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Haemoglobin Types and Production Traits in Rabbit Breeds and Crosses

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Abstract: This study was conducted to evaluate the Haemoglobin (Hb) types and production parameters of rabbit breeds and crosses randomly selected from rabbit unit of the Teaching and Research farm, Federal University of Technology, Akure. Blood samples from and performance data of 210 rabbits were collected. The rabbits comprised 4 genotypes namely New Zealand white x New Zealand white (NZW x NZW), Chinchilla x Chinchilla (CHA x CHA), New Zealand white Dutch belted x New Zealand white Dutch belted (NZWDBD x NZWDBD) and New Zealand white Croel x New Zealand white Croel (NZWCRL x NZWCRL). The blood samples were screened for Hb types by cellulose acetate electrophoresis. Performance data include Individual Kit weight (Ikt), Average Litter weight (Alt), Litter Weight (Lwt) and Gestation Length (Glt) at birth, weaning age of 35 days and post-weaning age of 56 days. The resultant data were subjected to statistical analysis to determine the effect Hb types on the performance characteristics. The haemoglobin types, AA and AB detected in the rabbit blood did not significantly ($p > 0.05$) affect production traits at various ages. However, Hb AB rabbits performed better than HbAA in Individual Kit weight (Ikt) and Average Litter weight (Alt) at weaning and post-weaning ages of 35 and 56 days.

Key words: Haemoglobin types, traits, rabbits

INTRODUCTION

Haemoglobin as the respiratory carrier is found in vertebrate red blood cells, in some invertebrates and in the root nodules of legumes. The molecule is a tetramer of four subunits, each of which has two parts: a polypeptic chain, globin and a prosthetic group, haeme, which is an iron containing pigment that combines with oxygen and gives the molecule its oxygen-transporting ability. The haeme portion is alike in all forms of haemoglobin, genetic variation being restricted to the structure of the globin portion only. Even within the globin polypeptic there is some restriction in the kinds of amino acid substitutions that are acceptable in terms of natural selection, since impairment of the oxygen-carrying function of the molecule cannot be tolerated (Thompson and Thompson, 1980; Peters *et al.*, 2004).

The haemoglobins occupy a unique position in medical genetics for many reasons. They have revealed more about the molecular basis of human, animal and medical genetics than any other system. They are historically important for their part in the demonstration of the relationship between genetic information and protein structure. They also illustrate mechanisms of forming new genes other than by point mutation, cast light on the process of evolution of both the molecular and the

population level and provide a model of gene action during development. Furthermore, haemoglobin variants are clinically important as causes of a variety of genetic disorders of blood. Consequently, the genetic background of the haemoglobins merits examination in some detail (Thompson and Thompson, 1980; Peters *et al.*, 2004).

Blood protein polymorphisms have been used by several researchers as markers to study evolutionary relationships in mammals. For example, evolutionary relationships between different sheep breeds, deer species, goat breeds and chicken genotypes have been examined (Kalab *et al.*, 1990; Emerson and Tate, 1993; Buchanan *et al.*, 1994; Guney *et al.*, 2003; Malan *et al.*, 2003; Yang and Jiang, 2005). Manwell and Baker (1977) compared the genetic variation at 30 blood protein loci to determine genetic distance (Nei, 1972) between the Australian Merino and the poll Dorset breeds.

There is more information about genetic variations of blood components than any other animal tissue (Bodmer and Cavalli-Storza, 1976). Most blood protein polymorphisms are genetically controlled by allelic series with no dominance or co dominance. An animal that has a gene for a specific substance, the substance can be detected in the blood by appropriate procedures, such as electrophoresis and the presence or absence of specific

substance is directly related to the genotype (Daly, 1979; Legates and Warwick, 1990; Adebambo, 2004). The study of genetically controlled biochemical polymorphisms of blood proteins is at present a useful tool to characterize livestock breeds and populations; hence it contributes to the knowledge of genetic similarity and the distance between them (Kidd *et al.*, 1975; Zaragoza *et al.*, 1987; Omitogun, 2004). These studies are of genetic, phylogenetic and practical importance in livestock improvement.

