Insulin-like Growth Factor-1 Gene Polymorphism and Its Effect on Egg Quality Traits of Funaab Alpha, Kuroiler and Sasso Chicken Reared in Hot Humid Tropics

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Abstract

A study was conducted on the effect of gene polymorphism of *Insulin like Growth Factor-1 (IGFI)* on egg quality traits in five chicken genotype. A total of 250 chicken comprising 150 FUNAAB-Alpha (50 Normal feather, 50 Naked neck and 50 Frizzle feather), 50 Kuroiler and 50 Sasso were used for this experiment. The chicks were generated through artificial insemination and were raised to maturity on deep litter system. At point of lay, 30 hens per genotype were selected and transferred into a battery cage of one unit per bird. Data was collected on the egg quality traits, 30 eggs for each genotype was collected, the following parameters were determined: egg (weight, length, width), shape index, shell thickness, albumen (height, weight), yolk weight and color, ratio of (shell, yolk, albumen) and Haugh unit. All collected data was subject to analysis of variance using a completely randomized design, of which genotype was the interest factor. At 16 weeks, 1ml of blood was collected from each hen and extraction of genomic DNA from the blood was done. PCR was conducted using the pair of primer and condition as described by Nagaraga, *et al*. (2000). The PCR amplicons were digested using *PstI* restriction enzymes following the manufacturer's procedure. The resulting fragments were analyzed using GenAnalyzer (GenAlEx 6.502) was used for the genetic diversity of the *IGFI* locus. This data was subject to the PROC GLM of SAS 9.2. Results showed the chicken genotypes significantly ($P<0.05$) affect all the egg-quality traits except the shell weight, yolk ratio and albumen ratio. The *IGFI*gene polymorphism had no significant effect ($P>0.05$) on egg quality traits for except the egg length and egg width.

Introduction

The improved Nigerian local chicken are unique breeds which serve as the nation's heritage. They have an appreciable body weight and are dual purpose in production (Addisu, 2013). In this study, the dual-purpose breeds of Sasso, Kuroiler, and FUNAAB Alpha are used. Three genotypes of the dual-purpose FUNAAB Alpha chicken exist: normal feather, naked neck, and frizzle feather. (Durosaro et al., 2021).

According to many researchers in various breeds, the external egg quality is demonstrated by the egg's weight, shape, percentage of eggshell, and thickness, all of which depend on the species, breed, variety, nutrition, management, and environment. Similar to these exterior qualities, internal egg quality is represented by albumen quality and yolk quality, which are in charge of the nutritional content of breed-specific eggs and decide whether or not consumers would accept them. (Zita et al., 2009; Sinha et al., 2017; Atsbaha et al., 2022). The qualities of an egg are what determine whether a consumer will accept it. Therefore, in today's production-oriented market, ongoing genetic evaluation of several egg quality features has become crucial to maintaining supremacy in an egg's overall quality (Sreenivas et al., 2013; Pradeepta et al., 2015)

Economic traits in animals show continuous variation. Although, they exhibit a complex genetic nature. Molecular marker assisted selection has proven to be efficient in helping to improve both productive and reproductive abilities. Nonetheless, an individual gene approach is a great method to understanding the genetic basis directive which aids the expression of differences that are quantitative amongst individuals as new latest technologies in molecular genetics provides opportunities to evaluate the variability of genes at the level of DNA (Kaya and Yildiz, 2008; Anh *et al*., 2015).

The growth hormone in chickens (cGH) and IGF-1 genes are quite enterprising in the way of genes that improve chicken performance and enhances certain quality traits (Anh *et al*., 2015). This gene is a mitogenic polypeptide with similarities to insulin and it plays a major role for cellular growth, assisting in mediating growth hormone actions and affects biological processes such as growth and reproductive differentiation in poultry. Authors also have suggested that the IGF-I show association amongst the body weight, carcass and reproductive traits of the chicken (Tang et al., 2010). Wu et al. (2015) reports that the IGF-1 was strongly expressed in the liver according to the patterns of expression and SNP analyses, and its mutation was linked to characteristics related with egg-laying.

