Shahid Bahonar University of Kerman
Agricultural Biotechnology Journal
Iranian Biotechnology Society
Print ISSN: 2228-6705 Online ISSN: 2228-6500

Insulin-like growth factor binding protein gene polymorphisms and its effect on some productive and physiological traits of local Iraqi chicken

Bassam G. M. AL-Khatib

* Corresponding author. Department of Animal Production, College of Agricultural Engineering Sciences, University of Baghdad, Baghdad, Iraq. E-mail: Bassam.ghazi@coagri.uobaghdad.edu.iq

Alan A. Noori

Department of Animal Production, College of Agricultural Engineering Sciences, University of Baghdad, Baghdad, Iraq. E-mail: alan.ayad@coagri.uobaghdad.edu.iq

H. A. Al-Mashhadani

Department of Animal Production, College of Agricultural Engineering Sciences, University of Baghdad, Baghdad, Iraq. E-mail: hisham.ahmed@coagri.uobaghdad.edu.iq

Abstract

Objective

Insulin-like growth factor binding protein (IGFBP) plays a crucial role in the growth and development of chicken embryos and during the post-hatching stage. The aim of this study was to investigate IGFBP-2 gene polymorphisms and their effects on some productive and physiological traits of local Iraqi chicken.

Materials and methods

This study was conducted at the poultry farm of the College of Agricultural Engineering Sciences, University of Baghdad. One hundred local chickens before sexual maturity were used in this study. Blood samples were collected from the wing vein to extract DNA and molecular analysis and PCR amplification. Blood serum was also collected to measure biochemical parameters including total protein, glucose, lipid profile, albumin, and globulin concentrations. Production traits were recorded from the first egg production for a period of 100 days, which was divided into seven periods. These traits included number of eggs produced, mean egg weight, egg mass, age and body weight at sexual maturity, and mean feed consumption. The qualitative characteristics of the egg were also measured. PCR was performed to amplify a 386 bp fragment of the IGFBP-2 gene. The amplified fragments were then sequenced using the Sanger method.

Results

Three genotypes wild (TT), heterozygous (TC), and mutant (CC) were obtained, with two alleles T and C. The CC genotype showed a significantly higher frequency ($p \leq 0.01$) compared with TC and TT genotypes (59%, 30%, and 11%, respectively). Genotype had a significant effect ($p \leq 0.05$) on the number of eggs produced only in the third week. The TT had the superiority over CC (47.09 and 44.09) respectively. A significant effect ($p \leq 0.05$) was observed for eggshell weight, where the TC genotype was superior to CC (7.14 vs. 6.63 g). For yolk height, TT and TC genotypes showed significantly higher values than CC (19.09, 19.00, and 17.77 mm, respectively). For albumen height, the TT genotype showed a significant increase compared with CC (7.38 vs. 6.49 mm). A significant effect ($p \leq 0.05$) was also observed on serum albumin concentration, and the CC genotype showed a significantly higher value than TC (2.51 and 2.34 g/dL, respectively). No other significant effect was observed on blood serum biochemical characteristics.

Conclusion

Our results show that polymorphism in the IGFBP-2 gene can probably influence some production and egg quality traits in local Iraqi chickens. So, it can be considered as potential genetic marker for selection programs.

Keywords: blood parameters, laying hens, local chicken, productive performance, sexual maturity

Paper Type: Research Paper.

Citation: AL-Khatib, B. G. M., Noori, A. A., & Al-Mashhadani, H. A. (2026). Insulin-like growth factor binding protein gene polymorphisms and its effect on some productive and physiological traits of local Iraqi chicken. *Agricultural Biotechnology Journal,* 18(3), 269-286.

Agricultural Biotechnology Journal, 18(3), 269-286. DOI: 10.22103/jab.2026.27008.1872

Received: January 26, 2026. Received in revised form: March 22, 2026.

Accepted: March 23, 2026. Published online: June 30, 2026.

Publisher: Shahid Bahonar University of Kerman & Iranian Biotechnology Society.

Introduction

Livestock production in general and domestic chicken production in particular plays a vital socio-economic role for people living in low-income countries of Africa and Asia (Mohamadinejad et al. 2024; Khezri et al., 2025). Domestic chickens are widely distributed avian species around the world, due to their short generation interval and adaptability in a wide range

of agro ecologies (Khabiri et al. 2025; Mohammadabadi et al., 2025b). The domestic chickens provide high quality protein and income for the poor rural households and are the most widely kept livestock species in the world (Mohammadabadi et al. 2010; Mohammadifar and Mohammadabadi, 2018). This is due to the presence of the valuable traits of chicken like disease resistance, adaptation to harsh environments and ability to utilize poor quality feeds (Khabiri et al. 2023; Mohammadabadi et al., 2025c). Insulin-like growth factor binding protein (IGFBP) is one of the most important peptides for in vivo and in vitro growth stimulation. It plays a crucial role in the growth and development of chicken embryos, as well as during the post-hatching stage. It shares this effect with growth hormone (Clemmons, 2016). Quantitative traits are controlled by a large number of genes and are not limited to one gene like Growth hormone receptor (GHR) gene and Prolactin (PRL) gene (Al-Khatib et al., 2025). This is what makes the metabolic path of growth in chickens affected by many hormones encoded by different genes (Mohammadifar and Mohammadabadi, 2017). Molecular markers have been widely used to study these genetic effects (Shahdadnejad et al. 2016; Mohammadabadi et al., 2025a). IGF-I and IGF-II are part of a complex regulatory system that interacts with several types of membrane receptors. These compounds are considered important for normal growth, development and cell proliferation. IGF-I and IGF-II genes are candidate genes for molecular studies (Aguirre et al., 2016; Szalai et al., 2019). The molecular markers have proven to be effective in the field of genetic selection for improving productive performance in farm animals by identifying superior alleles and genotypes associated with quantitative trait loci (Bhattacharya et al., 2015; Gu et al., 2017; Mohammadabadi et al., 2024). IGF-I has many effects on metabolism, skeletal characteristics, adipose tissue development, and fat deposition in chickens. It also has an important role in the growth of many tissues, including muscle cells, cartilage, and bones, by stimulating cell proliferation and differentiation, as well as regulating muscle cell growth in the embryonic stage (Fujita et al., 2018). IGFBP-1 is an important member of the IGFBP family that has many biological functions such as regulating the metabolism of IGF-I and IGF-II. The action of the different types of IGFs is regulated by many factors, including IGFBPs, by regulating the transport of IGFs to different tissues and controlling the bioavailability of IGF receptors at the cell membrane level (Clemmons, 2018). In humans, low circulating levels of IGFBP-I are associated with obesity and hypertension. Several in vitro and in vivo studies have indicated an inverse relationship between levels of IGFBP-I and non-tissue-bound IGF-I (Yau et al., 2015). In chickens, the IGFBP-I gene is approximately 5.2 kb long and consists of four exons with a coding sequence of about 1.5 kb. The molecular weight of the produced protein after translation of the mRNA is 30 kDa (Schoen et al., 1995). The total length of the IGFBP-II gene is 32 kb and consists of four exons extends to 2 kb in mice and 1.6 kb in humans. The molecular weight of the produced protein after encoding is 31