Due to the scanty information on biochemical genetic characterization of rabbits in the humid tropics, this study was therefore designed to screen the haemoglobin polymorphic types in rabbit breeds and crosses in this ecological zone of Nigeria and to further determine their possible putative effects on some production traits.

MATERIALS AND METHODS

Data used for this study were collected on 210 rabbits from a breeding experiment at FUTA Teaching and Research Farm between 1998 and 2001. Among the 210 rabbits were 49 does and 13 bucks which formed the parent stocks. Several random matings involving the does and the bucks gave rise to 148 offsprings. The kits were sexed at 21 days. Litters were weaned at 35 days of age when each kit was individually ear-tagged and weighed. Littermates were kept together in the same cage to 56 days of age. Thereafter, the rabbits were separated into individual cages provided with feeding and watering troughs, which were made from tins.

The rabbits were given *ad libitum* access to commercial diets of 15% crude protein and 2300 kcal kg⁻¹ metabolizable energy in the morning, supplemented with sweet potato leaves and *Aspillia africana* in the evening. Clean water was supplied regularly. The incidence of diarrhoea was combated with antibiotics such as embassin forte^R. To ensure absence of haemoparasites, internal and external parasites the animals were treated with Ivomec injection.

Blood samples were collected from the 62 rabbits that formed the parent stock used in this study. In addition, blood samples were collected from 148 offsprings of matings among the parent rabbits. In all, 210 blood samples were collected for analyses. The 62 parent rabbits comprised 18 New Zealand White (3 bucks and 15 does) pure breeds, 18 Chinchilla (5 bucks and 13 does) pure breeds, 14 New Zealand White-Dutch belted (3 bucks and 11 does) cross breeds and 12 New Zealand White Croel (2 bucks and 10 does) cross breeds. The 148 offsprings included 50 New Zealand White x New Zealand White, 61

Chinchilla x Chinchilla, 23 New Zealand White Dutch belted x New Zealand White. Dutch belted 14 New Zealand White Croel x New Zealand White Croel. About 3-5 mL of blood was drawn from the ear vein of each rabbit by means of 5 mL sterile needle and syringe. Each sample was expressed into a clean bijoux bottle containing dried EDTA powder as an anticoagulant. The bottles were labeled accordingly.

Hb alleles were typed using cellulose acetate electrophoresis as described by Fairbank and Klee (1986). Briefly, about 1 mL of whole unseparated blood was expelled into a centrifuge tube. The red cells were washed twice in a solution in the centrifuge tubes to remove the buffy coats by centrifugation. The samples were centrifuged at 5°C for 1 min at 900 g and the supernatant discarded. Cold distilled water was added to the sedimented cells to release the haemoglobin by haemolysis. The haemolysates were removed with a transfer pipette and stored at -10°C and 15°C until the electrophoretic studies was carried out.

Cellulose acetate strips (Oxoid) were prepared and labeled. They were soaked in Tris-EDTA borate buffer (TEB, pH 8.6) and blotted slightly with filter paper to remove excess buffer. Haemolysates were applied with a micropipette and electrophoresis was carried out using Shandon Southern Electrophoretic tank with TEB (pH 8.6) as the electrode buffer at 450v for 30-35 min. The strips were stained with ponceau red. S for 5-10 min and progressively destained in 5% and then 12% acetic acid solution. The strips were then dried in the oven for 30 min at 60°C. The direct gene counting method as described by (Zaragoza *et al.*, 1987) was used to score Hb bands based on the separation of Hb variations after electrophoresis as follows:

- A single faster band in an animal was designated as the AA homozygote.
- The presence of a single slower band in an animal was designated as BB homozygote
- The presence of both bands in an animal was designated AB heterozygote

It was assumed that sampling were from mixed populations which were not under Hardy-Weinberg equilibrium. Consequently, gene frequencies were not calculated.