Moreover, it is important to identify and understand the part of this candidate gene in order to speed up the rate of selection in reproductive performance traits in Nigerian local poultry, therefore the motive of this project was to probe the associations between IGF-I genes and egg quality traits of the laying performance in the selected chicken breed.

Materials And Methods

Experimental site

The research was carried out the PEARL Poultry Breeding unit of the University farm, Federal University of Agriculture, Abeokuta (FUNAAB). The molecular analysis was conducted at the Breeding and Genetics Bio-technology laboratory of the College of Animal Science and Livestock Production (COLANIM), FUNAAB.

Experimental animals

Two hundred and fifty (250) chickens comprising of 150 FUNAAB - Alpha (50 normal, 50 naked-neck and 50 frizzled-feathered), 50 Kuroiler and 50 Sasso dual purpose breed were used for this experiment. The chickens were generated via artificial insemination (AI) from the flocks in the PEARL poultry breeding unit, Directorate of the University Farms (DUFARMS), Federal University of Agriculture, Abeokuta, Ogun state, Nigeria.

Rearing and Management

The chicks generated from AI were brooded and raised under deep litter system, they were subsequently moved to cages. They were pedigreed along genotype for proper identification. They were fed with commercial feed (Chick mash, grower mash and layer mash). Medication and vaccination were administered as at required stages. At sexual maturity, cocks were separated from the hen and the hens were transferred into a battery cage (one bird/unit) in order to monitor their reproductive performances.

Egg collection

30 eggs per genotype was collected from the birds at 32 weeks of age, which was a peak period of laying. The eggs were used for analysis of the external and internal traits. The chickens were similar in age as they were hatched on the same day.

Egg quality evaluation: external qualities of the egg

The following were measured:

Weight of the egg - Mettler weighing balance.

Length and width of egg - digital vernier caliper.

Egg width - the distance between the widest cross sectional regions of the ends.

Egg length - as distance between the broadest and narrowest ends of the egg.

Egg Shape Index (ESI) = Egg Width / Length

The shell weight was obtained as a percentage of the weight of the air dried egg shells to that of the whole egg. Whilst shell thickness was obtained from the air dried shell using a micrometer screw gauge (Kgwatalala et al., 2016).

Internal qualities of the Egg

A spherometer was used to measure the height of the albumen. A mettler-weighing balance was used to measure the separated yolk. Yolk weight was obtained as the percentage weight of the yolk and whole egg. The difference obtained from the weight of the egg, sum of the yolk weight and dry egg shell was taken as albumen weight and this was expressed as a percentage of the total weight of egg. Haugh Unit (HU) = 100log (AH+7.5-1.7$We^{0.37}$), (Haugh, 1937; Atsbaha et al., 2022).

AH = Albumen height (mm), We = weight of egg

Blood Collection, DNA extraction and PCR-RFLP and Analysis

one (1) ml of blood sample was collected per chicken using a needle and syringe from the wing vein. The collected blood was transmitted into Ethylene Diamine Tetra acetic Acid (EDTA) bottle as an anticoagulant agent. The blood samples were transported to the laboratory for the extraction of genomic DNA extraction using Isolate II Blood DNA kits following the manufacturer procedures.

DNA purity and concentration was done with a Nanodrop spectrophotometer and 1% gel electrophoresis. The primer sequences used for PCR amplification was as described by Nagaraga *et al.* (2000). Polymerase chain reaction was done with a terminal reactive volume of 20µl. Each of one of these had 4µl of 5X Firepol PCR premix, 2µl of genomic DNA, 1µl each of forward and reverse primer and 12µl of Nuclease Free water. These reactive mixtures were subject to prior de-naturation at 94^{o}C for 5 minutes, 35 cycles of 94^{o}C for 45 seconds, 60^{o}C for 45 seconds and an extension at 72^{o}C for 1 minute then followed by a final extension at 72^{o}C for 10 minute.

About 10µl of the PCR product was subjected to 1.5 percent agarose-gel which contained gel red as a stain and ran at a 100 Volts steadied for 30 mins utilizing 1X TAE buffer. A 100 base pair ladder was the marker used to examine the size of the molecules of the bands that migrated. The product thus amplified were viewed under gel documentation system and their photograph taken.

