CHICKEN GROWTH HORMONE POLYMORPHIC VARIATION AND ITS ASSOCIATION WITH ECONOMIC TRAITS– A REVIEW

Adigun, U.O., Egena, S.S.A. and Tsado, D.N.
Department of Animal Production, Federal University of Technology, Minna, Niger State, Nigeria.
Corresponding Author: adigunolagoke@gmail.com

ABSTRACT
The classical approaches to the detection of genetic differences in farm animals have been mostly based on the use of blood proteins (protein in blood plasma and serum) and blood groups. More recently, DNA polymorphisms have become popular in the genetic characterization of farm animals. This has helped in the study of polymorphism of the genes encoding hormones and their receptors, as well as their association with economic traits. The chicken Growth Hormone (GH) gene plays a crucial role in controlling growth and metabolism, leading to potential correlations between GH polymorphism and economic traits in animals.The allelic variants of functional genes are a result of different modifications of nucleotide composition such as point mutations (Single Nucleotide Polymorphism-SNP), insertions/deletions and soon. Polymorphism identification and subsequent study of its relationship with productivity characters will provide a basis for further targeted breeding which is fully applicable to the poultry farming and other farm animal species. This correlation could be used as a basis for selection and genetic improvement of farm animals.

Keywords: Polymorphic, Chicken, Growth Hormone, Chicken Growth Hormone and Economic traits.

INTRODUCTION

Growth performance and carcass traits are very significant economic traits in broiler chickens production, and are controlled by sets of complex genes. Growth is a complicated procedure regulated by a wide variety of neuroendocrine pathways (Zhang *et al.*, 2008). For this reason, it is very difficult to make rapid progress using conventional methods of genetic selection within breeds (Zhang *et al.*, 2008). Recent advances in molecular technology have provided new opportunities to evaluate genetic variability at the DNA level (Kaya and Yildiz, 2008).Growth Hormone (*GH*) is secreted by somatotropic cells of the anterior lobe of the pituitary. The growth hormone gene, which is located on chromosome 27, contains 5 exons and 4 introns with a total length equal to 4.35kbp. *GH* influences animal processes such as growth, lactation, reproduction and metabolism (Breier, 1999). Therefore, the *GH* gene, with its functional and positional potential, has been widely used as a marker for example, caprine *GH* gene have been being correlated with milk traits and its possible usage for selectionof both dairy and meat type goats (Mousavizadeh*et al.*, 2009; Wickramaratne*et al.*, 2010). Growth hormone affects growth traits in broiler chickens production such as growth rate, body weight maturation, metabolism rates, egg production, reproduction, appetite control and aging (Harvey, 2013).Growth hormone promotes muscle and bone growth and development, as well as regulation of fat content and its metabolism (Zhang *et al.*, 2007).

Chicken Growth Hormone

The chicken Growth Hormone (*c*GH) is a 22-kDa protein, containing 191 amino acid residues (Hrabia*et al.,* 2008). In poultry, *cGH* consists of 4,101 base pairs, having five exons and four introns (Kansaku*et al.,* 2008). A polypeptide, the hormone is produced and secreted by the pituitary gland. *cGH* affects a variety of physiological functions and growth performance (Apa*et al.,* 1994) and has been reported to be one of the most important genes affecting chicken performance traits playing critical roles in both growth and metabolic rates (Vasilatos-Younken*et al.,* 2000). It also plays a crucial role in controlling growth and metabolism, leading to potential correlations between *cGH* polymorphisms and economic traits.*cGH* is involved in the processes of sexual differentiation, pubertal maturation and participates in gonadal steroidogenesis, gametogenesis and ovulation (Hull and Harvey, 2001). It plays an important role in a variety of secondary functions such as egg production, aging and reproduction (Kansaku *et al.,* 2008).

