Heritability of body weights in local chickens of Cameroon

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ABSTRACT

Eight hundred and six records on body weights of local chickens maintained at the University of Dschang Animal Teaching and Research Farm (Western Highlands of Cameroon) were used to calculate and compare heritability estimates at a day old, 4, 8 and 12 weeks of age. Estimates from paternal half-sib correlation, maternal half-sib correlation and full-sib correlation varied from 0.21 ± 0.03 to 0.35 ± 0.05, 0.46 ± 0.07 to 0.48 ± 0.07 and 0.36 ± 0.03 to 0.39 ± 0.03, respectively with a tendency to increase with age. The moderately high estimates of heritability indicate that selection based on individual performance could be effective in increasing body weight of local chickens.

Key words : Heritability, Body weights, Local chickens, Cameroon.

RESUME

A partir de 806 données collectées sur la poule locale à la Ferme d'Application et de Recherche de l'Université de Dschang (Hautes Terres de l'Ouest Cameroun), les valeurs de l'héritabilité du poids corporel à un jour, 4, 8 et 12 semaines d'âge ont été estimées et comparées. Ces valeurs obténues à partir des corrélations entre les demi-frères paternels, les demi-frères maternels et les pleins frères ont varié de 0,21 ± 0,03 à 0,35 ± 0,05, 0,46 ± 0,07 à 0,48 ± 0,07 et 0,36 ± 0,03 à 0,39 ± 0,03 respectivement, avec une tendance de s'accroître avec l'âge. Ces valeurs de l'héritabilité légèrement élevées suggèrent que l'amélioration du poids corporel de la poule locale pourrait être effective avec la sélection massale.

Mots clés : Héritabilité, poids corporels, poule locale, Cameroun.

INTRODUCTION

Although commercial production systems play an increasing role in the supply of poultry products in Cameroon urban areas, family poultry provides the population with a vital source of protein and income. It also plays a key role within the context of many socio-economic events (gift to distinguished guests, alarm clocks) and/or religious ceremonies (Agbede *et al.,* 1995). Largely dominated by domestic chickens production, family chickens constitute 80 % of the country's poultry population in Cameroon (Tchoumboue *et al.*, 2000). However, despite the importance of the sector, neither the production potential nor the developmental perspectives have been considered in an adequate manner. Nevertheless, for long-term improvements, selective breeding programmes adapted to environmental levels and limitations need to be highlighted. This is because local chickens represent an important reservoir of genetic variation that should be conserved, and because of their low cost and suitability as subsistence food supply for the poor.

For such genetic improvement, knowledge of heritability is essential for planning efficient breeding programmes and for predicting response to selection. Two concepts of heritability, designated as the narrow sense and the broad sense, were defined by Lush (1949). Heritability in the narrow sense, defined as a fraction in the phenotypic variance caused by the average or additive effects of genes, is often used in animal breeding. Heritability in the broad sense is the fraction of the phenotypic variation that is due to genetic differences of all kinds.

Estimates of heritability in local chickens scavenging under Cameroon conditions are scarce. The purpose of this study was to calculate and compare the heritability for body weights at day old, 4, 8 and 12 weeks in the local chickens of Cameroon.

MATERIALS AND METHODS

The study area

The study was carried out at the University of Dschang Animal Teaching and Research Farm situated within the sudano-guinean zone of Cameroon. The region lies approximately 5°30′ - 5°50′ NL and 10°50′ – 11°10′ EL at an altitude of about 1400 m above sea level. The climate is characterised by one rainy season (March –November) and one dry season (November – March). Annual rainfall averages 1600 mm. The mean annual temperature is 20°C, with a minimum of about 14°C and a maximum of about 30°C. The area is densely populated (more than 250 inhabitants/km²) and agricultural pressure on the land is very high.

Experimental animals

The 806 body weight records were obtained over a period of one year (1998) from local chicks hatched from mating between sires and dams randomly selected from a foundation flock maintained at the University of Dschang Animal Teaching and Research Farm. The foundation flock, non-selected, originated from the Western Highlands of Cameroon and were in their second generation of random breeding. Mating was hierarchical and by artificial insemination using undiluted semen collected from the sire by massage technique (Lake, 1959). There were 5 sires and 10 dams kept individually in cages where commercial layer mash and water were provided *ad libitum* (Table 1). Eggs were collected, pedigreed, and stored in an air – conditioned house for a maximum of two weeks before incubation. On hatching, day-old chicks were wing-banded, pedigreed by sire and dam. They were brooded for the first four weeks in an electrically heated brooding house and henceforth to 12 weeks of age on deep litter. They were weighed once a week and vaccinated against Newcastle disease, fowl pox and fowl typhoid.