Digestion of the amplified fragment was done using *PstI* restriction enzyme to detect polymorphism. The restriction enzyme digestion was performed using 10µl of the PCR product mix with 1µl of *PstI* and incubated at 37^{o}C for 20 minutes. Enzyme deactivation was at 80^{o}C for 5 minutes. The digested products were subjected to gel electrophoresis of 2% which ran at 100volts for 45 minutes, the fragments resulting from these were viewed with a gel documentation system. The gel picture was taken and analyzed using GelAnalyzer software (Peakall and Smouse, 2012).

Statistical analyses

The PROC GLM of SAS 9.2 software was used for the variance analysis of all collected data. The effect of *IGF1* gene polymorphism and egg quality traits was analyzed using this procedure. The ANOVA model is

$Y_{ijk} = \mu + G_i + B_j + (GB)_{ij} + \Sigma_{ijk}$

Where:

Y_{ijk} = Traits of interest (the egg quality traits)

µ= Overall mean

G_i= Fixed effects of ith genotype (i=1, 2, 3, 4, 5)

B_j= Fixed effects of the *IGFI* marker genotype (j=1, 2, 3)

$(GB)_{ij}$= The interaction effects of genotype and *IGF* marker genotype

Σ_{ijk}= Randomised error.

GenAlEx 6.502 (Peakall and Smouse, 2012) was used to analyzed the genetic diversity parameters. The allelic frequency distribution was compared using χ^2 test. Correlation coefficients among external and internal and between external and internal egg quality traits were determined using correlation procedure of SAS.

Results

The genetic impact on the exterior egg-quality characteristics of chickens is shown in Table 1. With the exception of shell weight, all external factors examined in the study were significantly influenced by genotype. Additionally, Kuroiler exceeded the rest of the breeds in terms of egg weight, length, and width. One of the economic elements that affects how well an egg retains is the thickness of the shell; compared to other eggs, Sasso eggs have the softest shells. This is closely related to how easily the eggs hatch and lose moisture. For the naked neck FUNAAB Alpha, the value of the shell thickness was highest.

Table 1: Genotype effect on the external egg-quality traits of five chicken genotype (Mean ± SEM)

Variables	Frizzle (30)	Kuroiler (30)	Normal (30)	Naked neck (30)	Sasso (30)
Egg weight	54.36 ± 1.22^{b}	58.08 ± 0.79^{a}	52.55 ± 0.83^{b}	52.33 ± 0.81^{b}	54.92 ± 1.16^{b}
Egg Length	54.44 ± 0.45^{ab}	55.42 ± 0.31^{a}	54.21 ± 0.41^{ab}	53.55 ± 0.28^{ab}	46.33 ± 1.04^{c}
Egg width	42.84 ± 0.34^{ab}	43.29 ± 0.23^{a}	41.60 ± 0.23^{b}	41.70 ± 0.24^{b}	34.25 ± 0.93^{c}
Shape Index	78.78 ± 0.63^{a}	78.16 ± 0.46^{ab}	76.83 ± 0.52^{b}	77.88 ± 0.38^{ab}	73.80 ± 0.68^{c}
Shell weight	5.27 ± 0.10	5.45 ± 0.07	5.27 ± 0.10	5.17 ± 0.10	5.30 ± 0.15
Shell thick.	0.41 ± 0.01^{a}	0.40 ± 0.01^{ab}	0.42 ± 0.02^{a}	0.43 ± 0.01^{a}	0.37 ± 0.01^{b}
Shell ratio	9.80 ± 0.25^{ab}	9.30 ± 0.27^{b}	10.14 ± 0.22^{a}	9.94 ± 0.22^{ab}	9.44 ± 0.21^{ab}

$^{a, b, c}$ the superscript shows a significant (p>0.05) difference between the means within the rows.

Table 2 illustrates how the genotype affects the internal characteristics of the chicken. The Sasso chicken genotype received the highest ratings for the bulk of the internal characteristics assessed in this study. It also had the highest Haugh unit. The Haugh unit, which also predicts how much protein will be present in relation to albumen height, is used to assess egg quality. On the other hand, genotype had no appreciable (p<0.05) impact on each chicken's yolk and albumen ratio.