Polymorphism of Chicken Growth Hormone

Genetic diversity in the *cGH* gene has been reported to exits in native chicken breeds when compared to commercial breeds (Nie *et al.,* 2002). This could be due to the genetic diversity of the native chickens. Thakur *et al.* (2009) in Kadakanath chicken of India observed three genotypes of the chicken growth hormone; AA, AB and BB at the *cGH1* locus. Bhattacharya *et al.* (2010) reported also reported three genotypes AA, BB and AC in White Leghorn chickens. Wenming *et al*. (2010) investigated the mutation characteristics of growthhormone (*GH*) gene in five Chinese indigenous goose populations. All the exons and introns of the gene were amplified by 20 pairs of primers and genotypes of all the primers were observed by PCR-SSCP;theyobserved six SNPs per 1000 nucleotides in exons compared to two SNPs per 1000 nucleotides in intron regions. Four SNPs were detected by two primers and four genotypes AA, BB, CC and DD were generated among the five populations evaluated. Tanmankaur*et al.* (2008) analyzed 776 bp amplicon of chicken *GH* gene digested with *Msp*1 with the results revealing three different patterns(AA, AC and CC) created by a combination of polymorphic *Msp*1 cut sites present in exon-1 (one site) and in intron-1 (one site). Polymorphism in intron 4 of the *cGH* gene was studied by Nie *et al*. (2002) in Chinese native chickens. A total of eight restriction digestion profiles were identified within the 1170 bp amplified PCR product, by *Msp*I restriction endonuclease. Among 20 populations, distinctly different allele numbers and fragments of intron 4 RFLPs between Chinese native chickens were observed. A new allele D was identified at a high frequency in the slow growing Taihe Silkies and Beijing Fatty strains.

In their study of a native chicken population by Makhsous *et al.* (2013) in Iran, a total of 142 chicken blood samples were collected and a specific primer set was used to amplify a fragment of the growthhormone locus using PCR. PCR products were then digested with *SacI*and *MspI*restriction endonucleases. Their results revealed the existence of three genotypes of the amplified fragment digested with *SacI*enzyme (+/+, +/- and -/-) controlled by two "+" (wild type) and "–" (normal type) alleles with allelic frequency of 0.898 and 0.102, respectively while the genotype frequency for the three genotypes were 0.817, 0.162, and 0.021, respectively. The amplified fragment digested with *MspI*enzyme revealed three alleles A, B and C with frequency of 0.599, 0.102, and 0.299, respectively; six genotypes AA, AB, AC, BB, BC, and CC were observed with genotype frequency of 0.338, 0.113, 0.409, 0.007, 0.070, and 0.063, respectively. Anh *et al.* (2015) studied crosses involving broiler breeder, PS with four Thai chicken breeds (Kaen Thong; KT, KhaiMoolEsarn; KM, Soi Nin; SN, and Soi Pet dam line; SP) with regard to the association of growth hormone polymorphism with growth performance and carcass trait. The authors observed the existence of three genotypes (AA, AG and GG) in all the crosses with the

following gene frequencies for the A and G alleles: 0.20 and 0.80 for the PSxKM, 0.30 and 0.70 for the PSxKT, 0.29 and 0.71 for the PSxSN, and 0.27 and 0.73 for the PSxSP crosses, respectively.