Table 1: Chemical characteristics of experimental diets (0 – 20 weeks)

Characteristics	0 - 4 weeks	5 - 20 weeks
Crude protein (%)	23.5	18.1
Crude fat (%)	5	5
Maximum Crude fibre (%)	5	5
Ca (%)	1.2	1.0
Available P (%)	0.5	0.4
Metabolizable energy(Kcal/kg)	2800	2860

Statistical analysis

The analyses were carried out using the General Linear Model (GLM) procedure of SAS (1987).

The model used was:

$$Y_{ijkl} = U + H_i + S_{(i)j} + D_{(ij)k} + e_{(ijk)l}$$

Where:

Y_{ijkl} was the observation (body weight at day old, 4, 8 and 12 weeks) on the l^{th} chick of the k^{th} dam mated to the j^{th} sire in the i^{th} hatch,

U was the general mean,

H_i was the effect due to the i^{th} hatch ($i = 1, 2, \ldots, 6$),

$S_{(i)j}$ was the effect due to the j^{th} sire within the i^{th} hatch ($j = 1, 2, \ldots, 5$),

$D_{(ij)k}$ was the effect due to the k^{th} dam mated to the j^{th} sire to the i^{th} hatch ($k = 1, 2, \ldots, 10$), and

$e_{(ijk)l}$ was the residual error on the effect due to the l^{th} chick from j^{th} sire and k^{th} dam within i^{th} hatch.

Also, the quantities $S_{(i)j}$, $D_{(ij)k}$ and $e_{(ijk)l}$ were random variables, which were normally and independently distributed with means zero and variances σ^2_S (between sires within hatch), σ^2_D (between dams within sire and within hatch), and σ^2_e (between chicks within dam, within sire and within hatch), respectively.

Estimates of heritability were thus calculated by multiplying the paternal half-sib correlation and the maternal half-sib correlation by four and by doubling the full-sib correlation. The correlations were derived from the variance components, which were obtained by equating the observed mean squares to their expectations (Henderson, 1953).

Standard errors of the heritability estimates were obtained as suggested by Falconer (1960).

RESULTS AND DISCUSSION

Body weights varied from 35.5 to 41.6 g, 173.2 to 230.4 g, 401.8 to 568.8 g and from 708.6 to 831.5 g at a day old, 4, 8 and 12 weeks respectively. Significant differences ($P < 0,01$) in body weights were observed between hatches at different ages (Table 2). Considerable variation in performance parameters of the village fowl in Africa has also been reported by several authors (Wilson, 1979; Kassambara, 1989; Sonaiya and Olori, 1989; Assan, 1990; Sall, 1990; Katule, 1992). Such variation resulted from random breeding within, and sometimes, between diverse populations (Oluyemi, 1989; Aklobessi, 1990; El Houadfi, 1990; Ravelson, 1990; Sonaiya, 1990b; Bulgen *et al.*, 1992; Agbede *et al.*, 1995; Gueye and Bessei, 1995; Ngou Ngoupayou, 1995; Tchoumboue *et al.*, 2000). Because of this variation, such birds could be improved genetically through selective breeding or by crossing with exotic stocks (Gueye, 1988; Assan, 1990; Fotsa and Manjeli, 1995). Heritability estimates based on the maternal half-sib correlation, the full-sib correlation, the paternal half-sib correlation, and on the assumption of random mating and the absence of environmental correlations, are shown in Table 3 for body weights at various ages. They varied from 0.31 to 0.35 for paternal half-sib correlation; 0.46 to 0.55 for maternal half-sib correlation and from 0.36 to 0.39 for full-sib correlation. Estimates of Heritability computed from dam component of variance are higher than those computed from sire component of variance. This would be expected because the dam component will contain contributions from the maternal effects, dominance deviation and sire x dam interaction if any. Theoretically, heritability estimates based on maternal half-sib correlation fall between heritability in the narrow sense and the heritability in the broad sense as they include the variance caused by the additive effects of the genes plus a frac-

Table 2 : Mean body weights (g) at various ages of local chickens by hatch number in the Western Highlands of Cameroon

HATCH N°	BODY WEIGHTS (g) AT			
	DAY OLD	4 WEEKS	8 WEEKS	12 WEEKS
1	35.5a	173.2a	401.8a	708.6a
2	38.2ab	190.1ab	480.3ab	750.1ab
3	41.6c	230.4c	568.8c	816.4b
4	40.3b	203.8b	510.7b	775.6ab
5	38.1ab	193.7ab	490.3ab	766.4ab
6	37.6ab	198.3ab	489.3ab	831.5c
Mean	38.6	198.3	490.2	774.8

a, b, c : values bearing the same letter in a column are not significantly different ($P>0.01$)

Table 3 : Heritability estimates of body weights at various ages of local chicks in the Western Highlands of Cameroon.