Data on Individual Kit weight (lkt), Litter Weight (Lwt), Average Litter weight (Alt) and Litter Size (Ltz) were collected from the production records of the rabbits and categorized into Hb genotype and genetic classes for statistical analysis.

Statistical analyses: The data were subjected to analysis of variance and mean separation was done where significance existed (Harvey, 1999; Duncan, 1955).

RESULTS

Haemoglobin genotype: The distribution of Hb genotypes AA and AB were 80 and 16%, 65.57 and 34.43%, 100 and 0% and 71.43 and 28.57% in NZW x NZW, CHA x CHA, NZWDUT x NZWDUT and NZWCRL x NZWCRL, respectively (Table 1). The Hb genotype (BB) was not observed.

Reproductive traits and haemoglobin genotype: Table 2 to 4 present means with their corresponding standard errors of reproductive traits at birth, weaning (35 days) and 56 days for rabbit's genetic groups among haemoglobin genotypes. There were no significant ($p>0.05$) differences among the Hb types means for reproductive traits considered at various ages. Based on total mean values, Hb genotype AA was however slightly superior in Ikt (50.23±0.24 g) and Alt (51.09±0.33 g) over AB, which was better in Lwt (219.63±1.58 g) at birth (Table 2). At weaning age of 35 days, Hb AB had better performance in total Ikt and Alt means (348.58±0.60 g and 356.56±2.86 g) than

Table 1: Distribution of haemoglobin (Hb) genotypes

Genetic groups	N	Hb Genotypes					
		AA	%	AB	%	BB	%
NZW x NZW	68	59	86	9	13	-	-
CHA x CHA	79	52	65.82	27	34.17	-	-
NZWDUT x NZWDUT	37	37	100.00	-	-	-	-
NZWCRL x NZWCRL	26	21	80.77	5	19.23	-	-

NZW x NZW = New Zealand white x New Zealand White, CHA x CHA = Chinchilla x Chinchilla, NZWDUT x NZWDUT = New Zealand White-Dutch belted x New Zealand White-Dutch belted, NZWCRL x NZWCRL = New Zealand White-Croel x New Zealand White-Croel

Table 2: Means of reproductive traits at birth in rabbit genetic groups among Hb types

Hb	Traits	NZW x NZW	CHA x CHA	NZWDUT x NZWDUT	NZWCRL x NZWCRL	Total
AA	Ikt (g)	48.75±0.04 (42)	50.86±0.04 (40)	51.36±0.14 (23)	49.95±0.73 (10)	50.23±0.24 (115)
	Alt (g)	49.75±0.12 (13)	51.08±0.10 (11)	51.22±0.27 (6)	52.30±0.84 (3)	51.09±0.33 (33)
	Lwt (g)	209.65±0.32 (13)	211.54±0.47 (11)	205.36±0.57 (6)	177.69±0.27 (3)	201.06±0.41 (33)
	Glt (days)	30.70±1.1 (13)	30.12±0.51 (11)	30.18±1.03 (6)	30.15±0.92 (3)	30.29±0.89 (33)
AB	Ikt (g)	53.62±0.53 (8)	42.93±0.14 (21)	-	50.36±0.11 (4)	48.97±0.26 (33)
	Alt (g)	53.58±0.47 (3)	44.53±0.16 (7)	-	50.38±0.34 (2)	49.50±0.32 (12)
	Lwt (g)	235.00±1.65 (3)	189.88±0.48 (7)	-	234.00±2.62 (2)	219.63±1.58 (12)
	Glt(days)	30.35±0.94 (3)	30.94±0.97 (7)	-	30.67±0.47 (2)	30.65±0.79 (12)
BB	-	-	-	-	-	-

Ikt = Individual kit weight; Alt = Average litter weight; Lwt = Litter weight; Glt = Gestation length, *Sample sizes are shown in parentheses

Table 3: Means of reproductive traits at weaning (35 Days) in rabbit genetic groups among Hb types

