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Investigation of Possible Genetic Background of Embryonic Mortality in two Populations of Nigeria Local Chicken Ecotypes

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ABSTRACT--- ***The study was conducted at Akpehe poultry farm Makurdi on 120 hens . The birds were housed singly in wire screened cages and hand mated in the cage. Data were collected on 1600 fertile eggs that were used to evaluate embryonic mortality. The eggs were incubated in batches. Candling was carried out on the 7th and 14th days to identify eggs with dead embryos. Sire , dam and ecotype had significant effect on embryonic mortality. The influence from the dam may be due to either chromosomal aberration and or the additive and non-additive genetic variance of the dam that determined its maternal effects, egg environment and nutrients delivery systems. While the influence from the sire may be due to either deleterious and lethal genes, or genes that had transition that disrupted proper messenger splicing due to chromosomal aberrations that were contributed by the sire to the embryo. The study revealed that there was genetic influence on embryonic mortality of the Nigerian local chicken ecotype. The Fulani chicken ecotype had lower embryonic mortality compared to the Tiv ecotype. This may be due to genetically strong risk factors during incubation that varied between the ecotypes. The Fulani ecotype appeared to be more adapted compared to the Tiv ecotype on this trait.***

Keywords--- Dam, ecotype, embryonic-mortality, genetic-effect and sire

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1. INTRODUCTION

Nigeria has a great variety of indigenous chicken bio-resources. The potentials of the rich chicken bio-resources however not maximized due to high embryonic mortality. Chicken embryonic mortality has long raised interest at both biological and economical points of view, reducing number of progeny hatched per hen and decreasing reproductive efficiency. In the domestic fowl, early data suggested that total embryonic mortality in small flocks and those under modern management practices were less than 10% and over 25%, respectively (Romanoff, 1949). More recently, it was observed that early embryonic mortality can affect 33% of fertile eggs in traditional chickens (Hocking et al., 2007) . Fertility and viability are multi-factorial traits which could be improved by controlling environmental and genetic factors. Embryonic mortality can be associated with faulty nutrition (Leeson et al., 1979; Wilson, 1997), breeding and husbandry practices (Harry, 1957; Quarles et al., 1970; Baxter and Jones, 1991; Bruce and Drysdale, 1991; Lerner et al., 1993; Deeming and Van Middelkoop, 1999), hatching eggs management before storage (Steinke, 1966; McDaniel et al., 1979; Kirk et al., 1980; Fasenko et al., 1991; Meijerhof et al., 1994), genetically strong risk factors during incubation and early age (Takashi et al., 2011) . Liptoi and Hidas, (2006) had reported that genetic factors contributes to embryonic mortality. For the conservation and maximal utilisation of Nigerian local chickens, it is useful to assess the mortality predominantly occurring during incubation and early age of life. Embryonic and early deaths pose a great challenge and are also a matter of great concern from both biological and economic points of view. However, few investigations have been published indicating the characteristics of Nigerian local chickens on embryonic mortality. The aim of this study was to provide information indicating the characteristics of two Nigerian local chicken ecotypes on embryonic mortality.

2. MATERIALS AND METHODS

The study was carried out at Akpehe poultry farm, Makurdi. Akpehe poultry farm is located on latitude 7^{0}41' N and longitude 8^{0}31^{1}E (Microsoft Encarta, 2008). Makurdi is warm with temperature range of 17.3^{0}C- 35.6^{0}C. Rainfall is between 508mm-1016mm (BSN, 1982). The relative humidity ranged from 47-85 percent (TAC, 2002). The Tiv and the Fulani local chickens were purchased from different rural farming communities and identified. The birds were housed, in dwarf wall wire mesh screened cages and the house was roofed with corrugated roofing sheets. The birds were housed individually. They were reared on deep litter and were fed a formulated diet containing 18 percent crude protein. The birds were fed in the morning and evening and water was provided *ad libitum.*

3. DATA COLLECTION AND ANALYSIS

A total of 1600 fertile eggs were used to evaluate embryonic mortality. The eggs were incubated in batches. Candling was carried out on the 7^{th} and 14^{th} days to remove infertile eggs and to identify eggs with dead embryos.

4. RESULTS

Effect of dam within the Fulani ecotype on embryonic mortality

Dam effect within the Fulani ecotype was significant (p<0.05) on embryonic mortality (Table 1). Embryonic mortality due to effect of dam within the Fulani ecotype ranges from 20.03+1.31 to 58.70±12.8 (Table 1). The coefficient of variation and the standard deviation due to the effect of dam within the Fulani ecotype on embryonic mortality were also high (Table 1).