ESTIMATION PROCEDURE	HERITABILITY ESTIMATES AT			
	DAY OLD	4 WEEKS	8 WEEKS	12 WEEKS
From sire group (h^2_S)	0.31 ± 0.03	0.35 ± 0.03	0.34 ±0.05	0.35 ±0.05
From dam group (h^2_D)	0.46 ± 0.07	0.48 ± 0.07	0.52 ±0.09	0.55 ±0.09
From sire and dam (h^2_{S+D})	0.36 ± 0.03	0.37 ± 0.02	0.38 ±0.03	0.39 ±0.03

tion of variance caused by non additive gene actions (Lush, 1949). However, it is believed that estimates based on the full-sib correlation are more reliable since any errors existing in the estimated variance components are multiplied by two rather than by four. Estimates of Heritability from sire, dam and full-sib correlation obtained from this study were lower than the estimates of 0.41, 0.66 and 0.36 respectively reported by Ebangi and Ibe (1994) in Nigeria. Nwosu and Assuquo (1984) obtained heritability estimates for 4-, 8-, 12- 16- and 20 week body weights as 0.36, 0.38, 0.37, 0.32 and 0.36, 0.34, 0.36, 0.38, 0.37 and 0.40, 0.49, 0.44, 0.33, 0.43 and 0.38 from sire, dam and combined variance components, respectively. Oluyemi and Oyenuga (1971) reported a heritability of 0.31 for 12 weeks body weight in local chickens of Nigeria. Observed differences could be due to several factors such as: method of estimation, sample size, age of the chicks, genotype x environmental interactions. In the present study significant differences due to sex of chicks could have increased the component of environmental variance to the chicks thereby lowering heritabilty estimates. As the age increased, heritability estimates tended to increase, although the differences were not significant. Henderson (1957) reported an effect of egg weight on chick weight up to twelve weeks of age. This would indicate that inherent potential of growing chicks would depend on the quantity and quality of the albumen and yolk contained in the eggs. During the early age, the quantity or quality of those reserves absorbed by the foetus would tend to affect the weight of the chick, thus increasing the environmental component of variance and lowering heritability. At the later age, when those reserves decrease, growth potential is less influenced and as such, the environmental component of variance decreases and the heritability estimates increase. The moderately high heritability estimates observed in this study suggest that selection based on individual performance could be effective in improving body weight of indigenous chicks. Because heritability of growth rate to a given age has been found to be very similar to the heritability of weight at that age and because selection for growth rate has also been found to successfully reduce age at slaughter (Johanssen and Rendel, 1968), it could be possible to reduce the age of sexual maturity of local chickens from 36 weeks (Wilson, 1979; Kassambara, 1989; Sonaiya and Olori, 1989; Assan, 1990; Sall, 1990; Katule, 1992) down to the range of eight to twelve weeks which is the age during which the typical broiler hybrid is slaughtered.

CONCLUSION

In practice high estimates of heritability obtained in the present study tended to increase with age, indicating that selection at 12 weeks based on individual performance could be more effective in improving body weights of local chickens. However, day old weight could be more appropriated than 12 weeks weight if high correlations existed between day old and later weights. Culled chicks would leave the flock earlier, decreasing cost of maintaining animals. This problem however requires further investigation.

REFERENCES

AGBEDE, G. B., TEGUIA, A. and MANJELI, Y. (1995). Enquête sur l'élevage traditionnel des volailles au Cameroun. *Tropicultura* 13 : 22 – 24.

AKLOBESSI, K. K. (1990). Smallholder rural poultry production in Togo. In CTA seminar proceedings, volume 2, Smallholder Rural Poultry Production, Thessaloniki, Greece,
237 –242.

ASSAN, B. E. (1990). L'élevage villageois de la volaille en République du Benin : situation actuelle. In: CTA

Seminar Proceedings, volume 2, Smallholder Rural Poultry Production, Thessaloniki, Greece, 17 – 26.

BULDGEN, A., DETIMMERMAN, F., SALL and COMPFERE, R. (1992). Etude des paramètres démographiques et zootechniques de la poule locale du bassin arachidier sénegalais. *Revue Elév. Méd. Vét. Pays Trop.* 45 : 341 – 347.

EBANGI L. A. and IBE S. N. (1994). Heritability of growth traits in local chickens at 6 weeks in Nigeria. *Revue Elev. Méd. Vét. Pays Trop.* 47(2) : 238 – 240.