Hb type	Traits	Genetic groups				Total
		NZW x NZW	CHA x CHA	NZWDUT x NZWDUT	NZWCRL x NZWCRL	
AA	Ikt (g)	292.38±0.12 (42)*	341.32±0.16 (40)	372.83±0.37 (23)	315.29±0.35 (10)	330.46±0.25 (115)
	Alt (g)	318.36±0.43 (13)	357.32±0.54 (11)	393.50±1.41 (6)	325.94±1.54 (3)	348.78±0.98 (33)
	Lwt (g)	1055.83±0.86 (13)	1199.90±1.02 (11)	1430.83±3.61 (6)	1119.37±3.03 (3)	1201.48±2.13 (33)
AB	Ikt (g)	331.10±0.70 (8)	337.89±0.50 (21)	-	376.75±0.61 (4)	348.58±0.60 (33)
	Alt (g)	346.00±3.69 (3)	382.83±1.52 (7)	-	340.84±3.36 (2)	356.56±2.86 (12)
	Lwt (g)	827.75±5.20 (3)	1052.00±3.41 (7)	-	753.50±8.73 (2)	877.75±5.78 (12)
BB	-	-	-	-	-	-

Ikt = Individual kit weight; Alt = Average litter weight; Lwt = Litter weight, *Sample sizes are shown in parentheses

Table 4: Means of reproductive traits at 56 days in rabbit genetic groups among Hb types

Hb type	Traits	Genetic groups				Total
		NZW x NZW	CHA x CHA	NZWDUT x NZWDUT	NZWCRL x NZWCRL	
AA	Ikt (g)	483.17±0.13 (42)*	463.98±0.18 (40)	546.39±0.55 (23)	480.45±0.40 (10)	493.50±0.32 (115)
	Alt (g)	496.37±0.46 (13)	449.24±0.67 (11)	2094.85±2.08 (6)	487.86±1.42 (3)	507.83±1.16 (33)
	Lwt (g)	2010.35±2.06 (13)	1514.53±1.21 (11)	3.53±0.23 (6)	1389.07±2.10 (3)	1752.11±2.44 (33)
AB	Ltz	3.06±1.05 (13)	3.20±0.05 (11)	-	2.41±0.32 (3)	3.05±0.16 (33)
	Ikt (g)	577.00±1.68 (8)	579.38±0.43 (21)	-	446.45±1.68 (4)	534.28±1.26 (33)
	Alt (g)	581.44±4.12 (3)	593.29±1.05 (7)	-	446.33±0.48 (2)	540.35±1.88 (12)
	Lwt (g)	1346.00±6.67 (3)	1738.14±4.41 (7)	-	892.00±12.54 (2)	1325.38±7.87 (12)
BB	Ltz	2.33±0.25 (3)	3.00±0.19 (7)	-	2.00±0.59 (2)	2.44±0.34 (12)
	-	-	-	-	-	-

Ikt = Individual kit weight; Alt = Average litter weight; Lwt = Litter weight; Ltz = litter size, *Sample sizes are shown in parentheses

HbAA, which recorded higher overall mean of 1201.48±2.13 g in Lwt (Table 3). Similar results were obtained for Hb genotypes at 56 days where Hb AB was superior in 1kt and Alt over Hb AA (Table 4).

DISCUSSION

In this study, two haemoglobin genotypes, AA and AB were detected which was contrary to general observation of A and B alleles with their corresponding genotypes AA, AB and BB in different species (Evans *et al.*, 1956; Maxwell and Baker, 1980; Zaragoza *et al.*, 1987; Tunon *et al.*, 1989). The two Hb genotypes observed among the rabbits may be due to poor resolution of Hb bands during electrophoresis; one or two bands may have effectively merged together confounding the interpretation of the resultant electrophoregrams. However, where there were mixtures of sub-populations with different gene frequencies (Bodmer and Cavalli-Sforza, 1976; Falconer, 1989), excess of both homozygotes and corresponding deficiency of heterozygotes would be expected. This study involving one locus, utilized sample sizes of mixed sub-population that did not investigate inheritance and segregation ratios or strength of heterozygosities at many loci. As a result, more information required making inferences about breeding structure and genetic architecture of rabbit breeds using loci is suggested.

