



POLYMORPHIC VARIATION OF CHICKEN GROWTH HORMONE – A REVIEW

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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 somatotrophic 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 selection of 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 (cGH) 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 exist 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 growth hormone (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; they observed 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 Makhous *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 growth hormone locus using PCR. PCR products were then digested with *Sac*I and *Msp*I restriction endonucleases. Their results revealed the existence of three genotypes of the amplified fragment digested with *Sac*I 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 *Msp*I 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, Khai Mool Esarn; 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 *cGH* 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 gravity and 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. Makhssous *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.

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