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MULTIVARIATE ANALYSIS OF PRODUCTION VARIABLES OF LAYER CHICKENS ON DEEP-LITTER IN THE HUMID TROPICS

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Summary

Chicken breeding is a technical enterprise that involves specific and timely strategies to manipulate latent Factors. It is also intensive and involves high managerial competence for high profitability. Data on Hen day production, egg weight, Age in production (Prodage), Season, Strain (genotype) and Batch on weekly basis were obtained from Layer chicken from a popular chicken farm in Ibadan. These data covered the production cycle of 2 Strains – Bovan Nera and Isa Brown – of chicken. Data covered 20 batches of each strain covering a period of 10 years. Data were analyzed using the Multivariate procedures of descriptive, ANOVA (P<0.05), Pearsons' Correlation, Principal component Analysis (PCA) and Common Factor analysis (CFA). Findings from the study indicated better productive indices for Wet than Dry season. PCA extracted 3 components while the Varimax rotation with Keizer normalization produced 3 orthogonal Factors with high loadings for Prodage and egg weight under Age Factor, Batch and Season under Environmental Factors, and Hen day production and Strain under Genetic Factor. These results have implications and require management and breeding strategies to utilize them for technical efficiency in the environment.

Key words: Egg weight, Hen house production, Principal component analysis, Principal factor analysis, Nigeria.

Description of Problem

The deep litter poultry system is affected by most variables affecting the battery cage system. Some common production variables include age, egg weight, hen day production, health, and nutrition. Other variables affecting production include genotype of Strain, batch and climatic condition of the environment. These variables produce causes and effects which influence egg production in opposite directions. The multivariate technique was utilized to analyze six variables generated from the deep litter system of poultry production in order to understand the structure, their inter-relationship and reduce the number of variables generated to a smaller number which can aid in future research, production and breeding decisions. The hypothesis being tested was that all variables are of same structure.

Materials and Methods

Data on Hen house production (HHP), Egg weight (Ewt), Batch, Season, Age-In -Production (Prodage) and Strain (Genotype) were collected on two strains of Parent stock Chicken - Bovan Nera (BN) and Isa Brown (IB) - from a breeding Farm in Ibadan, Nigeria. The data were generated on a weekly basis for 70-week life cycle including the egg production period, on 20 batches of each strain covering a period of 10 years (1999-2008). The two strains of poultry were managed on same feeding regime, housing type, health regime and management. These were subjected to Multivariate Analysis of descriptive, 2-way ANOVA *(p<0.05)*, Pearsons' Correlation, Principal component Analysis (PCA) and Common Factor analysis (CFA). The Coefficient of Variation was calculated as: CV (%) = (SD/Mean) * 100. Analysis of variance was conducted using PAST 3.0 (2013), Correlation and PCA was computed on measured variables space while the CFA was conducted using the Varimax rotation method to classify and detect the latent structure of the variables with the SPSS Statistics (2007).

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Results and Discussion

Table 1 presented the descriptive statistics mean, Standard Error (SE), Standard Deviation (SD) and Coefficient of Variation (CV) values of HHP and Ewt partitioned by Strain and Climatic Season. ANOVA also revealed significant difference *(p<0.014)* between Genotypes and between Seasons in HHP; and significant difference *(p<0.05)* between seasons and between genotypes in Egg weight. The Table revealed that both HHP and Ewt were higher in Wet than Dry Season, and that BN had lower values compared to Isa Brown. Significant differences *(P<0.05)* in HHP (%) were observed between strains in favour of Isa Brown within the wet (65.64 vs 72.49) and the dry (64.66 vs 71.12) seasons. Values obtained in the Wet season were higher than those of Dry season for both strains respectively. The lower production values recorded in Dry season compared to Wet Season could be attributed to Seasonal effects while the differences in values observed between Strains within season could be attributed to genotypic effects. Thus in production output of HHP and Ewt, IB probably exhibited superiority between Seasons and Strains. Egg weight (gm) was higher in the Wet season (56.86 vs 58.12) than Dry season (56.75 vs 57.61) within and between strains. Higher SD was obtained for HHP than Egg weight in both seasons (Wet 17.79 - 21.80; Dry 17.25 – 18.83 for HHP; and 5.07 – 4.81 Wet; 4.91 – 3.83 Dry for Egg weight) for strains respectively. This suggested that HHP was highly sensitive to Seasons than Egg weight. Better manipulation of the environment of the strains could lead to substantial increase in Egg production in both strains. The CV measured the variability between batches within strains. The CV values of Ewt in both strains were higher than those of HHP in both seasons and also higher in the Dry (11.56 vs 15.04) than Wet season (8.91 vs 12.08) in Bovan Nera and Isa Brown respectively. This suggested that Egg weight could be improved by selection of Batches within Strains. The Interaction observed between genotypes and seasons in HHP meant that both are Factors to be managed for increased HHP in layer chickens. This result therefore revealed the interactive effects of genotypes and Seasons on Layer production in SW Nigeria.

