported that an increase in deaths during middle period (8-18 days in chickens) usually ascribed to nutritional problems, notably vitamins or minerals deficiency. He also reported that the causes of clear eggs (infertile eggs) usually related with undernourished males, too few males, competition among breeding males, and diseased flock. He again reported that the causes of chicks fully formed, but dead without pipping (death at later stage) are low average humidity, improper incubation temperature, improper ventilation in the incubator, improper turning of eggs and diseased or poorly conditioned breeder flock. Immature males, male with abnormal sperm, too few males, resulting in infrequent mating; too many males, resulting in fighting or interference, breeder flock disease, nutritional deficiencies or excess: severe feed restriction, parasites such as mites and decreased mating frequency or no mating was indicated for the major causes of clear or infertile eggs (19). It has also been indicated that the improper incubator temperature, humidity, turning, ventilation, contamination, nutritional deficiencies and lethal genes are the major causes of deaths between 8–18 days (19). Finally improper incubator temperature, humidity, turning, ventilation, improper hatcher temperature, humidity, ventilation, contamination especially from molds (aspergillis), too severe or too prolonged fumigation and nutritional deficiencies are reported be the major causes of death at later stage (>18 day) (19).

Since the incubator temperature for the incubation period was between 32^{0}C and 37.7^{0}C and the metabolic heat production of the developing embryo is sufficient to raise the internal egg temperature by 1.5^{0}C to 2^{0}C (17) that is above the incubator temperature. This may contribute the high percent of death at later stage. (18) indicated that chickens eggs don't survive continuously in an incubator at a temperature less than 35^{0}C or greater than 39.5^{0}C.

IV. Summary and Conclusions

This study was conducted at DZARC to determine the effect of spraying vegetable oil and elevating relative humidity during incubation to control water loss of fertile eggs. Increasing the relative humidity by 5% (90% RH) than the recommended level (80-85%) during the hatching period only caused the increase in hatchability of RIR eggs. Oil treatment of eggs drastically reduced the hatchability than the recommended level (<10% and >15%) of weight loss were observed for all treatments except for oil treatment and 90% relative humidity for 21 days.

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Table 1 : Multiple comparisons of means of percent fertility and hatchability on total eggs set, hatchability on fertile eggs and total number of hatched chicks among treatments.

Treatment	Mean percent fertility (%)	Mean hatchability on fertile eggs (%)	Mean hatchability on total set eggs (%)
T_1 =(80-85%RH) for 21 day	80.90[a]	61.40[a]	49.70[a]
T_2= (T_1 + spraying vegetable oil)	50.30[b]	2.00[b]	1.00[b]
T_3=(90%RH) for 21 days	85.90[a]	23.20[b]	19.90[b]
T_4 =(90%RH) after 11th days	79.50[a]	25.00[b]	19.90[b]
T_5=(90%RH) in hatching period	90.10[a]	71.30[a]	64.30[a]

[ab] means in the same column for each parameter with different superscripts are different at P<0.5

Table 2 : Average weight of eggs before setting (g), average weight of eggs at 18th day (g) and % weight loss.

Treatment	Weight of the eggs before setting (g)	Weight of the eggs on 18th day (g)	Weight loss (%)
T_1 =(80-85%RH) for 21 day	58.2	50.2	13.5
T_2= (T_1 + spraying vegetable oil)	59.4	57.0	4.0
T_3=(90%RH) for 21 days	58.1	52.5	9.6
T_4 =(90%RH) after 11th days	59.4	51.5	13.3
T_5=(90%RH) in hatching period	58.2	50.2	13.5

Table 3 : Breakout analysis result from unhatched eggs

Treatment	Infertile eggs (%)	Early period death (%)	Middle period death (%)	Late period death (%)
T_1 =(80-85%RH) for 21 day	32.4	17.6	0	50.0
T_2= (T_1 + spraying vegetable oil)	50.0	13.2	7.9	28.9
T_3=(90%RH) for 21 days	20.0	0	14.3	65.7
T_4 =(90%RH) after 11th days	23.5	0	17.6	58.8
T_5=(90%RH) in hatching period	25.7	0	5.7	68.6