kDa in mice and 36 kDa in humans. In chickens, this gene extends to about 38 kb. It consists of four exons and encodes an mRNA similar to that in mice and humans (Shimasaki & Ling, 1991). There are no current studies that clearly indicate the role of this gene in the productive performance of chickens. Bacterial expression systems have been used to study the chicken IGFBP gene through gene expression in the bacteria and then purification and characterization. It was found that the phosphate group attached to the amino acid serine is responsible for the association of IGFs with the IGFBPs. In other studies, it was found that regulation of fetal growth and development by IGFs is also closely associated with IGFBPs. Several studies have investigated the structure and function of IGFBP-I and its relationship with productive traits. However, limited information is available regarding its association with physiological parameters, body weight, egg production, egg weight, and age at sexual maturity in laying hens. Therefore, this study aimed to determine the genetic polymorphisms of the IGFBP-2 gene in Iraqi local chickens and to identify the effects of different alleles on productive traits, physiological performance and egg quality characteristics.

Material and methods

Birds' management and blood sampling: This study was carried out in the poultry farm of the Faculty of Agricultural Engineering Sciences, University of Baghdad, Iraq. To monitor egg production from sexual maturity until 100 days of laying, 100 chickens at 10 weeks of age were used. The birds were identified using wing tags and housed individually in numbered cages. Furthermore, all vaccinations and preventive measures were performed based on the standard poultry health program. Two diets were used. the first diet was applied before egg production period and the second diet was started from 18 weeks of age until the end of the study. Three milliliters of blood were collected from the brachial vein of each chicken. Then the samples collected in EDTA anticoagulant tubes was stored at -20 ºC until the molecular analysis.

DNA extraction and polymerase chain reaction (PCR): The DNA was extracted using a standard extraction kit (Geneaid Co, Taiwanese), with minor modifications in the volumes of lysis buffer and blood as described by (Ibtisam et al., 2020). The target region (intron 2) of IGFBP gene amplification was carried out using the following primers: F: 5-GGCAAAGAGCAACCCAACAC-3, R: 5-GGGCATTTATATCTGAGGAACAC-3 (Lei et al, 2007). Primers were synthesized as a freeze-dried powder with varying quantities by Alpha DNA (Canada). PCR amplification was performed using GoTaq® Green Master Mix (Promega, USA) in a Thermal Cycler (TC-5000). The Thermal Cycler TC-5000 were used to amplify the target region by PCR technique. PCR conditions were as follows: initial denaturation at 94 °C for 4 min, followed by 35 cycles of denaturation at 94 °C for 30 s, annealing at 60 °C for 35 s, extension at

72 °C for 35 s, and a final extension at 72 °C for 7 min. Afterwards, PCR products were separated by electrophoresis on 1.5% agarose gel for 1.5 h at 5 V/cm. The amplified DNA fragments were seen under a UV transilluminator. The amplicon length was 386 bp.

Blood serum parameters measurement: Five milliliters of blood were collected from each chicken at 30 weeks of age. Then, blood serum was separated by centrifugation and the following parameters were measured: glucose, total protein, albumin, cholesterol, triglycerides, low-density lipoprotein (LDL), high-density lipoprotein (HDL), and very-low-density lipoprotein (VLDL).

Productive performance traits: Body weight and age at sexual maturity, egg mass, egg weight, feed consumption, and the egg quality traits were measured during the 100-day production period. This 100-day production was divided into seven production periods (1, 2, 3, 4, 5, 6, and 7). Each of one represented two weeks of production.

Statistical analysis: The data were statistically analyzed using SAS (2012). Genotype frequencies were analyzed using the chi-square (χ^2) test. Then, the Statistical computations were done using SAS software to explore the influence of genotype of IGFBP-2 gene. Duncan's multiple range test (Duncan, 1955) was used to compare means. Below statistical model was used:

$Yij = \mu + Gi + eij$

Where, Yij = observation of the dependent trait, μ = overall mean, Gi = effect of the IGFBP-2 genotype, and eij = random error.

Results and discussion

Polymerase chain reaction (PCR) and sequencing: Figure 1 shows the PCR amplification of the target region of the IGFBP-2 gene, producing a fragment of 386 bp. The result of this study is consistent with the results of previous study performed by Lei et al. (2007) in broiler chicken. Figure 2 shows the T979C SNP identified by the Sanger sequencing method. This transition mutation led to three genotypes including wild type (TT), heterozygous (TC), and mutant (CC). Eight samples had C956G SNP, in previous research, these SNPs were not mentioned, and the reason may be the difference in the type of chicken used in the experiment.

Genotype and allele frequency: Table 1 presents the genotype distribution and allele frequencies of the T979C SNP. Highly significant differences ($p \leq 0.01$) were found. The CC genotype showed the highest frequency (59%), followed by TC (30%) and TT (11%). The allele frequency of C mutant allele had the superiority over the T wild allele amounted (0.74 and 0.26, respectively). These results differ from those reported by the previous studies (Lei et al., 20007; Bozena et al., 2020). It may be because of the differences between the type of studied samples. Thu et al. (2020) also showed that there were three genotypes for another target region for this

gene in Lien Minh chickens, which were AG, AA, and GG, and the AG genotype was the highest according to the Hardy-Weinberg equation.