Table 2: Genotype effect on the internal egg-quality traits of five chicken genotype (Mean ± SEM)

Variables	Frizzle(30)	Kuroiler (30)	Normal (30)	Naked neck (30)	Sasso (30)
Alb. Weight	35.06 ± 1.27^{ab}	37.35 ± 0.77^{a}	33.25 ± 0.64^{b}	32.70 ± 0.69^{b}	35.43 ± 0.87^{ab}
Alb. Height	6.64 ± 0.21^{b}	5.38 ± 0.22^{c}	6.64 ± 0.21^{b}	6.88 ± 0.27^{ab}	7.51 ± 0.25^{a}
Yolk Colour	8.31± 0.20^{a}	6.94 ± 0.21^{b}	8.30 ±0.19^{a}	6.91 ± 0.18^{b}	8.40 ± 0.18^{a}
Yolk weight	14.04 ± 0.31^{b}	15.82 ± 0.28^{a}	14.04 ± 0.31^{b}	14.46 ± 0.23^{b}	14.19 ±0.27^{b}
Haugh unit	82.39 ± 1.43^{b}	71.54 ± 1.75^{c}	83.05 ± 1.30^{b}	84.23 ± 1.66^{ab}	87.57 ± 1.32^{a}
Yolk ratio	26.20 ± 0.84	26.33 ± 1.10	26.77 ± 0.56	27.75 ± 0.49	25.94 ± 0.36
Alb. Ratio	63.96 ± 1.09	62.27 ± 0.97	63.19 ± 0.63	62.35 ± 0.52	64.41 ± 0.36

$^{a, b, c}$ the superscript shows a significant (p>0.05) difference between the means within the rows.

The genotype and allele frequency of the IGFI polymorphisms found in the chicken genotypes are shown in Table 3. In this investigation, the A allele was more frequent. When genotypic frequency was considered, it was found that the AC genotype was more common in this study population (Ogunpaimo *et al*., 2021).

Table 3: Frequency of *IGFI* gene genotypes and alleles in the five chicken genotypes

	Genotypic Frequency			Allele Frequency			
	AA	AC	CC	A	C	^{2}	Probability
Frizzle feather	0.233	0.499	0.267	0.483	0.517	60.00	0.000
Kuroiler	0.284	0.498	0.218	0.533	0.467	60.00	0.000
Normal feather	0.360	0.480	0.160	0.600	0.400	60.00	0.000
Naked neck	0.381	0.473	0.147	0.617	0.383	60.00	0.000
Sasso	0.321	0.491	0.187	0.567	0.433	60.00	0.000

Table 4 displays the impact of the IGFI gene polymorphism on the egg characteristics of the chicken population. With the exception of egg length and width, the IGFI gene polymorphism had no effect (P>0.05) on the egg quality parameters. The AC genotype's eggs had the longest lengths and the widest widths.

Table 4: The Effect of *IGFI* gene polymorphism on egg traits of five chicken genotype (Mean ± SEM)

Variables	AA	AC	CC
Egg weight	53.33 ± 0.90	55.14 ± 0.59	53.55 ± 1.32
Egg Length	52.01 ± 0.71^{ab}	53.41 ± 0.48^{a}	51.59 ± 0.97^{b}
Egg width	40.09 ± 0.70^{ab}	41.23 ± 0.41^{a}	39.81 ± 1.06^{b}
Shape Index	76.94 ± 0.50	77.18 ± 0.34	77.00 ± 1.06
Shell weight	5.19 ± 0.10	5.36 ± 0.05	5.16 ± 0.17
Shell thick.	0.40 ± 0.01	0.41 ± 0.01	0.41 ± 0.02
Alb. Weight	33.89 ± 0.69	35.31 ± 0.55	33.96 ± 1.19
Alb. Height	6.73 ± 0.20	6.56 ± 0.17	6.61 ± 0.26
Yolk weight	14.25 ± 0.23	14.63 ± 0.18	14.43 ± 0.37
Haugh unit	83.16 ± 1.32	80.97 ± 1.14	82.52 ± 1.60
Shell ratio	9.75 ± 0.15	9.79 ± 0.11	9.68 ± 0.32
Yolk ratio	26.80 ± 0.34	26.38 ± 0.45	27.14 ± 0.82
Alb. Ratio	63.44 ± 0.39	63.83 ± 0.50	63.18 ± 0.98

$^{a, b}$ the superscript shows a significant (p>0.05) difference between the means within the rows.