Association between Chicken Growth Hormone and Economic Traits

Chicken growth hormone gene has been used as a candidate gene for marker assisted selection for improved performance (Muhammed *et al.,* 2018). The results showed that c*GH* gene could be linked to a major gene significantly affecting the growth and carcass traits in chicken. Fotouhi *et al*. (1993) observed significant ($p<0.05$) correlation of alleles of the growth hormone gene and growth hormone receptor gene with juvenile body weight, age at first egg, the hen-day rate of egg production, egg specific gravityand egg weight in a strain of White Leghorns. Refraction fragment length polymorphisms characterized in the introns of *cGH*gene of White leghorn has been associated with egg production phenotype, resistance to Marek's disease and avian leukosis (Kunhlein *et al.,* 1997). In various populations of Chinese native chickens, an allele present in intron 1 had been linked to laying performance (Mou *et al.,* 1995). Lei *et al.* (2007) reported that an SNP with G and A substitution of *cGH* was associated with abdominal fat pad weight, abdominal fat pad ratio and crude fat content of the breast muscle.Makhsous *et al.* (2013) reported no significant ($p>0.05$) effect of the six *cGH* genotypes on egg number, laying % and mean egg weight (g) at 28, 30 and 32 days weeks of age in Iranian native chickens; the three *Sacl*-RFLP generated genotypes however, affected ($p<0.05$) egg number and laying % with chickens having +/+ genotype laying more eggs. Laying rate was however similar in chickens having +/+ and -/- genotypes. In their study, Anh *et al.* (2015) observed no significant ($p>0.05$) effect of the genotypes on body weight (except at between week 2 and 4, and week 4 and 6 which were significant, $p<0.05$); birds carrying the AG and GG genotypes were observed to have better body weight ($p>0.05$) over those having AA genotype ($p<0.05$). Average daily gain was significant ($p<0.05$) only at 0-2 weeks, and 0-6 weeks again with birds carrying AG and GG genotypes having better performance ($p<0.05$) compared to those having the AA genotype.

CONCLUSION

Polymorphism of chicken growth hormone exists which is adduced to genetic diversity. This kind of diversity is a useful tool for characterization and improvement of the chickens as the various polymorphic forms could be used as candidates for marker assisted selection. It is interesting to search for polymorphism in the gene, the products of which are involved in the regulation of many functions, primarily those associated with support of growth and differentiation.

REFERENCE

Anh, N.T.L., Kunhareang, A. and Duangjinda, M. (2015). Association of chicken growth hormone and insulin-like growth factor gene polymorphisms with growth performance and carcass traits of Thai broilers. *Asian Australasian Journal of Animal Science* 28: 1686-1695.

Apa, R., Lanzone, A., Miceli, F., Mastrandrea, M., Caruso, A., Mancuso, S., Canipari, R. (1994). Growth hormone induces in vitro maturation of follicle-and cumulus-enclosed rat oocytes. *Molecular Cell Endocrinol*.106: 207-212.

Bhattacharya, T.K., Chatterjere, R.N., Sharma, R.P., Niranjan, M. and Ranjkumar, U. (2010) Association between novel polymorphisms at the 5`- UTR region of the prolactin gene and egg production and the quality in chickens. *Theriogenolog xx (2010) xx.*

Breier, B.H. (1999). Regulation of protein and energy metabolism by the somatotropic axis. *Domestic Animal Endocrinology* 17: 209-218.

Fotouhi, N., Karatzas, C.N., Kuhnlein, U. and Zadworny, D. (1993). Identification of growth hormone DNA polymorphisms which respond to divergent selection for abdominal fat content in chickens. *Applied Genetic*. 85: 931-936.

Harvey, S.2013. Growth hormone and growth? Genetic Comp. Endocrinology. 190:3–9. http://dx.doi.org/10.1016/j.ygcen.2013.01.008.

Hrabia, A., Paczoska-Eliasiewicz, H.E., Berghman, L.R., Harvey, S. and Rząsa, J. (2008). Expression and localization of growth hormone and its receptors in the chicken ovary during sexual maturation. *Cell Tissue Res.* 332: 317-328.

Hull, K.L. and Harvey, S. (2001). Growth hormone roles in female reproduction. *Journal of Endocrinology. 168: 1-23*

Kansaku, N., Hiyama, G., Sasanami, T. and Zadworny, D. (2008). Prolactin and growth hormone in birds: Protein structure, gene structure and genetic variation. *Journal of Poultry Science*. 45: 1-6.

Kaya, M. and Yildiz, M.A. (2008). Genetic diversity among Turkish native chickens, Denizli and Gerze, estimated by microsatellite markers, *Biochem. Genet.*46: 480-491.

