Journal of Biology, Agriculture and Healthcare
ISSN 2224-3208 (Paper) ISSN 2225-093X (Online)
Vol.4, No.17, 2014

Heterosis of Body Weights and Egg Weights of F_1 Snails (*Archachatina marginata var. saturalis*) in Obubra, Nigeria

L. A. Ibom[1*] B. Okon[1] L. E. Asuquo[2]
1.Department of Animal Science, University of Calabar, P.M.B. 1115, Calabar, Nigeria
2.Department of Agric. Education, Akwa Ibom State College of Education, Afaha Nsit, AKS, Nigeria
* E-mail of the corresponding author: lawuibom@yahoo.com, ibomlawrence@gmail.com

Abstract
A study was conducted to provide baseline information on the trends of heterosis in snail traits, so that reproductive and production performance of snails will be enhanced as is the case with other farm animal species. Three hundred (300) grower snails, one hundred and fifty each of the black-skinned (BS) and white-skinned (WS) ectotypes of *Archachatina marginata* snail were generated from an earlier study in the same location. The snails had weight ranging from 43.31 to 45.43 g for both ectotypes at the time of selection and were allotted into three mating groups. The mating groups are; black skinned x black skinned (BS X BS), white skinned x white skinned (WS X WS) and black skinned x white skinned (BS X WS). The mating groups were used to generate snails whose body and egg weights were compared with that of their parents. Results from the study showed that all the mating groups (BS X BS, WS X WS and BS X WS) expressed positive body weight at hatch and at the juvenile stages of growth (1 wk to 4 wk). The heterotic values for body weight were 38.89 %, 37.01 % and 53.59 % for BS X BS, WS X WS and BS X WS mating groups respectively at hatch. The heterotic value for the crossbred (BS X WS) mating group was significantly (P<0.05) different from the values of the purebred mating groups (BS X BS and WS X WS). Similarly, all the mating groups recorded positive heterotic values for egg weight at lay. The crossbred (BS X WS) mating group expressed the highest value of 60.77 % and was significantly (P<0.05) different from the values expressed by the purebred mating groups, 59.39 % for BS X BS and 54.26 % for WS X WS. The results of this study suggest that hetrosis (hybrid vigour) can be exploited to improve snails' reproductive and growth traits if appropriate selection programme is applied. We therefore recommend the continued crossing of the black- and white- skinned snails for the production of better offspring and preservation of their genetic potentials.
Keywords: Heterosis, body, egg, weight, snail

1. Introduction

Livestock production is an important part of the Nigerian economy, providing high quality food for human population. However, the contribution of mini-livestock, especially snails (*Archachatina marginata, Achatina achatina, Achatina fulica, Limicolaria aurora* and *Limicolaria martensis*) to the Nigerian livestock sub-sector of the economy is generally undervalued. This could be because snail production (snailery) and snail based research are new brides of animal agriculture in Nigeria (Akinnusi, 2004, Ibom, 2009, Okon and Ibom, 2012). Besides, the precious genetic resource of snail as a species has not been realized and so is yet to find a place in the Nigerian livestock census chart. Also, no serious step has been taken for its domestication and improvement. It is possible that Nigeria's quest for food sufficiency, especially animal protein intake which is reportedly between 12 – 20 g per caput per day (FAO, 1998), will increase in the next decades. This calls for vigourous and concerted efforts to produce food (meat protein) to meet the demands of the ever increasing population of Nigeria. The crossbreeding of snail breeds and ectotypes (black- and white- skinned) for effective supply of animal protein in Nigeria could serve as a solution to the low animal protein intake.

Snails are indigenous to the Nigerian environment and are therefore not fraught with the problem of adaptation (Okon and Ibom, 2010, Ibom et al., 2012). This corroborates Raut and Barker (2002), that the Achatinidae gastropod family is native to Africa. The authors further stated that the family is represented by about 200 species in 13 genera. It could also be that snails have high accumulation of adaptability genes. According to Ibom, 2009 and Ibom et al., 2012, it is possible that giant African land snails (GALS) is a reservoir of some valuable traits (disease resistance, high fertility and fecundity, unique product qualities, longevity and adaptation to local harsh conditions and poor quality feed) like other livestock of African origin. These are all desirable qualities for achieving sustainable food production and could be influenced by some advantageous tropically relevant genes. Snails have become attractive as a functional food. They are becoming more important in the diet of Nigerians due to their nutritional value, related to high quality protein, minerals and low cholesterol, fat/energy contents.