The phenotypic relationships between the characteristics that determine egg quality in the five chicken genotypes employed in this investigation are shown in Table 5. Egg weight was positively correlated with egg length (0.45-0.80), width (0.48-0.94), and shell weight (0.61-0.77), with the exception of the frizzle feathered FUNAAB Alpha chicken which had a non-significant value (-0.02) between egg weight and shell weight. The same genotype however, exhibited a significant (p<0.001) inverse correlation coefficient between egg weight and shell ratio (-0.76), egg weight and yolk ratio (-0.68). All genotypes showed a negative connection (p<0.001) with yolk – albumen ratio (-0.6 : -0.86) and most had positive relationships (p<0.05) with albumen weight: egg weight (0.69-0.97), egg length (0.4-0.76), egg width (0.43–0.92) and shell weight (0.43–0.72). Egg width did not significantly (p>0.05) affect the yolk weight for the FUNAAB Alpha chicken strains with frizzle (-0.11), naked neck (0.33) and normal feather (0.34).

Except for the connection (p<0.001) between shell thickness and shell ratio in the naked neck FUNAAB Alpha chicken (0.55), Sasso (0.8), and between shell thickness and yolk ratio (p<0.05) for Sasso chicken (-0.38), there was no significant link between most of the reported features. For all genotypes, albumen height and Haugh unit had a strong and positive connection (p<0.001), with the normal and Sasso showing the highest close range value (0.98). Only the Sasso chicken had no discernible impact (p>0.05) on the yolk weight and albumen ratio (0.25), as well as the yolk weight and ratio (-0.15). For the shell to yolk ratio, only the frizzle chicken exhibited a significant (p<0.001) value (0.76). While the shell to albumen ratio was positively (p<0.05) correlated (0.86) and negatively correlated (-0.54) for the frizzle and naked feather FUNAAB chickens, respectively. With the kuroiler genotype having the highest value (-0.99), all genotypes in this investigation demonstrated a high (p<0.001) inverse relationship between yolk and albumen ratio.