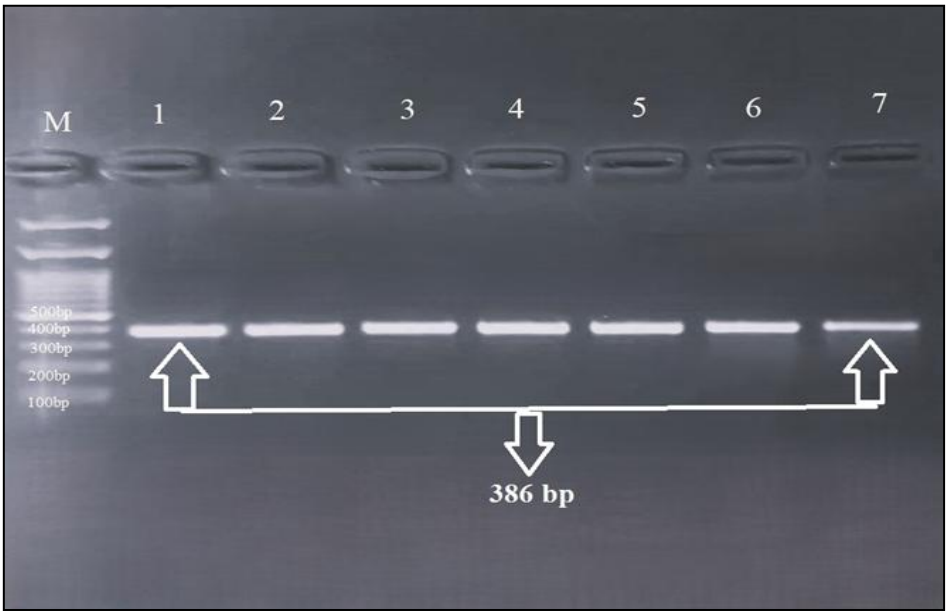

Figure 1. The polymerase chain reaction (PCR) product of the 386 bp amplified segment of the intron 2 of IGFBP gene electrophoresed on a 1.5% agarose gel at 5 V/cm for 1 hour and stained by the ethidium bromide-stained. M: represents a DNA ladder (100-1000) bp, lens 1-7 represent the amplified fragment

Table 1. Genotype and allele frequencies of the T979C SNP in the IGFBP-2 gene

Genotype	Number (n)	Frequency (%)	Allele	Frequency
TT	11	11.00	T	0.26
TC	30	30.00	C	0.74
CC	59	59.00		
Total	100	100.00		
$\chi^2 = 62.08$**		**P < 0.01		

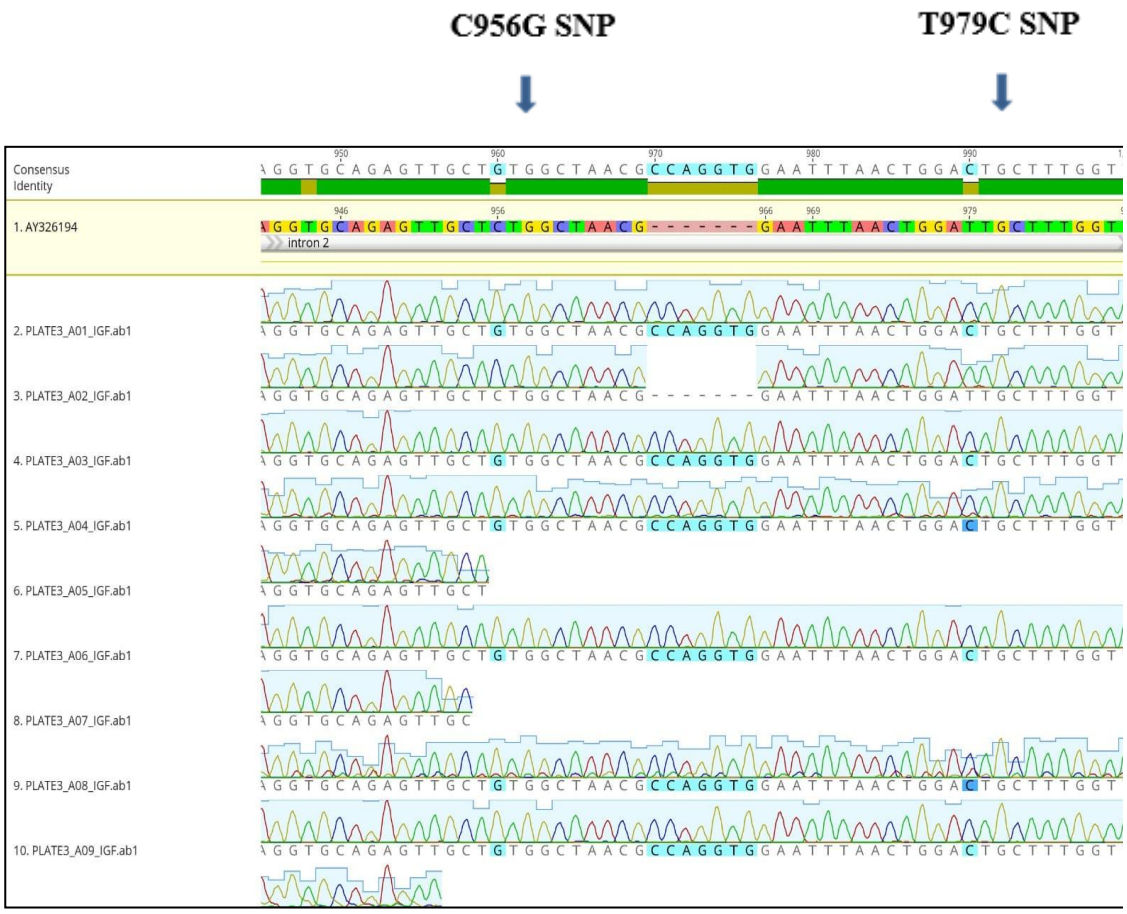

Figure 2. The alignment of PCR product 386bp that presented T979C SNP using Sanger method.