EL HOUADFI, M. (1990). Rapport sur la production avicole et problèmes liés aux élevages traditionnels au Maroc. In CTA seminar proceedings, volume 2, Smallholder Rural Poultry Production, Thessaloniki, Greece, 161 – 171.

FALCONER, D. S. (1960). Introduction to Quantitative Genetics. Ronald Press, Co., New York.

FOTSA J. C. and MANJELI Y. (1995). Essai d'amélioration de la poule locale Camerounaise : analyse des performances de croissance des poussins locaux, Jupiter et F_1 en claustration. *Cam. Bull. An. Prod.* 3(1) 18 – 25.

GUEYE, E. F. (1998). Village egg and fowl meat production in Africa. *World's Poultry Sc. J.*, 54 : 73 – 86.

GUEYE E. F. and BESSEI, W. (1995). La poule locale sénégalaise dans le contexte villageois et les possibilités d'amélioration de ses performances. Proceeding of ANRPD Workshop and General Meetings, 13 – 16 June 1995, Addis Ababa, Ethiopia.

HENDERSON C. R. (1953). Estimations of variance and covariance components. *Biometrics,* 9 : 226 – 252.

HENDERSON C. R. (1957). Inherent variation in influence of hatching egg weight on early chick growth. Quarterly bulletin of the Michigan Agricultural Experiment Station Michigan State University, East Lansing Vol. 39 N° 3, 393 – 397.

JOHANSSON I. and RENDEL J. (1968). Genetics and Animal Breeding W.F. Freeman and Company Press. San Francisco. CH. 13.

KASSAMBARA, I. (1989). La production avicole au Mali : problèmes et perspectives. In Proc. Of an International Workshop on Rural Poultry Development in Africa 13 – 16 November 1989 Ile – Ife, Nigeria,140 – 150.

KATULE A. M. (1992). Study on the potential value of chickens native to Tanzania. ANRPD Newslelter 2 : 4.

LAKE P. E. (1959). Fowl semen as collected by the massage methods. *J. Agric. Sci.*, 49 : 120 – 126.

LUSH, J. L. (1949). Heritability of quantitative characters in Farm Animals. Proc. 8th International Congress Genetics (Hereditas Suppl. Vol.) page 356.

NWOSU C. E. and ASUQUO B. O. (1984). Heritability estimates of body weight in local chickens. In Proc. 9th annual conference on self sufficiency in animal protein supply under changing fortune. Nsukka, University of Nigeria, 44 – 48.

NGOU NGOUPAYOU, J. D. (1995). The role of smallholder in poultry production in Cameroon. ANRPD Newsletter 5 : 3 – 4.

OLUYEMI J. A. and OYENUGA V. A. (1971). A preliminary evaluation of the Nigerian indigenous fowls as table birds. Proc. Agric. Sci. Nigeria. 8 : 22 – 25.

OLUYEMI J. A. (1989). Germplasm component of rural poultry development in Africa. In : Proceedings of an International Workshop on rural poultry Development in Africa 13 – 16 November 1989, Ife – Ife, Nigeria, 49 – 55.

RAVELSON, C. (1990). Situation et contraintes de l'aviculture villageoise à Madagascar. In : CTA Seminar Proceedings, Volume 2, Smallholder Rural Poultry Production. Thessaloniki, Greece, 135 – 138.

SALL, B. (1990). Contribution à l'étude des possibilités d'amélioration de la production en aviculture traditionnelle : mesure du potentiel de la race locale et des produits d'un croisement améliorateur, Travail de fin d'Etudes d'Ingénieur Agronome. INDR, Thies, Sénégal.

SAS (1987). Statistical analysis systems. Procedures guide for Personal Computers.

SONAIYA, E. B. and OLORI, V. E. (1989). Village chicken production in South Western Nigeria. In : Proc. of an International workshop on Rural Poultry Development in Africa 13 – 16 November 1989, Ile – Ife, Nigeria, 243 – 247.

SONAIYA, E. B. (1990b). The context and prospects for development of smallholder rural poultry production in Africa. In : CTA seminar Proceedings, Volume I, Smallholder Rural Poultry Production, Thessaloniki, Greece, 35 – 52.

TCHOUMBOUE J., MANJELI Y., TEGUIA A. and EWANE N.J. (2000). Productivité et effets comparés de trois systèmes de conduite de l'élevage sur les performances de l'aviculture villageoise dans les hautes terres de l'Ouest Cameroun. *Sci. Agron. Et Dév.* 1 (1) : 6-14.

WILSON, R.T., (1979). Studies on the livestock of southern Darfur VII. Production of poultry under simulated traditional conditions. *Trop. Anim. Health Prod.*, 11: 143-150.

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