TABLE 5 SHOWS THE PHENOTYPIC CORRELATIONS AMONGST EGG QUALITY TRAITS IN THE FIVE CHICKEN GENOTYPE

G	T	EW	EL	ED	SW	ST	SI	AH	AW	YW	YC	HU	SR	YR	AR
FZ	EW	1	0.64***	0.84***	-0.02	0.07	0.19	0.06	0.97***	0.02	0.02	-0.23	-0.76***	-0.68***	0.74*
NK		1	0.79***	0.92***	0.65***	-0.06	-0.16	0.31	0.90***	0.48**	0.27	0.13	-0.21	-0.24	0.26
N		1	0.80***	0.94***	0.61***	-0.1	0.24	0.2	0.95***	0.41*	-0.23	0.02	-0.26	-0.52**	0.57*
SA		1	0.45**	0.48**	0.77***	0.25	0.26	0.56***	0.97***	0.74***	0.31	0.39*	0	0.46**	0.46*
K		1	0.71***	0.92***	0.77***	0.08	0.16	0.24	0.69***	0.69***	0.18	0.04	-0.39*	0.03	0.06
FZ	EL		1	0.46**	0.17	0.42*	-0.51**	-0.19	0.58**	0.14	0.12	-0.37*	-0.36	-0.34	0.36*
NK			1	0.51**	0.52**	-0.04	-0.72***	0.35	0.61***	0.60***	0.37*	0.22	-0.15	0.05	-0.01
N			1	0.61***	0.53**	-0.12	-0.36*	0.40*	0.76***	0.3	-0.14	0.28	-0.15	-0.45**	0.47*
SA			1	0.94***	0.29	0.05	0.28	0.07	0.40*	0.48**	0.26	-0.05	-0.1	0	0.05
K			1	0.42**	0.53**	0	0.56**	-0.08	0.48**	0.63**	-0.08	-0.24	-0.29	0	0.03
FZ	ED			1	-0.16	0.12	0.53**	-0.08	0.84***	-0.11	0.09	-0.33	-0.72***	-0.66***	0.71*
NK				1	0.55**	-0.08	0.22	0.23	0.88***	0.33	0.19	0.05	-0.25	-0.38	0.37*
N				1	0.49**	-0.11	0.51**	0.12	0.92***	0.34	-0.3	-0.06	-0.34	-0.54**	0.61*
SA				1	0.35	0.12	0.59***	0.14	0.43*	0.49**	0.27	0.3	-0.03	-0.04	0.06
K				1	0.67***	0.14	0.51**	0.34	0.66***	0.59**	0.33	0.18	-0.43*	-0.06	0.09
FZ	SW				1	0.08	-0.33	-0.03	-0.22	0.46**	0.2	0.01	0.66***	0.36	-0.46*
NK					1	0.18	-0.15	-0.03	0.43**	0.46**	0.2	-0.14	0.60***	0.03	-0.17
N					1	0.38*	0	-0.04	0.53**	0.12	-0.15	-0.15	0.61***	-0.42*	0.22
SA					1	0.70***	0.28	0.42*	0.72***	0.45**	0.06	0.27	0.64***	-0.52**	0.2
K					1	0.19	0.09	0.12	0.51**	0.58**	0.16	-0.02	0.29	0	0.01
FZ	ST					1	-0.26	-0.33	0.05	0.06	-0.03	0.03	0.05	0.04	-0.04
NK						1	-0.02	0.09	-0.08	-0.04	-0.09	0.12	0.29	0.01	-0.08
N						1	0	-0.3	-0.14	-0.08	-0.01	-0.29	0.55***	0.02	-0.18
SA						1	0.23	0.05	0.23	-0.01	-0.26	0	0.80***	-0.38*	-0.02
K						1	0.13	0.31	-0.04	0.12	0.02	0.32	0.16	0.11	-0.12
FZ	SI						1	0.1	0.27	-0.24	-0.04	0.03	-0.35*	-0.33	0.35
NK							1	-0.22	0.02	-0.42	-0.26	-0.22	-0.03	-0.35*	0.33
N							1	-0.29	0.26	0.07	-0.2	-0.37*	-0.24	-0.14	0.21
SA							1	0.21	0.24	0.21	0.14	0.17	0.14	-0.1	0.03
K							1	0.39*	0.14	-0.06	0.38*	0.39*	-0.12	-0.04	0.06
FZ	AH							1	0.04	0.08	0.16	0.95***	-0.06	0.02	0
NK								1	0.34	0.07	0.15	0.97***	-0.36*	-0.15	0.22
N								1	0.18	0.17	-0.16	0.98***	-0.21	-0.02	0.08
SA								1	0.60***	0.24	0.08	0.98***	-0.03	-0.51**	0.52*
K								1	0.22	0.06	0.47**	0.97***	-0.18	-0.08	0.1
FZ	AW								1	-0.26	-0.04	-0.24	-0.85***	-0.86***	0.90*
NK									1	0.06	0.23	0.17	-0.40*	-0.63**	0.66*
N									1	0.13	-0.29	0.02	-0.31	-0.74***	0.79*
SA									1	0.61***	0.34	0.44**	-0.06	-0.61***	0.63*
K									1	0.41*	0.05	0.08	-0.31	-0.74***	0.76*
FZ	YW									1	0.16	0.1	0.28	0.70***	-0.62*
NK										1	0.16	0.02	0.12	0.73***	-0.68*
N										1	0.12	0.08	-0.24	0.56***	-0.46*