Association between T979C SNP and feed consumption: No significant effects of the different genotypes on feed consumption were observed during all production periods (Table 2). There were no previous studies about this trait to compare the results. But in a study on Chinese chickens, Kita et al. (2002) indicated that there is a relationship between nutrition and the gene expression of this gene when the chicken was starved for two days and then re-fed. As he noted that the level of gene expression in the brain decreased significantly and did not increase after re-feeding. As for gene expression in the liver and gizzard, it increased significantly when food was rationed and then increased after re-feeding. But, the gene expression of this gene in the kidney was not significantly affected by starvation and re-feeding of the chickens. It was also found that feeding chickens a low-protein diet for seven days reduced gene expression in the brain and increased it in the gizzard compared to chickens fed a diet containing 20% protein.

The effect of T979C SNP on weight and age at sexual maturity: The results presented in Table 3 indicate that no significant differences were observed among the genotypes for age or body weight at sexual maturity. These results were differed from Ou et al. (2009) that refers to

the significant effect of the different genotypes of IGFBP gene on body weight and the age of first egg of laying hens in different periods.

Table 2. Effect of the T979C SNP of the IGFBP-2 gene on feed consumption (g/bird/period) (mean ± SD)

Period	TT	TC	CC	Significance
1	1176.04 ± 26.79	1122.54 ± 35.32	1123.47 ± 70.72	NS
2	1202.86 ± 25.39	1153.27 ± 34.15	1135.74 ± 57.17	NS
3	1226.49 ± 24.06	1180.02 ± 32.46	1168.41 ± 53.77	NS
4	1248.78 ± 22.18	1217.77 ± 29.86	1202.27 ± 47.90	NS
5	1278.54 ± 19.56	1260.36 ± 26.80	1248.06 ± 42.91	NS
6	1302.73 ± 17.13	1298.05 ± 23.74	1291.84 ± 39.70	NS
7	1510.24 ± 15.99	1496.65 ± 22.73	1508.54 ± 41.97	NS

NS: Not significant (P > 0.05)

Table 3. Effect of the T979C SNP of the IGFBP-2 gene on age and body weight at sexual maturity (mean ± SD)

Trait	TT	TC	CC	Significance
Age at sexual maturity (days)	160.71 ± 2.41	164.23 ± 3.78	157.18 ± 4.72	NS
Body weight at sexual maturity (g)	1368.75 ± 27.86	1344.23 ± 39.62	1397.82 ± 68.00	NS

NS: Not significant (P > 0.05)

The effect of T979C SNP on egg production: Recently, it was found that the gene expression of IGFBP-2 is affected by reproductive hormones and IGF1, as Hu et al. (2024) indicated that the mRNA level of IGFBP-2 increased significantly in granulosa cells after follicle selection and was higher in pyramidal granulosa cells than it was before the hierarchy of granulosa cells, meaning that the secretion of IGFBP-2 is regulated by FSH and IGF1 and plays important roles in the reproductive system of chickens. However, the results presented in Table 4 showed no significant differences among genotypes in egg number during the production periods. The results of this study are consistent with the results of Das et al. (2017) indicated about the relationship of the polymorphism of this gene to the number of eggs produced in Turkish chickens.

Table 4. Effect of the T979C SNP of the IGFBP-2 gene on egg number (mean ± SD)

Period	TT	TC	CC	Significance
1	8.84 ± 0.28	9.03 ± 0.32	8.90 ± 0.72	NS
2	9.40 ± 0.31	9.70 ± 0.34	10.27 ± 0.57	NS
3	9.47 ± 0.30	9.73 ± 0.32	10.00 ± 0.53	NS
4	9.86 ± 0.28	9.90 ± 0.29	10.45 ± 0.47	NS
5	9.49 ± 0.25	9.93 ± 0.26	10.54 ± 0.42	NS
6	9.59 ± 0.26	9.96 ± 0.23	9.72 ± 0.39	NS
Total	67.81 ± 1.51	69.66 ± 2.27	71.27 ± 4.19	NS

NS: Not significant (P > 0.05)

The relationship between the various genotypes and egg weight: The results in Table 5 indicate a significant effect (P ≤ 0.05) of genotype on egg weight during the third production period. While, no significant effects were observed in the remaining periods of the experiment. The TT genotype outperformed the TC and CC genotypes, reaching (47.09, 45.68 and 44.09) gm respectively. This effect may be related to the role of IGFBP proteins in regulating IGF activity, which is involved in cell growth and ovarian follicle development. This effect varies between individuals depending on the nutrition and health status of the bird.

Table 5. Effect of the T979C SNP of the IGFBP-2 gene on egg weight (g) (mean ± SD)

Period	TT	TC	CC	Significance
1	42.87 ± 0.62	42.27 ± 0.72	42.67 ± 1.15	NS
2	45.30 ± 0.57	44.85 ± 0.69	44.00 ± 1.42	NS
3	47.09 ± 0.50^{a}	45.68 ± 0.58^{ab}	44.09 ± 1.19^{b}	*
4	48.62 ± 0.60	47.61 ± 0.82	48.07 ± 1.46	NS
5	46.91 ± 0.73	46.90 ± 0.92	45.44 ± 1.20	NS
6	46.29 ± 0.64	48.62 ± 0.88	46.87 ± 1.93	NS
7	46.06 ± 0.44	45.99 ± 0.56	45.42 ± 0.86	NS

Means within the same row with different superscripts differ significantly (P ≤ 0.05), * P ≤ 0.05, NS: Not significant (P > 0.05)

Effect of T979C SNP on egg quality: The results presented in Table 6 indicate that the different genotypes affected several egg quality traits. There was a highly significant (p≤0.01)

effect on the yolk height, as the TT wild genotype outperformed the CC mutant genotype and reached 19.09, 19.00 and 17.77 mm respectively. There was also a significant effect ($p \leq 0.05$) of these genotypes on egg shell weight, as the TC heterozygous genotype outperformed the mutant genotype CC and reached (7.14 and 6.63) grams, respectively and no significant difference was observed between the genotypes TT and TC, TT and CC genotypes. There was also a significant effect ($p \leq 0.05$) of the TT wild genotype on albumin height compared to the CC mutant genotype, as it reached (7.38 and 6.49) mm, respectively. Bal et al. (2020) indicated that the different genotypes of some candidate genes, such as the IGF1 gene, show a varying association with the qualitative characteristics of the egg according to different breeds of chickens. Also, Das et al. (2017) did not find a significant effect of genetic polymorphisms of the IGFBP-2 gene on the qualitative characteristics of eggs produced in Turkish chickens.