Table 1. Effect of dam within the Fulani ecotype on embryonic mortality

Dam	Mean	Standard error	Standard deviation	Coefficient of variation
1	37.3^{a}	3.39	8.96	24.13
2	31.73^{b}	2.09	3.61	11.39
3	46.9^{c}	10.9	24.3	51.84
4	31.39^{d}	1.21	3.62	11.52
5	30.58^{abc}	4.12	13.03	42.60
6	58.7^{c}	12.8	28.6	48.74
7	20.03^{e}	1.31	2.62	11.38
8	36.65^{abc}	28.0	4.55	12.42
9	35.67^{abc}	2.18	3.77	10.58
10	31.23^{f}	3.54	8.68	27.78
11	24.80^{f}	2.60	4.50	18.18
12	42.23^{ac}	2.44	4.23	10.02
13	41.50^{ab}	2.08	4.16	10.02
14	29.65^{g}	4.38	12.40	41.82
15	41.25^{ac}	3.98	12.40	41.82
16	36.50^{ac}	1.94	3.88	10.62
17	35.80^{ac}	2.10	3.64	10.18
18	45.75^{c}	5.08	10.15	22.19
19	26.07^{gh}	3.71	9.10	34.91
20	29.78^{i}	3.24	10.76	36.12
21	42.20^{acg}	1.25	2.49	5.90
22	33.65^{acd}	1.11	2.21	6.58
23	39.70^{acg}	0.45	0.78	1.97

a,b,c,d…….i, figures with different superscripts vertically are significantly different at

p<0.05.

Effect of dam within the Tiv Ecotype on Embryonic mortality

The effect of dam within the Tiv ecotype also had significant (p<0.05) effect on embryonic mortality (Table 2). The mean squared embryonic mortality values ranges from 11.60±5.83 to 54.70±17.70 (Table 2). The standard deviation and the coefficient of variation due to this effect were high (Table 2).

Table 2. Effect of dam within the Tiv Ecotype on Embryonic mortality

Dam	Embryonic Mortality	Standard error	Standard deviation	Coefficient of variation
34	22.60[a]	3.71	6.43	28.44
35	24.20[b]	4.28	7.41	30.60
37	11.60[c]	5.83	10.10	87.03
38	44.0[d]	15.4	30.70	69.87
39	39.15[d]	2.40	4.80	12.25
40	45.99[d]	8.11	21.46	46.67
41	35.93[abcd]	7.50	24.89	69.27
45	54.7[d]	17.7	30.6	56.00
46	24.45[abcd]	8.46	16.93	69.24
47	38.47[dc]	3.31	5.73	14.89
48	39.70[c]	2.23	4.47	11.26
50	37.28[d]	2.80	5.61	15.05
51	38.68[d]	2.40	4.80	12.41
52	38.35[d]	2.61	5.23	13.64
55	40.85[d]	3.47	6.94	16.98

A, b ,c ,d, Figures with different superscripts down the group are significantly different at $p<0.05$.

Effect of dam between the ecotypes on embryonic mortality

The effect of dam between the ecotypes was significant ($p<0.05$) on embryonic mortality (Table 3). The mean squared embryonic mortality values due to dam effect between the ecotypes ranges from 58.77±12.8 to 54.77 ±17. 7 upper limit for the Fulani and Tiv ecotype respectively (Table 3). While the lower limit ranges from 11. 60 ±5 . 83 to 24.80 ± 2.60 for the Tiv and the Fulani ecotype respectively. Analysis of variance result also indicated that the dam had significant ($p<0.05$) effect on embryonic mortality (Table 8).