SA			1	0.21	0.09	-0.18	0.25	-0.15
K			1	0.18	-0.04	-0.21	0.61**	0.52*
FZ	YC			1	0.12	0.12	0.1	0.11
NK				1	0.07	-0.02	-0.03	0.03
N				1	-0.14	0.04	0.33	-0.33
SA				1	0.04	-0.3	-0.19	0.34
K				1	0.45**	-0.08	0.11	-0.1
FZ	HU				1	0.18	0.24	-0.23
NK					1	-0.31	-0.08	0.15
N					1	-0.17	0.06	-0.01
SA					1	-0.06	-0.48**	0.50*
K					1	-0.09	0.08	0.08
FZ	SR					1	0.76***	0.86*
NK						1	0.03	-0.54*
N						1	0.03	-0.32
SA						1	-0.25	-0.25
K						1	-0.02	-0.07
FZ	YR						1	-0.98*
NK							1	-0.97*
N							1	-0.95*
SA							1	-0.87*
K							1	-0.99*
FZ	AR							1
NK								1
N								1
SA								1
K								1

represents sig. diff (p<0.05), **(p<0.01), ***(p<0.001). G- GENOTYPE, TR–TRAITS, EW– EGG WEIGHT, EL– EGG LENGTH, ED– EGG WIDTH, S – SHELL WEIGHT, ST– SHELL THICKNESS, SI– SHAPE INDEX, AH– ALBUMEN HEIGHT, AW– ALBUMEN WEIGHT, YW– YOLK WEIGHT, HU– HAUGH UNIT, SR– SHELL RATIO, YR– YOLK RATIO, AR– ALBUMEN RATIO, FZ – FRIZZLE, NK-NAKED NECK, N-NORMAL, SA-SASSO, K-KUROILER

Table 6 display the phenotypic relationships between the egg weight and length for the IGF-1 polymorphism discovered in this study. The AA naked neck FUNAAB Alpha chicken had more influenced ($p<0.05$) traits than other genotypes, this was on EL (0.72), EW (0.95), SW (0.61), AW (0.93), YW (0.64). Meanwhile, the frizzle feather FUNAAB Alpha chicken had only one significant ($p<0.05$) coefficient (0.97), which was between EW and AW. The AC polymorphism had the highest influence on the traits observed in this study. With the Normal feather FUNAAB Alpha chicken having more correlated ($p<0.05$) features, this between EW and the following: EL (0.82), ED (0.94), SW (0.64), AW (0.96), YC (-0.58), YR (-0.69), AR (0.72). Moreover, the Sasso chicken had the highest significant ($p<0.001$) correlation between EW and AW (0.97). The naked neck FUNAAB Alpha chicken had no significant value ($p<0.05$) in all the measured traits for the CC polymorphism. Whilst the Sasso chicken had the highest egg and albumen weight relationship (0.99), and a similar inverse relationship between egg weight and yolk ratio (-0.99).

The Sasso chicken had a high correlation coefficient ($p<0.001$) for EL and EW in the AA IGF-1 polymorphism. Frizzled feathered FUNAAB Alpha chicken had no significant value for all the observed qualities in this study for the AC and CC IGF-1 polymorphism, it however, had one significant ($p<0.05$) value between EL and YW (0.89). The kuroiler chicken had no significant ($p>0.05$) trait for the AC IGF-1 polymorphism. Whilst the normal FUNAAB Alpha chicken had a higher numbers of influenced traits. Although, the Sasso chicken had a significant ($p<0.001$) value for EL and ED (0.94). Only the naked neck FUNAAB Alpha and Sasso chicken had significant ($p<0.05$) values in the CC IGF-1 polymorphism. EL and (0.99) SW, (0.95) SI, (0.97) YW, (0.98) YR and (-0.97) respectively for the former chicken, with (0.92) between EL and YW for the latter. Overall, the AC IGF-1 polymorphism had the highest influence on the measured traits.