Table 6. Effect of the T979C SNP of the IGFBP-2 gene on egg quality traits (mean ± SD)

Trait	TT	TC	CC	Significance
Shell weight (g)	6.94 ± 0.09^{ab}	7.14 ± 0.15^{a}	6.63 ± 0.15^{b}	*
Shell thickness (mm)	0.38 ± 0.004	0.38 ± 0.007	0.37 ± 0.01	NS
Yolk weight (g)	16.04 ± 0.18	15.77 ± 0.35	15.86 ± 0.57	NS
Yolk height (mm)	19.09 ± 0.18^{a}	19.00 ± 0.21^{a}	17.77 ± 0.26^{b}	**
Yolk diameter (mm)	39.20 ± 0.24	38.58 ± 0.32	38.94 ± 0.41	NS
Albumen weight (g)	26.88 ± 0.45	25.80 ± 0.64	25.54 ± 0.86	NS
Albumen diameter (mm)	75.42 ± 0.75	74.70 ± 1.11	75.48 ± 1.61	NS
Albumen height (mm)	7.38 ± 0.16^{a}	7.19 ± 0.22^{ab}	6.49 ± 0.20^{b}	*

Means within the same row with different superscripts differ significantly, * $P \leq 0.05$, ** $P \leq 0.01$, NS: Not significant ($P > 0.05$).

Effect of T979C SNP on some blood serum parameters: The results in Table 7 indicate a significant effect ($P \leq 0.05$) of the T979C SNP on serum albumin concentration. where the CC genotype showed a higher albumin concentration compared with the TC genotype. While, no significant effects were observed in the rest of the blood serum studied characteristics. Previous research has indicated that there is a relationship between the percentage of protein in poultry diets and the concentration of insulin-like growth factor in the blood serum (Nagao et al., 2010; Al Ani & Al Khatib, 2025) which in turn affects the level of gene expression of IGFBP mRNA. This relationship may be a reason for the effect of the genetic makeup of this gene on the level of serum albumin in chickens, but this effect varies according to the physiological state of the bird.

The occurrence of genetic mutations in this gene can negatively or positively affect its gene expression depending on the type of genetic mutation and its effect in the codon of the amino acid that produced this protein.

Table 7. Effect of the T979C SNP of the IGFBP-2 gene on some serum biochemical parameters (mean ± SD)

Parameter	TT	TC	CC	Significance
Glucose (mg/dL)	236.25 ± 3.27	240.20 ± 7.66	247.81 ± 4.48	NS
Cholesterol (mg/dL)	162.85 ± 6.51	161.93 ± 8.73	148.09 ± 7.26	NS
Triglycerides (mg/dL)	549.63 ± 3.33	537.47 ± 9.75	554.64 ± 3.71	NS
HDL (mg/dL)	52.49 ± 1.42	49.83 ± 2.25	51.18 ± 3.11	NS
LDL (mg/dL)	23.54 ± 1.05	23.06 ± 2.03	19.54 ± 2.38	NS
VLDL (mg/dL)	86.81 ± 5.52	89.03 ± 6.84	77.36 ± 6.76	NS
Albumin (g/dL)	2.40 ± 0.02^{ab}	2.34 ± 0.05^{b}	2.51 ± 0.02^{a}	*
Total protein (g/dL)	5.32 ± 0.06	5.31 ± 0.14	5.62 ± 0.14	NS
Globulin (g/dL)	2.94 ± 0.05	2.96 ± 0.13	3.11 ± 0.14	NS

Means within the same row with different superscripts differ significantly ($P \leq 0.05$), * $P \leq 0.05$, NS: Not significant ($P > 0.05$).

Conclusions: The results of our study showed that the IGFBP gene may be considered as a candidate gene that influences some productive traits in laying hens. The T979C SNP showed significant associations with egg weight during the third production period and with some egg quality traits such as yolk height, shell weight, and albumen height. In addition, this polymorphism affected serum albumin concentration. These findings suggest that genetic variation in the IGFBP gene may contribute to the regulation of productive and physiological traits in local Iraqi chickens.

Author contributions

B. G. M. A. and A. A. N. contributed to the study methodology and experimental design and performed data collection, H. A. A. and B. G. M. A. assisted with data analysis and contributed to writing the initial draft and statistical analysis, and B. G. M. A., A. A. N. and H. A. A. drafted the original manuscript and reviewed, discussed, and approved the final version of the manuscript.

Acknowledgments

The researchers would like to thank the Department of Animal Production, College of Agricultural Engineering Sciences, University of Baghdad, Baghdad, Iraq, and all those who helped complete this project.

Funding

This research was supported by the Department of Animal Production, College of Agricultural Engineering Sciences, University of Baghdad, Baghdad, Iraq, and self-funded.

Data availability

The data contributing to the findings of this study are available from the investigating researcher upon request.

Ethical considerations

The animal study protocol was approved by the Ethics Committee of University of Baghdad (approval date and protocol code available upon request). All experimental protocols and sampling techniques were conducted in accordance with this approval.

Conflict of interest

The researchers declare no conflict of interest regarding the publication of this paper.