Table 3. Effect of dam between the ecotypes on embryonic mortality

Ecotype	Dam	Embryonic mortality	Standard error
1	1	37.30[a]	3.39
2	34	22.60[b]	3.71
1	2	31.73[a]	2.09
2	35	24.20[b]	4.28
1	3	46.9[a]	10.9
2	37	11.60[b]	5.83
1	4	31.39[a]	1.21
2	38	44.0[b]	15.4
1	5	30.58[a]	4.12
2	39	39.15[b]	2.40
1	6	58.7[a]	12.8
2	40	45.99[b]	8.11
1	7	20.03[a]	1.31
2	41	35.93[b]	7.50
1	9	36.65[a]	2.28
2	45	54.7[b]	17.7

1	10	35.67[a]	2.18
2	46	24.45[b]	8.46
1	11	31.23[a]	3.54
2	47	38.47[b]	3.31
1	12	24.80[a]	2.60
2	48	39.70[b]	2.33
1	16	42.23[a]	2.44
2	50	37.28[b]	2.80
1	17	41.50[a]	2.08
2	51	38.68[a]	2.40
1	18	29.65[a]	4.38
2	52	38.35[b]	2.61
1	19	41.25[a]	3.98
2	55	40.85[b]	3.47

a,b, Figure with different superscripts in the column are significantly different at ($p<0.05$).

Effect of ecotype on embryonic mortality

The effect of ecotype was significant ($p<0.05$) on embryonic mortality (Table 4). The standard deviation and the coefficient of variation were consistently lower in the Fulani ecotype compared to the Tiv ecotype (Table 4).

Table 4 : Effect of ecotype on embryonic mortality

Ecotype	Embryonic Mortality(%)	Standard error	Standard deviation	Coefficient of variation
1	35 . 19[a]	1.18	2.72	36.15
2	36 . 64[b]	2.54	8.12	49.46

a, b, Figures within different superscripts down the group are significantly ($P<0.05$) different

Effect of sire on embryonic mortality

Effect of sire within the Fulani ecotype on embryonic mortality

Mean squared values due to effect of sire within the Fulani ecotype vary extensively. Sire four recorded the highest embryonic mortality which differed significantly from all the others (table 5).

Table 5 : Least square mean values of effect of sire within the Fulani ecotype on embryonic mortality

Sire	Embryonic Mortality(%)	Standard error
1	36 . 66[a]	2.98
2	35 . 98[a]	2.51
3	35 . 00[b]	3.41
4	39 . 83[c]	3.45
5	35 . 25[b]	3.19

a,b,c,d, Figures with different superscript down the column are significantly ($P<.0.05$) different.

Effect of sire within the Tiv ecotype on embryonic mortality

Sire effect within the Tiv ecotype on embryonic mortality varied significantly ($P<0.05$). Sire eight recorded highest embryonic mortality (43.79 ± 3.55) followed by (40.85 ± 6.63) and (38.10 ± 3.89) for sires ten and eleven respectively (Table 6). The least embryonic mortality was recorded by sire seven (26.00 ± 6.63) followed by sire six (28.31 ± 3.25) and (34.20 ± 4.04) for sire ten. All these values differed significantly ($P<0.05$) from each other (table 6).

Table 6 : Least square means of effect of sire within the Tiv ecotype on embryonic mortality

Sire	Embryonic Mortality(%)	Standard error
6	28 . 31[a]	3.25
7	26 . 00[b]	6.63
8	43 . 79[c]	3.35
9	34 . 20[d]	4.04
10	38 . 10[e]	3.89
11	40 . 85[c]	6.63

a,b,c,d,e, Figures with different superscript down the column are significantly (P<.0.05) different.

Effect of sire between the ecotypes on embryonic mortality

The effect of sire between the ecotype varied significantly (p<0.05) in all the parameters (Table 7). All the sires between the ecotype differed significantly (p<0.05) in their effect on fertility, hatchability and embryonic mortality (Table 7). Analysis of variance result also indicated that sire had a significant effect on fertility, hatchability and embryonic mortality (Table 8).

Table 7 : Mean square values of effects of sire between ecotypes on embryonic mortality

Ecotype	Sire	Embryonic mortality	Standard error
1	1	36.66[a]	2.98
2	6	28.31[b]	3.25
1	2	35.98[a]	2.51
2	7	26.00[b]	6.63
1	3	35.00[a]	3.41
2	8	43.79[b]	3.55
1	4	39.83[a]	3.45
2	10	34.20[b]	4.04
1	5	35.25[a]	3.19
2	11	8.10[b]	3.89

a,b, Figures with different superscript down the column are significantly (P<.0.05) different

Table 8 : Analysis of variance results on effect of sire and dam on embryonic mortality

Sources of variation	DF	SS	MS	F
Sire	38	629.763	314.881	1.789*
Dam	28	9426.213	336.650	1.913*
Error	11	24459.295	175.966	

*Significantat(p<0.05)