Table 1: – MEAN HEN HOUSE PRODUCTION AND EGG WEIGHT OF BOVAN NERA AND ISA BROWN CHICKENS WITHIN SEASONS

Strains	Parameters	Season	Period	Mean	SE	SD	CV
Bovan Nera	HHP (%)	Wet	Apr-Oct	65.64^{b}	0.63	17.79	3.69
		Dry	Nov-Mar	64.66^{y}	0.70	17.25	3.75
	Egg Weight (gm)	Wet	Apr-Octo	56.86	0.19	5.07	8.91
		Dry	Nov-Mar	56.75	0.21	4.91	11.56
Isa Brown	HHP (%)	Wet	Apr-Oct	72.49^{a}	0.93	21.80	3.33
		Dry	Nov-Mar	71.12^{x}	0.82	18.83	3.78
	Egg Weight (gm)	Wet	Apr-Oct	58.12	0.23	4.81	12.08
		Dry	Nov-Mar	57.61	0.28	3.83	15.04
NOTE: Values with same type of superscripts (ab, xy) and within the same seasons were significant different (P<0.05).							

Table 2: – RESULTS OF PRINCIPAL COMPONENT ANALYSIS OF STUDY VARIABLES IN THE DIP LITTER SYSTEM OF POULTRY BREEDING

VARIABLES/Principal Components	Loadings/Variances		
	PC1	PC2	PC3
Egg weight	0.916	-0.152	-
Prodage	0.752	-	-0.527
Batch	-	-0.810	0.130
Season	-	0.674	-0.345
HHP	0.513	-	0.621
Genotype of Strain	0.187	0.493	0.590
Initial Eigen values	**1.704**	**1.382**	**1.149**
% Variation	28.396	23.041	19.146
% Cum. Variation		51.437	**70.583**

Table 2 shows result of PCA with the variables, components extracted and variances extracted by the procedure. First the ratio of cases to variables condition which was the minimum sample size requirement was fulfilled (211.83:1 > 5:1). Bartlett's test of sphericity (**2014)** tested whether the correlation matrix is an identity matrix (a correlation matrix with 1.00 on the principal diagonal and zeros in all other correlations), which would indicate that the factor model is inappropriate. This statistic indicated $X^2 = 1796.69$, $P<0.001$. This implied that PCA was applicable to the present set of data. The Kaiser-Meyer-Olkin measure of sampling adequacy[4] tested whether the partial correlations among variables were small. Sampling Adequacy an overall index which predicted whether the data collected were likely to "factor well" based on correlation and partial correlation as measured by the Kaiser-Meyer-Olkin (KMO) statistic. This measure of sampling adequacy for individual variable was displayed on the diagonal of the anti-image correlation matrix. A value of 0.686 which exceeded the 0.6 minimum requirement was returned. This proved that the data supported the use of factor analysis and suggested that the data may be grouped into a smaller set of underlying factors. Eigen values represent the variances extracted by each successive component from the original variables by the Analysis. The Keiser Criterion (Annotated SPSS Output, 2014) of 1960 stipulated the retention of components which extract Eigen values greater than 1, thus the PCA extracted 3 Principal Components (with Eigen values varying from 1.149 – 1.704) from the set of variables measured. Hence the technique of PCA was utilized to reduce the number of variables into a smaller number of principal components for further analysis. Close study of component loadings showed that the variances of the variables extracted in the components were not clearly defined between PC1 (0.752) and PC3 (-0.527) on Prodage, between PC2 (0.513) and PC3 (0.621) on HHP and between PC2 (0.493) and PC3 (0.590) on genotype. This distribution constituted what is known as 'Complex Structure' of the extracted components, since the variances were not clearly apportioned to components - that is, they were very close to each other. This meant successive components extracted in the PCA result above were correlated, and thus the need for rotation of the component matrix space by the Varimax Method to obtain a clear pattern of loadings. That meant each Factor having very high loadings for some variables and at the same time having very low loadings for same variables in other Factors. This is referred to as Simple Structure, so that Common or Latent Factors could explain a large percentage of the observed variance or default correlation is explained by non-retained factors.

Table 3: RESULTS OF THE VARIMAX ROTATION WITH KEIZER NORMALIZATION OF THE PRINCIPAL COMPONENTS

Variables	**Loadings / Variances**			
Principal Factors	PF1	PF2	PF3	Comm.
Prodage	0.892	0.170	-0.142	0.845
Egg weight	0.865	-0.160	0.296	0.862
Batch	-	-0.805	-0.143	0.673
Season	-	0.751	-	0.574
HHP	0.217	-0.155	0.764	0.655
Genotype of Strain	-0.115	0.253	0.741	0.625
Rotated Eigen Values	**1.615**	**1.355**	**1.265**	
% Variation	26.921	22.583	21.079	
% Cumm. Variation	-	49.504	**70.583**	
Cumm. = Communality				