References

Aguirre, G. A., De Ita, J. R., de la Garza, R. G., & Castilla-Cortazar, I. (2016). Insulin-like growth factor-1 deficiency and metabolic syndrome. *Journal of Translational Medicine, 14*, Article 3. https://doi.org/10.1186/s12967-015-0762-z

Al Ani, M. A. K., & Al Khatib, B. G. M. (2025). Leptin receptor gene polymorphisms and its effect on some productive and physiological traits of local Iraqi chicken. *Iraqi Journal of Agricultural Sciences, 56*(2), 736–743. https://doi.org/10.36103/kb89xk27

Al-Khatib, B. G. M., Noori, A. A., & Abdulkareem, I. Q. (2025). Prolactin gene polymorphisms associated with productive and physiological traits of local chickens. *Journal of Animal Health & Production, 13*(1), 846–853. https://doi.org/10.17582/journal.jahp/2025/13.s1.846.853

Bal, G. R., Vishesh, K. S., & Usha, R. (2020). PCR-RFLP study of candidate genes for egg production in layer chicken. *Archives of Animal & Poultry Sciences, 1*(3), 52–58. https://doi.org/10.19080/AAPS.2020.01.555563

Bhattacharya, T. K., Chatterjee, R. N., Dushyanth, K., Paswan, C., Shukla, R., & Shanmugam, M. (2015). Polymorphism and expression of insulin-like growth factor 1 (IGF1) gene and its association with growth traits in chicken. *British Poultry Science, 56*(4), 398–407. https://doi.org/10.1080/00071668.2015.1041098

Clemmons, D. R. (2016). Role of IGF binding proteins in regulating metabolism. *Trends in Endocrinology & Metabolism, 27*(6), 375–391. https://doi.org/10.1016/j.tem.2016.03.019

Clemmons, D. R. (2018). Role of IGF-binding proteins in regulating IGF responses to changes in metabolism. *Journal of Molecular Endocrinology, 61*(1), T139–T169. https://doi.org/10.1530/JME-18-0016

Das, H., Tarim, B., Demir, S., Küçükkent, N., Cengiz, S., TüleK, E., & Aksakal, V. (2018). Association of IGF and IGFBP2 gene polymorphisms with growth and egg traits in Atak-S laying hens. *Journal of the Hellenic Veterinary Medical Society, 68*(2), 237–242. https://doi.org/10.12681/jhvms.15611

Duncan, D. B. (1955). Multiple range and multiple F-tests. *Biometrics, 11*(1), 1–42. https://doi.org/10.2307/3001478

Fujita, S., Yamaguchi, M., Hiramoto, D., Saneyasu, T., Honda, K., & Kamisoyama, H. (2018). Effects of fasting and refeeding on the mRNA levels of insulin-like growth factor-binding proteins in chick liver and brain. *The Journal of Poultry Science, 55*(4), 269–273. https://doi.org/10.2141/jpsa.0180005

Gu, L., Sun, C., Gong, Y., Yu, M., & Li, S. (2017). Novel copy number variation of the TGFβ3 gene is associated with TGFβ3 gene expression and duration of fertility traits in hens. *PLoS ONE, 12*(3), Article e0173696. https://doi.org/10.1371/journal.pone.0173696

Hosnedlova, B., Vernerova, K., Kizek, R., Bozzi, R., Kadlec, J., Curn, V., Kouba, F., Fernandez, C., Machander, V., & Horna, H. (2020). Associations between IGF1, IGFBP2 and TGFß3 genes polymorphisms and growth performance of broiler chicken lines. *Animals, 10*(5), Article 800. https://doi.org/10.3390/ani10050800

Hu, L., Li, D., Wei, Q., Kang, L., Sun, Y., & Jiang, Y. (2024). Characterization of a novel IGFBP-2 transcript in the ovarian granulosa cells of chicken follicles: mRNA expression, function and effect of reproductive hormones and IGF1. *Poultry Science, 103*(12), Article 104501. https://doi.org/10.1016/j.psj.2024.104501

Ibtisam, Q. A. K., Al-Khatib, B. G. M., & Noori, A. A. (2020). Detection of C3678T SNP in growth hormone secretagogue receptor (ghsr) gene polymorphisms and its effect on some of production and physiological traits of Iraqi local chicken. *Plant Archives, 20*(1), 2138–2142. https://www.plantarchives.org/List%2020-1.html

Khabiri, A., Toroghi, R., Mohammadabadi, M., & Tabatabaeizadeh, S. E. (2023). Introduction of a Newcastle disease virus challenge strain (sub-genotype VII.1.1) isolated in Iran. *Veterinary Research Forum, 14*(4), Article e221. https://doi.org/10.30466/vrf.2022.548152.3373

Khabiri, A., Toroghi, R., Mohammadabadi, M., & Tabatabaeizadeh, S. E. (2025). Whole genome sequencing and phylogenetic relative of a pure virulent Newcastle disease virus isolated from an outbreak in northeast Iran. *Letters in Applied Microbiology, 78*(4), Article ovaf049. https://doi.org/10.1093/lambio/ovaf049

Khezri, A., Shafabakhsh, H., Alizadeh, A., Mohammadabadi, M., & Shakeri, M. (2025). Effects of encapsulated mixtures of plant essential oils and organic acids as an alternative to antibiotic growth promoters on humoral immune response and expression of interleukin-4 and interferon-gamma genes in broilers. *Journal of Poultry Sciences and Avian Diseases, 3*(3), 12–19. https://doi.org/10.61838/kman.jpsad.3.3.3

Kita, K., Nagao, K., Taneda, N., Inagaki, Y., Hirano, K., Shibata, T., Yaman, M. A., Conlon, M. A., & Okumura, J. (2002). Insulin-like growth factor binding protein-2 gene expression can be regulated by diet manipulation in several tissues of young chickens. *The Journal of Nutrition, 132*(2), 145–151. https://doi.org/10.1093/jn/132.2.145

Lei, M., Luo, C., Peng, X., Fang, M., Nie, Q., Zhang, D., Yang, G., & Zhang, X. (2007). Polymorphism of growth-correlated genes associated with fatness and muscle fiber traits in chickens. *Poultry Science, 86*(5), 835–842. https://doi.org/10.1093/ps/86.5.835