Integrating snails into target gene pool in an organized breeding project will be beneficial for the following reason; Firstly, Ibom, 2009, Ibom et al. (2010) and Okon et al. (2011) noted that the black- and white-skinned snail ectotypes exhibit appreciable nicking when crossbred. Secondly, GALS possess high resistance and tolerance to diseases (Akinnusi, 2004, Ibom, 2009). The continued crossing of black- and white- skinned

GALS will help evolve the genetic base material needed for successful selective snail breeding in Nigeria. Besides, different genetic merits will be obtained, prevent the extinction of the endangered black-skinned ectotype which is indiscriminately hunted for, enhance sustainable production, environmental conservation and maintenance of biodiversity. Ultimately, crossbreeding will lead to the preservation of the genetic potentials of GALS. Offspring with greater performance (heterosis or hybrid vigour) than the average of their parents will also be produced.

Farmers had used hybrid vigour or heterosis to enhance reproductive and production performance of farm animal species (cattle, sheep, goats, pigs and poultry) (Clift, 2010). Information is lacking in the literature on the achievement of hybrid vigour in the improvement of performance of economic traits in giant African land snails. This study was therefore designed to evaluate heterosis of some economic traits in *A. marginata* snail. The traits evaluated included body weight of juveniles (at hatch to four weeks of age) and egg weight (at lay). The findings will provide baseline information on the trends of heterosis in these snail traits for future studies.

2. Materials and Methods

*2.1*Experimental site: This study was carried out at the Snailery Unit, Department of Animal Science Teaching and Research Farm, Cross River University of Technology (CRUTECH.), Obubra Campus, Nigeria. The location, temperature and mean annual rainfall of Obubra had been previously described by Ibom et al. (2008), Ibom, 2009 and Ibom and Okon (2010). These authors also described the micro-environment of the study area.

2.2 Experimental animals: Three hundred (300) grower snails, one hundred and fifty each of the black-skinned and white-skinned ectotypes of *A. marginata* snail were selected from an earlier study for use in this experiment. Selection was based on active appearance and absence of injury, blister or lesion on the foot and/or shell. The selected grower snails had weights ranging from 43.31 to 45.43 g for both ectotypes.

2.3 Housing and management of snails: The experimental snails were randomly allotted into three treatments (mating groups) of one hundred black-skinned, one hundred white-skinned and one hundred mixed skin colour (fifty black-skinned : fifty white-skinned) ectotypes and managed in wooden cell compartments kept outside under trees shed throughout the duration of the study (sixteen weeks). The mating groups were, black skinned x black skinned (BS X BS), white skinned x white skinned (WS X WS) and black skinned x white skinned (BS X WS). The cells in which the snails were managed had dimensions of 40 cm (length), 40 cm (width) and 30 cm (depth). Each treatment was replicated fifty times in the completely randomized design for purposes of reproduction. Each replicate in a cell consisted of two snails of similar weights. The snails were marked for easy identification. The pair of snails were allowed together in one cell for one week and then separated for another one week before being returned in that cycle until they laid eggs. This enabled us to identify eggs laid by a particular snail. The mating arrangement for each treatment is shown in Table 1.

The snails were fed on a mixed regime of formulated diet (10 g) supplemented with pawpaw leaves (15 g) once daily at 5 – 7 pm. The diet was formulated to contain 24 % crude protein (CP) and 2650 Kcal/Kg Metabolizable Energy (ME) using maize (41.6 %), soyabean meal (30.3 %), crayfish dust (7.6 %), bone meal (2.0 %), wheat offal (10.0 %), oyster shell (8.0 %), and vitamin/mineral premix (0.5 %). Water in shallow troughs was served *ad libitum* throughout the study period.