Kuhnlein, U., Liu, N., Weigend, S., Gavora, J.S., Fairfull. W. and Zadworny, D. (1997). DNA polymorphisms in the chicken growth hormone gene: response to selection for disease resistance and association with egg production. *Animal Genetic* 28: 116-123.

Lei, M., Luo, C., Peng, X., Fang, M., Nie, Q., Zhang, D., Yang, G. and Zhang X. (2007). Polymorphism of growth-correlated genes associated with fatness and muscle fibre traits in chickens. *Poultry Science*86:835-842.

Makhsous, S.G., Mirhoseini, S.Z., Zamiri, M.J. and Niazi, A. (2013). Polymorphisms of growth hormone gene in a native chicken population: association with egg production. *Bull. Vet. Inst. Pulawy*57: 73-77.

Mou, L., Liu, N., Zadworny, D., Chalifour, L., and Kuhnlein, U. (1995). Presence of an additional PstI fragment in intron 1 of the intron 1 of the chicken growth hormoneencoding gene. *Genetic* 160: 313-314.

Mousavizadeh, A., Abadi, M.M., Torabi, A., M.R., Nassiry, H.G. and Koshkoieh, A.E. (2009). Genetic polymorphism at the growth hormone locus in Iranian Talli goats by polymerase chain reaction-single strand conformational polymorphism (PCR-SSCP). *Iranian Journal of Biotechnology* 7: 51-53.

Muhammad, A.P., Andi, M.T., and Niken. U. (2018). Association of cGH|EcoRV Gene with production in Tolaki Chicken. *International Journal of Science, Basic and Applied Research Volume 00 No1: pp00-00* http://gssrr.org/index.php?journal=JournalofBasicandApplied

Nie, Q., Stephen, C.Y., Zhang, X., Leung F.C. and Yang G. (2002). New variations in intron 4 of growth hormone gene in Chinese native chickens. Journal of Heredity 93: 277-279.

Tanmankaurd, G.V.P., Ravikumar, P.S., Bajwa, I.S. and Trehan, P.K., (2008). PCR-RFLP of growth hormone gene in meat type chicken. Indian. *Journal of Poultry Sci*ence, 43(2):129-131.

Thakur, M.S., Parmar. S.N.S., Chaudhari, M.V. and Bhardwaji, J.K. (2009). Growth hormone gene polymorphism and its association with egg production in Kadaknath chicken. *Livestock Research for Rural Development 21 (8)*

Vasilatos-Younken, R., Zhou, Y., Wang, X., McMurtry, J.P, Rosebrough W., Decuypere, E., Buys, N., Darras, M., Geyten, V., Tomas, F. (2000). Altered chicken thyroid hormone

metabolism with chronic GH enhancement in vivo: consequences for skeletal muscle growth. *Journal of Endocrinology* 166: 609-620.

Wenming, Z., Qiao, N., Wang, X., Chen, Q. and Guo-Hong, C., (2010). Comparative genomic analysis of growth hormone gene in geese. *Journal of Animal Science*, 8:62–66.

Wickramaratne, S.H.G., Ulmek, B.R., Dixit, S.P., Kumar, S. and Vyas, M.K. (2010). Use of growth hormone gene polymorphism in selecting Osmanabadi and Sangamneri goats. *Trop. Agric. Res.* 21: 398–411.

Zhang, C., Zhang, W., Luo, H., Yue, W., Gao, M. and Jia, Z. (2008). A new single nucleotide polymorphism in the IGF-I gene and its association with growth traits in the Nanjiang Huang goat. *Asian Australasian Journal of Animal Science* 21: 1073-1079.

Zhang, X.L., Jiang, X., Liu, Y.P., Du, H.R. and Zhu, Q. (2007). Identification of AvaI polymorphisms in the third intron of *GH* gene and their associations with abdominal fat in chickens. *Poultry Science*86: 1079–1083.