5. DISCUSSION

Effect of dam on embryonic mortality

Significant effect of dam on embryonic mortality within and between the ecotypes indicated that, either the additive genetic variance of the dam and or the genetic potentials of the dam that determined its maternal effects, egg environment and nutrients delivery systems influenced embryonic mortality. The high variation between dams within ecotype on embryonic mortality as shown by high standard deviation and coefficient of variation indicated that there were differences between dams on their effect on embryonic mortality. Since dams were exposed to common environment, its worthy to infer that, observed differences were due to possible different genetic influence arising from genetic differences between the dams. Genetic influence on embryonic mortalities may be due to chromosomal aberrations and lethal genes; which may vary depending on the cytological process during meiosis, the type and extent of the chromosomal aberration and the possible degree of looping to enhance point by point pairing. This cytological processes during meiotic cell division though identical from genotype to genotype, the chromosomes involved differ ,the type of chromosomal aberration created may also differ from one genotype to another, the degree of looping of aberrated chromosomes in order to pair point by point with normal chromosome may also vary. The degree of the genetic information lost due to chromosomal aberration may also vary from one genotype to another. The totality of these would create in the population deleterious and lethal genes. A good proportion of embryonic mortality to a large extent in the population may be due to these genetic abnormalities and the frequencies of deleterious and lethal genes created in the population. This indicated possible genetic background on embryonic mortality. Lipoi and Hidas (2006) made similar observation. The viability of the embryo during incubation, the internal and external egg environment was affected by the genes contributed by the dam, and also common permanent and temporal environmental effect dictated by the dams genotype . There were thus dams in these populations with inferior and superior additive and non-additive genetic variances that could be selected for genetic improvement of these traits. The observed significant differences within and between the ecotypes due to dam effect on embryonic mortality was also expected. Embryonic mortality is a function of the genotype of the embryo that depended part by the genes received from the dam; and the egg environment which depended solely on the dam.

There also appeared to exist higher variation within dams of the Tiv ecotype compared to dams of the Fulani ecotype on embryonic mortality. This may be due to genetically strong risk factors during incubation that varied between dams between ecotypes. The Fulani ectype appeared to be more adapted compared to the Tiv ecotype on this trait. Takashi et al., (2011) also reported the expression of genetically strong risk factors in native Japanese chicken breeds.

Effect of hereditary maternal nutrients delivery deficiency

Significant effect of dam on embryonic mortality within and between the ecotypes could also be related to, either the additive genetic variance of the dam and or the genetic potentials of the dam that determined the nutrients delivery systems of the dam. The maternal nutrient delivery systems required for the formation of such nutritional complete eggs adoptedly evolved in stages from those needed for shell and the complexity and efficiency of oogenesis and embryogenesis (Harold and White, 1996) . It has also been reported that hereditary riboflavin deficiency from hens could cause embryonic mortality due to mutation. Harold and White ,(1996) observed that the mutation blocked the formation of a riboflavin-binding protein (RfBP), a normal component of egg yolk and egg white produced , respectively by hen liver and oviduct in response to ostrogen (Winter et at.,(1967). Maclachlan et at. (1993) showed that the defects in " riboflavinuria " is a G to A transition that disrupts proper messenger splicing. The observed improperly spliced messenger RNAs encode truncated non-functional forms of RfBP (Maclachlan et al.,(1994). Harold and White ,(1996) reported that strains of single-comb white leghorn hens, which are genetically unable to produce RfBP , lays egg containing insufficient riboflavin to sustain embryogenesis beyond 13 to 14 days of incubation. And concluded that embryos in these eggs grow normally until the day of death due to this genetic deficiency. This of course would also vary from dam to dam depending on the genetic inferiority or superiority of the dam and the ecotype on the trait.

Effect of egg characteristics and quality

Significant effect of dam on embryonic mortality within and between the ecotypes could also be related to, either the additive genetic variance of the dam and or the genetic potentials of the dam that determined egg characteristics and quality. Egg weight determined nutrients sufficiency available to the embryo. Dams with lower egg weight than normal may not be able to provide sufficient nutritional support for the developing embryo thereby recording embryonic mortality. Egg weight is a dams traits determined by the additive, non-additive genetic variance and common maternal effect of the dam. It is also expected to vary from dam to dam , also varying with it the nutrient support (sufficiency or deficiency) available to the developing embryo. Sewalem and Wilhelmson, (1999) also reported significant effect of egg weight on embryonic mortality. Egg yolk albumin ratio had been reported to vary with egg weight, egg size and these are determined by the ecotype and the dams genetic inferiority or superiority on the trait. The contribution of egg yolk albumin ratio to embryonic mortality is expected to vary from dam to dam as observed. Hartmann et al . (2002) and Machal et al.(1992) also reported effect of egg yolk albumin ratio on embryonic mortality . The occurrence of double yolk in an egg is another dam genetic abnormality that influences embryonic mortality. Fasenko et al. (2000) also reported similar observation.