In this study, haemoglobin genotypes detected had no significant effects on any of the traits considered. In sheep, Dalal *et al.* (1985) reported that there were no significant differences in birth weight among Hb types. Arora *et al.* (1971) reported a marginally, though not significantly, better birth weight in Hb BB type animals. But the effects of Hb AB and Hb BB alleles on productive performance in sheep had been reported elsewhere. (Dally *et al.*, 1980; Barowicz and Pacek, 1984; Arora, 1984 and Dratch *et al.*, 1986). No Hb BB type was detected in the present study. This could be due to the possibility of the situation being different in rabbits for genetic reasons or due to the sample size and mixed sub-populations used in this study. However, Hb AB performed better in individual and average weights of rabbits at weaning and post-weaning ages of 35 and 56 days.

CONCLUSION

The Hb types, AA and AB detected had no significant effects on production parameters namely individual kit weight, average kit weight and litter weight at various ages considered in the study. AB rabbits had heavier individual kit weight and average kit weight at

weaning and post-weaning ages of 35 and 56 days than AA rabbits. From the fore-going, a single locus involved in this study, utilized a mixed sub-population of rabbits. There is therefore the need for further study to uncover the breeding structure and genetic architecture of the rabbit breeds and crosses using many loci.

REFERENCES

- Adebambo, O.A., 2004. Animal Genetics and Quality of Life. Proceedings of the 29th Annual Conference of the Genetics Society of Nigeria. Ariyo, O.J., C.O.N. Ikeobi, M.O. Ozoje, I.T. Omoniyi and O.B. Kehinde (Eds.), held on 11-14 October at Abeokuta, Nigeria, pp: 42-53.
- Arora, C.L., R.M. Acharaya and S.M. Kakar, 1971. A note on the association of haemoglobin types with ewe and ram fertility in Indian sheep. *Anim. Prod.*, 13: 371-373.
- Arora, C.L., 1984. Selecting of biochemically polymorphic traits for improving economic traits in Indian sheep. 2. Haemoglobin types. *Livestock Advisers*, 9: 9-18.
- Barowicz, T. and K. Pacek, 1984. Relationships between productivity and haemoglobin types in Polish long wool sheep. In 35th Annual meeting of the EAAP. The Hague, the Netherlands. 6-9 August 1984.2.
- Bodmer, W.F. and L.L. Cavalli-Storza, 1976. *Genetics, Evolution and Man*. W.H. Freeman and Co. San Francisco.
- Buchanan, F.C., L.J. Adams, R.P. LittleJohn, J.F. Maddox and A.M. Crawford, 1994. Determination of evolutionary relationships among sheep breeds using micro-satellites. *Genomics*, 22: 397-403.
- Dalal, S.K., J.V. Solanki, M.M. Patel and R.K. Shukla, 1985. Haemoglobin types in Patan wadi sheep and their association with growth, wool and wool quality characters. *Gujarat. Agric. Univ. Res. J.*, 10: 46-52.
- Dally, M.R., W. Hohenboken, D.L. Thomas and M. Craig, 1980. Relationships between Hb type and reproduction. Lambs, wool and milk production and health-related traits in crossbred ewes. *J. Anim. Sci.*, 50: 418-427.
- Daly, J., 1979. The ecological genetics of the European wild rabbit (*Oryctolagus cuniculus*) in Australia. Ph.D. Thesis Australian National University Canberra.
- Dratch, P.A., A.J. Allison, T.L. Williams, B. Kyle, J.G. Wyllie and R.P. LittleJohn, 1986. Haemoglobin type and prolificacy in Booroola sheep. *Proceedings of New Zealand Soc. Anim. Prod.*, 46: 237-240.
- Duncan, D.B., 1955. Multiple range and multiple F-tests. *Biometrics*, 11: 1-42.