Table1: Mating arrangement of snails in each treatment (mating group).

Mating group	Number of snails	Number of cells
BS X BS	2	50
WS X WS	2	50
BS X WS	2	50

BS = Black-Skinned ectotype, WS = White-Skinned ectotype.

2.4 Data collection and statistical analysis: Data were collected on eggs weight of both the parent stock and F_1 generation offspring. Data were also obtained from snailets obtained from the hatching of eggs laid by the F_1 offspring. Offspring (i.e. F_2) of the F_1 snails were raised to four weeks of age and data collected used to estimate heterosis. Data were collected on juveniles' growth parameters. The weights were measured using Scout^{TM} Pro electronic scale having a sensitivity of 0.01 g. Eggs weight (g) was taken at lay, while juveniles' weight (g) was taken at hatch and weekly thereafter through to reproductive phases of the snails. Heterosis was estimated using the formula outlined by Ibe (1998). Means were separated using analysis of variance by Duncan's Multiple Range Test (DMRT), Procmean procedure of SAS (2007) package.

The formula according to Ibe (1998) is:

$$\% \text{ Heterosis} = \frac{H_1 - \overline{P}}{\overline{P}} \times \frac{100}{1} \quad (1)$$

Where: H_1 = Average performance of offspring
$\overline{P}$ = Average performance of parents
The fixed model used in the experiment is:

$$Y_{ij} = \mu + S_i + e_{ij} \quad (2)$$

Where: Y_{ij} = Single observation
μ = Common mean
S_i = Fixed effect of ectotype (i = 1, 2)
e_{ij} = Random error associated with the measurement of each

3. Results and Discussion

The values of heterosis for body weights and egg weight at lay obtained in this study are presented in Table 2. The results showed that all the mating groups (BS X BS, WS X WS and BS X WS) expressed positive body weight at hatch and at the juvenile stages of growth (1 wk to 4 wk). Expectedly, the values increased with age of snails from hatch to week 4 (Table 2). The positive heterotic body weight values expressed by these juveniles could suggest that the parents have good combining ability. Besides, it could be that the trait being considered is heritable. This corroborates Clift, (2010) who held that heterosis tends to be greater for traits that have low heritability (e.g. reproduction) and smaller for traits that are highly heritable (e.g. growth rate). The heterotic values at hatch were 38.89 % for BS X BS mating group, 37.01 % for WS X WS mating group and 53.59 % for BS X WS mating group (Table 2).The heterotic value for the crossbred (BS X WS) mating group was significantly ($P<0.05$) different from the values of the purebred mating groups (BS X BS and WS X WS) (Table 2). This trend continued to week 2. However, the numerical differences in values between the purebred (BS X BS and WS X WS) and the crossbred (BS X WS) mating groups did not differ statistically in weeks 3 and 4 of the juveniles' life (Table 2).

The heterotic values of egg weight at lay obtained in this study are presented in Table 2. The results showed that the values of egg weight at lay for all the mating groups were positive. The trend was similar to that of the body weight values. The value of egg weight for the crossbred (BS X WS) mating group was significantly different ($P<0.05$) from the values of the purebred mating groups (BS X BS and WS X WS) (Table 2). The values were 59.39 % for BS X BS mating group, 54.26 for WS X WS mating group and 60.77 % for BS X WS mating group. This could suggest that the genes responsible for the expression of this trait are favourable to reproduction and are dominant over their opposites. The result further confirmed Clift, 2010), that heterosis tends to be greater for reproductive traits.

The findings of this study are in agreement with the reports of Ibom, 2009 for body weight and egg weight heterosis. The positive values expressed by traits in this study were in line with Nwakpu and Omeje (2005) who reported that the effects of heterosis are most often but not always positive, and depend mainly on choice of parents and selection pressure applied in parental lines (breeds). These results showed that the crossbred (BS X WS) mating group has advantage over the purebreds (BS X BS and WS X WS) mating groups.

Table 2: Heterosis (%) values of body and egg weights measured on snails.