Table 3 showed the result of Varimax rotation performed on the Principal Components. This gave a clear picture of new Principal Factors (PF) and new loadings for easy interpretation. The rotated Eigen values for PF1 (**1.704** to **1.615**) and PF2 (**1.382** to **1.355**) decreased while the value for PF3 (**1.149** to **1.265**) increased. Factor loadings also changed from that of Component loadings obtained in Table 3. Principal Factor1 (PF1) was highly loaded by Prodage (0.892) and Egg weight (0.865). This could be termed the Age factor. PF2 was highly loaded by Batch (-0.805) and Season (0.655) and could be termed the Environmental factor. The PF3 composed highly of HHP (0.764) and Strain (0.741), and could be named the Genetic Factor. The communality values represented the proportion of variance in the original variables that was accounted for by each common Factor. The Communality values for variables in the Age factor were highest (0.845-0.862), followed by Environmental factor (0.574-0.673) and Genetic factor (0.625-0.655). Varimax rotation of the principal component space, extracted 3 factors namely Age, Environmental and Genetic factors. This revealed that in South-west Nigeria, Age, Environment and genetic factors contributed 27, 23 and 21 (%) respectively to the variation involved in Egg production of layer chickens on Deep litter system. Thus PFA procedure was able to capture about 71% of the variations involved in Egg production in Layers on the Deep-litter, and this was comparable to 61.9 - 87.8% (Mendeş, 2009) and 74.76 - 70% (Udeh and Ogbu, 2011) obtained by previous researchers. Findings also pointed out that due consideration should be attached to these Factors in their order of communality values, when making decisions, policies and strategies for management, production and breeding purposes. The result had implications for breeding strategies, in light of genotype – environment interaction operating on HHP in the Region. The need to put in place appropriate breeding strategies that will manipulate these Factors in the Region for high performance of adapted layer strains was elucidated. PFA has been applied in quantifying size and morphological indices of domestic Rabbits (Yakubu and Ayoade, 2009). Three other Authors did a comparative multivariate analysis of biometric traits of West African Dwarf and Red Sokoto goats (Yakubu *et al.*, 2011). Mendeş (2009) had worked on Multiple linear regression models based on principal component scores to predict slaughter weight of broiler while Yakubu *et al.* (2010) performed a multivariate analysis of spatial patterns of morphological traits in West African Dwarf Goats in three Agro-ecological zones of Nigeria. Another report on PCA of body measurements in three strains of broiler chicken was also published in 2011 by Udeh and Ogbu, At Abeokuta, Okpeku *et al.* (2011) published another work on the application of multivariate PCA to morphological characterization of indigenous goats in southern Nigeria. All these studies were on morphometric traits and their predictive models but this study focused on the reproductive traits and the inter-relationship between them.

Conclusion

The identified Factors could have important interacting influences on egg production, chicken breeding, profitability and programme sustainability. The higher effect of environment over that of genotype meant that environmental factors must be properly manipulated to reduce its depressing influence in order to obtain high egg productivity in layer chickens in the region.

REFERENCES

1. Annotated SPSS Output. (2014). Institute for Digital Research and Education, IDRE, Ucla. Retrieved in April 2014 from http://www.ats.ucla.edu/stat/spss/output/factor1.htm.

2. Bartlett's test of sphericity. (2014). Retrieved in April from http://peoplelearn.homestead.com/Topic20-FACTORanalysis3a.html.

3. Mendeş, M. (2009). Multiple linear regression models based on principal component scores to predict slaughter weight of broiler. Arch.Geflügelk, 73 (2): 139–144.

4. Okpeku, M.; A. Yakubu; S. Peters; M. Ozoje; C. Obiora; N. Ikeobi; O. Adebambo and I. Imumorin. (2011). Application of Multivariate Principal Component Analysis to Morphological Characterization of Indigenous Goats in Southern Nigeria. Acta agriculturae Slovenica, 98 (2): 101–109. Ljubljana.

5. PAST 3.0 (2013). PAleontological STatistics Software Version 3.0 by Øyvind Hammer.

6. SPSS Statistics 17.0. (2007). Statistical Package for Social Sciences Software Package. SPSS Incorporated, Illinois. USA.

7. Udeh. I and C. Ogbu (2011). Principal Component Analysis of Body Measurement in Three Strains of Chicken. Science World Journal. 6 (2): Retrieved in April 2014 from Www.Scienceworldjournal.Org.

8. Yakubu, A. and J. Ayoade. (2009). Application of Principal Component Factor Analysis in Quantifying Size and Morphological Indices of Domestic Rabbits. Int. J. Morphology, 27 (4): 1013-1017.

9. Yakubu, A., A. Salako and I. Imumorin. (2010). Multivariate Analysis of Spatial Patterns of Morphological Traits In West African Dwarf Goats in Three Agro-Ecological Zones of Nigeria. J. Appl. Anim. Res, 38: 257-260.

10. Yakubu, A; A. Salako and I. Imumorin. (2011). Comparative Multivariate Analysis of Biometric Traits of West African Dwarf And Red Sokoto Goats. Trop Anim Health Production, 43:561–566.

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