- Emerson, B.C. and M.L. Tate, 1993. Genetic analysis of evolutionary relationships among deer (subfamily Cervinae). *Heredity*, 84: 266-273.
- Evans, J.V., W.B. King, B.L. Cohen H. Harris and F.L. Warren, 1956. Genetics of haemoglobin and blood potassium differences in sheep. *Nature (Lond)*, 182: 320-321.
- Falconer, D.S., 1989. *Introduction to Quantitative Genetics*. 3rd Edn. Longman/John Wiley and Sons, New York.
- Fairbanks, V.F. and G.G. Klee, 1986. Biochemical Aspects of Hematology. In: *Textbook of Clinical Chemistry*. Tietz, N.W. (Ed.) W.B. Saunders and Co; Philadelphia, pp: 1495-1584.
- Guney, O., O. Ozuyank, O. Torun and M.N. Gorgulu, 2003. Relationship between some polymorphic parameters and performances in Damascus goats. *Pak. J. Biol. Sci.*, 6: 738.
- Harvey, W.R., 1999. User's guide for LSMLMW: Mixed model least squares and maximum likelihood computer program pc-1 version. The Ohio state Univ. Columbus (Mimeo).
- Kalab, P., A. Straltil and V. Glasnak, 1990. Genetic polymorphism of serum vitamin D-binding protein (GC) in sheep and mouflon. *Anim. Gen.*, 21: 317-321.
- Kidd, K.K., O. Osterhof, L. Erhard and W.H. Stone, 1975. The use of genetic relationships among cattle breeds in the formulation of national breeding policies: An example with South Devon (South Afri.) and Gelbvieh (Germany). *Anim. Blood Groups and Biochem. Gene.*, 5: 21-28.
- Legates, J.E. and E.J. Warwick, 1990. *Breeding and Improvement of Farm Animals*. 8th Edn., McGraw Hill, New York.
- Malan, D.D., C.W. Scheels, J. Buyse, C. Kwakemaak, F.K. Siebrits, J.D. Van der Kliss and E. Decuyper, 2003. Metabolic rate and its relationship with ascites in chicken genotypes. *Br. Poul. Sci.*, 44: 309-315.
- Manwell, C. and C.M.A. Baker, 1977. Genetic distance between the Australian Merino and the Poll Dorset sheep. *Gen. Res.*, 29: 239-253.
- Maxwell, C. and C.M.A. Baker, 1980. *Molecular Biology and the Origin of Species: Heterosis, Protein Polymorphism and Animal Breeding*. Sidgwick and Jackson, London.
- Nei, M., 1972. Genetic distance between populations. *Am. Nat.*, 106: 283-292.
- Omitogun, O.G., 2004. Analysis of Swine Genome Organization: Evolution of Porcine Chromosomal G-T-G Bands for Physical Mapping. Proceedings of the 29th Annual Conference of the Genetics Society of Nigeria. Ariyo, O.J., C.O.N. Ikeobi, M.O. Ozoje, I.T. Omoniyi and O.B. Kehinde (Eds.), Held on 11-14 October at Abeokuta, Nigeria, pp: 54-57.
- Peters, S.O. M.C. Ozoje, N.E. Nwagbo and C.O.N. Ikeobi, 2004. Haemoglobin Polymorphism and phenotypic variation in coat and wattle incidence Among West African Dwarf (WAD) goats. Proceeding of the 29th Annual Conference of the Genetics Society of Nigeria, October 11th-14th, Abeokuta, Nigeria, pp: 84-87.
- Thompson, J.S. and M.W. Thompson, 1980. *Genetics in Medicine*. 3rd Edn., M.W Saunders company Philadelphia London Toronto.
- Tunon, M.J. P. Gonzalez and M. Vallejo, 1989. Genetic relationships among 14 Spanish breeds of goats. *Anim. Gen.*, 20: 205-212.
- Yang, N. and R.S. Jiang, 2005. Recent advances in breeding for quality chickens. *World Poul. Sci. J.*, 61: 373-381.
- Zaragoza, P., A. Arana, I. Zaragoza and B. Amorena, 1987. Blood biochemical polymorphisms in rabbits presently bred in Spain: Genetic variation and distances among populations. *Aust. J. Biol. Sci.*, 40: 275-286.