Trait (g)	**Age**	**BS X BS**	**WS X WS**	**BS X WS**
Body weight	At hatch	38.89^b	37.01^b	53.59^a
	Juvenile (1 wk)	53.73^b	57.75^b	81.71^a
	2 wk	65.51^b	68.19	83.71
	3 wk	80.00	82.94	93.43
	4 wk	90.57	95.05	98.48
Egg weight	At lay	59.39^b	54.26^b	60.77^a

BS = Black Skinned ectotype, WS = White Skinned ectotype.
^{ab}Means with different superscript along the same row are significantly ($P<0.05$) different.

4. Conclusion

The results of this study further confirmed that appreciable nicking is possible between the black-skinned and white-skinned ectotypes of *A. marginata* snail. The results indicated that hetrosis (hybrid vigour) can be exploited to improve snails' reproductive and growth traits if appropriate selection programme is applied.

References

Akinnusi, O. 2004. Introduction to Snails and Snail Farming: Triolas Exquisite Ventures. 2nd Edn., Abeokuta, Nigeria.

Clift, L. 2010. Hybrid vigour or heterosis in farm animals, *experiences with dairy cattle crossbreeding in New Zealand. Proceedings of the* 53rd Annual Meeting of the European Association for Animal Production, (AMEAAP'10), Winnipeg, MB., Canada, pp: 1-4.

FAO., 1998. Food and Agriculture Organization. Production Year Book, Rome, Italy. pp.52.

Ibe, S. N. 1998. *An Introduction to Genetics and Animal Breeding.* Longman Nigeria Plc, Ikeja, Nigeria.

Ibom, L. A., B. Okon and A. Essien 2008. Morphometric analysis of eggs laid by two ectotypes of Snails <I>*Archachatina marginata*</I> (Swainson) raised in captivity. *Global J. Agric. Sci.,* 7: 119-12

Ibom, L. A. 2009. Variations in reproductive and growth performance traits of White-skinned x Black-skinned African giant snail hatchlings [<I>*Archachatina marginata*</I> (*Swainson*)] in Obubra, Nigeria. Ph.*D. Thesis*, Department of Animal Science, University of Calabar, Calabar, Nigeria.

Ibom, L. A., B. Okon and L. J. Isaac 2010. Effects of body weight ranges on variations in morphological traits of parent snails and eggs obtained from their matings in Obubra, Nigeria. *Articlesbase.com,* 11: 1 – 11.

Ibom, L. A. and B. Okon 2010. Variations in morphometric traits of eggs produced from the cross of two ectotype snails [<I>*Archachatina marginata*</I> (*Swainson*)] in a humid tropical environment. *Proceedings, 35th Annual Conference, Nigerian Society for Animal Production.* March 14-17, 2010, University of Ibadan, Ibadan, Oyo State, Nigeria. pp: 28-31.

Ibom, L. A., B. Okon and B. E. E. Bassey 2012. Egg traits, hatchability and snailet survivability of black-skinned, white-skinned and crossbred <I>*Archachatina marginata*</I> snails. *Int. J. Agric. Sci. Bioresour. Eng. Res.,* 1: 10-18.

Nwakpu, P. E. and S. I. Omeje 2005. Influence of genotype and weight of gilts on the litter size and litter growth of inbred Native by Largewhite pig crosses. *Trop. J. Anim. Sci.,* 8: 1-4.

Okon, B. and L. A. Ibom 2010. Commercialization of Snail production in Nigeria: Potentials, viabilities and challenges. *J. Appl. Sci.,* 13: 9139-9158.

Okon, B., L. A. Ibom and E. E. Odido 2011. Reproductive performance and egg quality traits of crossbreeding between two strains of snails. *Arch. Zootec*., 60: 153-156.

Okon, B. and L. A. Ibom 2012. *Snail Breeding and Snailery Management*. Freshdew Productions, Calabar, Nigeria. Pp. 90.

Raut, S. K. and G. M. Barker 2002. *Achatina fulica Bowdwich* and other Achatinidae as Pest in Tropical Agriculture. CABI Publishing, New Zealand, pp: 55-114.

SAS, 2007. Statistical Analysis Systems Users Guide Statistics. Statistical Analysis Systems Institute Inc., Cary, NC., USA.