Genetically determined metabolism

Genetically determined metabolism of the parents and genetic homeostasis, the phenomenon of super-dominance,the manifestation of some genes inducing certain abnormalities of the metabolism, or other factors determining some other property, which to some extent modifies embryo viability.It is possible that all these factors may interact in their effect on embryonic mortality. Ladislav et al. (2003) reported that genetically determined metabolism of parents determine egg quality that may or may not support embryogenesis.

Effect of ecotype

The significant effect of ecotype on embryonic mortality may also be due to the additive and non- additive genetic differences that existed between the ecotypes. Ladislav et al. (2003) also reported significant effect of breeds on embryonic mortality in three lines of laying strains during incubation. The author observed that breed and line had relatively marked effect on incidence and distribution of embryonic mortality. The Fulani ecotype had lower embryonic mortality compared to the Tiv ecotype. This may be due to genetically strong risk factors during incubation that varied between dams between ecotypes. The Fulani ectype appeared to be more adapted compared to the Tiv ecotype on this trait.

Effect of sire

The significant effect of sire on embryonic mortality could be because embryonic survival is a function of its genotype. The sire also contributes her genes to the embryo genotype. It is possible that the genes contributed by the sire to the embryo were either deleterious and lethal or had transition that disrupts proper messenger splicing due to chromosomal aberrations. This indicates that embryonic mortality had a genetic background. Lipoi and Hidas (2006) reported similar observations. The significant ($P<0.05$) differences that existed between the sires within the ecotype indicated that there was a genetic background on embryonic mortality that was affected by the variation in the additive genetic differences between the sires used in the study. Thus selecting superior sires for mating will improve these traits. Lariviere et al. (2009) reported significant effect of sire on embryonic mortality. The authors also reported heritability and genetic correlation estimates from sire variance components on embryonic mortalities at different stages of development, and concluded that the different stages of embryonic mortality during embryo development are distinct traits as reflected by the different heritability values (Beautmont et al.,1997). Variation in genetic parameter estimates from sire variance components due to breed was also reported by Lariviere et al. (2009).

Possible genetic background on embryonic mortality of Nigeria local chicken ecotypes

The significant ($P<0.05$) differences that existed between the sires within the ecotype indicated that there was a genetic background on embryonic mortality that was affected by the variation in the additive genetic differences between the sires used in the study. The significant effect of ecotype on embryonic mortality may also be due to the additive and non-additive genetic differences that existed between the ecotypes. Significant effect of dam on embryonic mortality within and between the ecotypes indicated that, either the additive genetic variance of the dam and or the genetic potentials of the dam that determined its maternal effects, egg environment and nutrients delivery systems influenced embryonic mortality. The high variation between dams within ecotype on embryonic mortality as shown by high standard deviation and coefficient of variation indicated that there were genetic differences between dams on their effect on embryonic mortality. Tatsuhiko et al. (2011) also reported that genetic factors are predominant during embryonic death in native Japanese chicken breeds. Beaumont et al. (1999) also reported significant influence on embryonic mortality. Lariviere et al. (2009) also reported the genetic influence on embryonic mortality of traditional chicken breed.

6. CONCLUSION

The study revealed that there was genetic influence on embryonic mortality of the Nigerian local chicken ecotypes. The influence from the dam may be related to effect of deleterious and lethal genes due to chromosomal aberration and or the additive and non-additive genetic variance of the dam that determined its maternal effects, egg environment and nutrients delivery systems. While the influence from the sire may be due to either deleterious and lethal genes, or genes that had transition that disrupts proper messenger splicing due to chromosomal aberrations that were contributed by the sire to the embryo. The Fulani chicken ecotype had lower embryonic mortality compared to the Tiv ecotype. This may be due to genetically strong risk factors during incubation that varied between ecotypes. The Fulani ecotype appeared to be more adapted compared to the Tiv ecotype on this trait.

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