Mohamadinejad, F., Mohammadabadi, M., Roudbari, Z., Eskandarynasab Siahkouhi, S., Babenko, O., Klopenko, N., Borshch, O., Starostenko, I., Kalashnyk, O., & Assadi Soumeh, E. (2024). Analysis of liver transcriptome data to identify the genes affecting lipid metabolism during the embryonic and hatching periods in ROSS breeder broilers. *Journal of Livestock Science and Technologies, 12*(2), 61–67. https://doi.org/10.22103/jlst.2024.23814.1554

Mohammadabadi, M. R., Nikbakhti, M., Mirzaee, H. R., Shandi, M. A., Saghi, D. A., Romanov, M. N., & Moiseyeva, I. G. (2010). Genetic variability in three native Iranian chicken populations of the Khorasan province based on microsatellite markers. *Russian Journal of Genetics, 46*(4), 505–509. https://doi.org/10.1134/S1022795410040198

Mohammadabadi, M., Afsharmanesh, M., Khezri, A., Kheyrodin, H., Babenko Ivanivna, O., Borshch, O., Kalashnyk, O., Nechyporenko, O., Afanasenko, V., Slynko, V., & Usenko, S. (2025a). Effect of mealworm on GBP4L gene expression in the spleen tissue of Ross broiler chickens. *Agricultural Biotechnology Journal, 17*(2), 343–360. https://doi.org/10.22103/jab.2025.25277.1714

Mohammadabadi, M., Akhtarpoor, A., Khezri, A., Babenko, O., Stavetska, R. V., Tytarenko, I., Ievstafiieva, Y., Buchkovska, V., Slynko, V., & Afanasenko, V. (2024). The role and diverse applications of machine learning in genetics, breeding, and biotechnology of

livestock and poultry. *Agricultural Biotechnology Journal, 16*(4), 413–442. https://doi.org/10.22103/jab.2025.24662.1644

Mohammadabadi, M., Khezri, A., Afsharmanesh, M., Kheyrodin, H., Bahreini Behzadi, M. R., Babenko, O., Usenko, S., & Momen, M. (2025b). Investigation of interleukin-6 gene expression in liver and spleen tissues of broiler chickens fed mealworm, probiotics, and mealworm with probiotics. *Agricultural Biotechnology Journal, 17*(4), 469–486. https://doi.org/10.22103/jab.2025.26228.1793

Mohammadabadi, M., Khezri, A., Babenko, O., Borshch, O. O., Kalashnyk, O., Starostenko, I., Tkachenko, S., Klopenko, N., Tytarenko, I., Bezpalyi, I., & Khabiri, A. (2025c). The effect of adding mealworm, probiotics, and mealworm plus probiotics on IL-8 gene expression in liver and spleen tissues of broiler chickens. *OBM Genetics, 9*(4), Article 315. https://doi.org/10.21926/obm.genet.2504315

Mohammadifar, A., & Mohammadabadi, M. R. (2017). Effect of uncoupling protein polymorphisms on growth, breeding value of growth and reproductive traits in the Fars indigenous chicken. *Iranian Journal of Applied Animal Science, 7*(4), 679–685. https://journals.iau.ir/article_535799.html

Mohammadifar, A., & Mohammadabadi, M. R. (2018). Melanocortin-3 receptor (MC3R) gene association with growth and egg production traits in Fars indigenous chicken. *Malaysian Applied Biology, 47*(5), 85–90. https://doi.org/10.5555/20193005103

Nagao, K., Hiramatsu, K., Tsukada, A., & Kita, K. (2010). Effects of insufficient levels of dietary protein on IGF-I and IGFBPs in young chickens. *The Journal of Poultry Science, 47*(3), 236–239. https://doi.org/10.2141/jpsa.010031

Ou, J. T., Tang, S. Q., Sun, D. X., & Zhang, Y. (2009). Polymorphisms of three neuroendocrine-correlated genes associated with growth and reproductive traits in the chicken. *Poultry Science, 88*(4), 722–727. https://doi.org/10.3382/ps.2008-00497

Schoen, T. J., Mazuruk, K., Waldbillig, R. J., Potts, J., Beebe, D. C., Chader, G. J., & Rodriguez, I. R. (1995). Cloning and characterization of a chick embryo cDNA and gene for IGF-binding protein-2. *Journal of Molecular Endocrinology, 15*(1), 49–59. https://doi.org/10.1677/jme.0.0150049

Shahdadnejad, N., Mohammadabadi, M. R., & Shamsadini, M. (2016). Typing of Clostridium perfringens isolated from broiler chickens using multiplex PCR. *Genetics in the Third Millennium, 14*(4), 4368–4374. https://elmnet.ir/doc/1603253-71422

Shimasaki, S., & Ling, N. (1991). Identification and molecular characterization of insulin-like growth factor binding proteins (IGFBP-1, -2, -3, -4, -5 and -6). *Progress in Growth Factor Research, 3*(4), 243–266. https://doi.org/10.1016/0955-2235(91)90003-m

Statistical Analysis System. (2012). *SAS users guide: Statistics*. SAS Institute Inc.

Szalai, K., Károly, T., Erika, L., & Ágnes, B. (2019). Genotyping of four loci in Hungarian yellow and broiler chickens. *Acta Veterinaria Hungarica, 67*(1), 1–10. https://doi.org/10.1556/004.2019.001

Thu, H. D. T., Binh, N. T. T., Duc, L. D., Huu, D. B., Nhung, D. T., Xuan, C. N., Viet, L. N., Thai, A. N., Quang, M. L., Pham, D. K., & Hoang, T. N. (2020). Indigenous Lien Minh chicken of Vietnam: Phenotypic characteristics and single nucleotide polymorphisms of GH, IGFBP and PIT candidate genes related to growth traits. *Biodiversitas Journal of Biological Diversity, 21*(11), 5344–5352. https://doi.org/10.13057/biodiv/d211140

Yau, S. W., Russo, V. C., Clarke, I. J., Dunshea, F. R., Werther, G. A., & Sabin, M. A. (2015). IGFBP-2 inhibits adipogenesis and lipogenesis in human visceral, but not subcutaneous, adipocytes. *International Journal of Obesity, 39*(5), 770–781. https://doi.org/10.1038/ijo.2014.192

مجله بیوتکنولوژی کشاورزی
شاپا چاپی: ۶۷۰۵-۲۲۲۸ شاپا الکترونیکی: ۶۵۰۰-۲۲۲۸

چندشکلی ژن پروتئین متصل‌شونده به فاکتور رشد شبه‌انسولینی و تأثیر آن بر برخی صفات تولیدی و فیزیولوژیکی در مرغ بومی عراق

بسام غ. م. الخطیب

* نویسنده مسئول. گروه تولیدات دامی، دانشکده علوم مهندسی کشاورزی، دانشگاه بغداد، بغداد، عراق. ایمیل: assam.ghazi@coagri.uobaghdad.edu.iq

الان ع. نوری

گروه تولیدات دامی، دانشکده علوم مهندسی کشاورزی، دانشگاه بغداد، بغداد، عراق. ایمیل: alan.ayad@coagri.uobaghdad.edu.iq

ح. ا. المشهدانی

گروه تولیدات دامی، دانشکده علوم مهندسی کشاورزی، دانشگاه بغداد، بغداد، عراق. ایمیل: hisham.ahmed@coagri.uobaghdad.edu.iq

تاریخ دریافت: ۱۴۰۴/۱۰/۰۵ تاریخ دریافت فایل اصلاح شده نهایی: ۱۴۰۴/۱۲/۳۰ تاریخ پذیرش: ۱۴۰۵/۰۱/۰۱

چکیده

هدف: پروتئین متصل‌شونده به فاکتور رشد شبه‌انسولینی (IGFBP) نقش مهمی در رشد و تکامل جنین جوجه‌ها و همچنین در مراحل پس از تفریخ ایفا می‌کند. هدف این مطالعه بررسی چندشکلی ژن IGFBP-2 و تأثیر آن بر برخی صفات تولیدی و فیزیولوژیکی در مرغ بومی عراق بود.

مواد و روش‌ها: این مطالعه در مزرعه طیور دانشکده علوم مهندسی کشاورزی دانشگاه بغداد انجام شد. در این پژوهش از ۱۰۰ قطعه مرغ بومی قبل از بلوغ جنسی استفاده گردید. نمونه‌های خون از ورید بال برای استخراج DNA، انجام آنالیزهای مولکولی و تکثیر ژن با روش PCR جمع‌آوری شدند. همچنین سرم خون برای اندازه‌گیری شاخص‌های بیوشیمیایی شامل پروتئین کل، گلوکز، پروفایل چربی، آلبومین و گلوبولین اندازه‌گیری شد. صفات تولیدی از زمان شروع تخم‌گذاری به مدت ۱۰۰ روز ثبت شد که این دوره به هفت بخش تقسیم گردید. این صفات شامل تعداد تخم تولیدی، میانگین وزن تخم، توده تخم، سن و وزن بدن در بلوغ جنسی و میانگین مصرف خوراک بود. همچنین ویژگی‌های کیفی تخم‌مرغ اندازه‌گیری شد. برای تکثیر ژن IGFBP-2 از روش PCR برای قطعه‌ای به طول ۳۸۶ جفت‌باز استفاده شد و قطعات تکثیرشده با روش توالی‌یابی سنگر تعیین توالی شدند.

نتایج: سه ژنوتیپ شامل وحشی (TT)، هتروزیگوت (TC) و جهش‌یافته (CC) با دو آلل T و C شناسایی شد. ژنوتیپ CC دارای بیشترین فراوانی معنی‌دار ($p\leq0.01$) نسبت به ژنوتیپ‌های TC و TT بود (به‌ترتیب ۵۹٪، ۳۰٪ و ۱۱٪). ژنوتیپ اثر معنی‌داری ($p\leq0.05$) بر تعداد تخم‌های تولیدی تنها در هفته سوم داشت، به‌طوری که ژنوتیپ TT نسبت به CC برتری نشان داد (۴۷/۰۹ در مقابل ۴۴/۰۹). اثر معنی‌داری ($p\leq0.05$) بر وزن پوسته تخم نیز مشاهده شد، به‌طوری که ژنوتیپ TC نسبت به CC برتر بود (۷/۱۴ در مقابل ۶/۶۳ گرم). در مورد ارتفاع زرده، ژنوتیپ‌های TT و TC مقادیر بیشتری نسبت به CC داشتند (به‌ترتیب ۱۹/۰۹، ۱۹/۰۰ و ۱۷/۷۷ میلی‌متر). همچنین ارتفاع سفیده در ژنوتیپ TT نسبت به CC افزایش معنی‌داری نشان داد (۷/۳۸ در مقابل ۶/۴۹ میلی‌متر). اثر معنی‌داری ($p\leq0.05$) بر غلظت آلبومین سرم خون نیز مشاهده شد، به‌طوری که ژنوتیپ CC نسبت به TCمقدار بیشتری داشت (۲/۵۱ در مقابل ۲/۳۴ گرم بر دسی‌لیتر). در سایر ویژگی‌های بیوشیمیایی سرم خون اثر معنی‌داری مشاهده نشد.

نتیجه‌گیری: نتایج این مطالعه نشان می‌دهد که چندشکلی ژن IGFBP احتمالاً می‌تواند بر برخی صفات تولیدی و کیفیت تخم‌مرغ در مرغ‌های بومی عراق تأثیر بگذارد. بنابراین، این ژن می‌تواند به‌عنوان یک نشانگر ژنتیکی بالقوه در برنامه‌های اصلاح نژاد مورد استفاده قرار گیرد.

کلمات کلیدی: بلوغ جنسی، شاخص‌های خونی، عملکرد تولیدی، مرغ بومی، مرغ تخم‌گذار

نوع مقاله: پژوهشی

استناد: بسام غ. م. الخطیب، الان ع. نوری، ح. ا. المشهدانی (۱۴۰۵) چندشکلی ژن پروتئین متصل‌شونده به فاکتور رشد شبه‌انسولینی و تأثیر آن بر برخی صفات تولیدی و فیزیولوژیکی در مرغ بومی عراق. *مجله بیوتکنولوژی کشاورزی*، ۱۸(۳)، ۲۶۹-۲۸۶.

Publisher: Shahid Bahonar University of Kerman & Iranian Biotechnology Society.