TABLE 6 SHOWS THE PHENOTYPIC CORRELATONS ON THE EGG QUALITY TRAITS IN THE FIVE CHICKEN GENOTYPE

G	IGF	TR	EW	EL	ED	SW	ST	SI	AH	AW	YW	YC	HU	SR	YR	AR
F	AA	EW	1	0.58	0.66	-0.39	-0.52	0.22	-0.46	0.97*	0.15	0.14	-0.56	-0.8	-0.79	0.8
NK			1	0.92***	0.93***	0.77**	-0.03	-0.42	0.12	0.97***	0.65*	0.25	-0.12	-0.23	-0.52	0.53
N			1	0.72**	0.95***	0.61*	0	0.19	-0.08	0.93***	0.64*	0.36	-0.24	0.01	-0.16	0.16
SA			1	0.27	0.24	0.80***	0.1	0.13	0.55	0.99***	0.77**	0.74*	0.34	-0.6	-0.51	0.58
K			1	0.81	0.82	0.79	-0.66	-0.13	-0.08	0.99**	0.96**	0.72	-0.32	-0.66	-0.53	0.65
F	AC		1	0.67**	0.87***	-0.1	0.06	0.13	0.006	0.56***	0	-0.03	-0.23	-0.78***	-0.68***	0.74***
NK			1	0.66***	0.95***	0.54*	-0.05	0.21	0.25	0.92***	0.25	0.33	0.08	-0.31	-0.49	0.51*
N			1	0.82***	0.94***	0.64**	-0.05	0.2	0.46	0.96***	0.22	-0.58*	0.32	-0.33	-0.69**	0.72**
SA			1	0.53*	0.59**	0.81***	-0.4	0.31	0.49*	0.97***	0.85***	0.37	0.36	-0.33	-0.09	0.21
K			1	0.58	0.66	-0.39	-0.52	0.22	-0.46	0.97	0.15	0.14	-0.56	0.8	-0.79	0.8
F	CC		1	0.77	0.95**	-0.29	0.34	0.75	0.57	0.98**	-0.25	0.14	0.12	-0.84	0.9*	0.89*
NK			1	0.84	0.57	0.82	0.36	-0.62	0.79	0.01	0.91	0.61	0.73	0.47	0.83	-0.79
N			1	0.69	0.99**	0.39	0.11	0.8	-0.37	0.98*	0.03	-0.71	-0.51	-0.77	-0.77	0.89
SA			1	0.54	0.68	0.88*	0.82	0.57	0.91*	0.99***	0.89*	-0.64	0.8	0.58	-0.99***	0.82
K			1	0.85	-0.16	0.4	-0.1*	-0.51	-0.54	0.98	-0.99	0.99	-0.57	0.13	-0.1*	0.93
F	AA	EL		1	0.75	0.23	0.16	-0.17	-0.72	0.42	0.8	0.88	-0.78	0.19	-0.3	0.9
NK				1	0.74*	0.58	0.1	-0.73**	0.38	0.86***	0.74**	0.36	0.16	-0.4	-0.34	0.42
N				1	0.5	0.23	-0.34	-0.54	0.41	0.87***	0.15	0.32	0.31	-0.27	-0.52	0.65*
SA				1	0.98***	0.16	-0.31	0.75**	0.33	0.2	0.45	0.07	0.23	-0.11	0.17	-0.14
K				1	0.37	0.65	-0.5	0.67	0.61	0.76	0.89*	0.6	0.27	-0.5	0.06	0.27
F	AC			1	0.45*	0.18	0.41	-0.56**	-0.13	0.58**	0.19	0.11	0.32	0.39	-0.3	0.34
NK				1	0.42	0.21	-0.24	-0.59*	0.07	0.61**	0.19	0.42	-0.06	-0.37	-0.29	0.35
N				1	0.64**	0.86***	0.18	0.36	0.56*	0.73**	0.31	-0.47	0.48	0.14	-0.49	0.42
SA				1	0.94***	0.49*	0.1	0.13	-0.29	0.47	0.55*	0.41	-0.2	-0.08	0.1	-0.06
K				1	0.75	0.23	0.18	-0.18	-0.72	0.42	0.8	0.88	-0.78	-0.19	-0.04	0.09
F	CC			1	0.59	-0.33	0.35	0.2	0.19	0.82	-0.63	-0.01	-0.19	-0.69	-0.87	0.83
NK				1	0.03	0.99**	0.62	0.95*	0.86	-0.5	0.97*	0.67	0.84	0.86	0.98*	-0.97*
N				1	0.58	0	0.38	0.12	-0.76	0.54	0.66	-0.01	-0.8	-0.76	-0.13	0.31
SA				1	0.92*	0.12	0.16	0.27	0.43	0.62	0.39	0	0.35	-0.29	0.47	0.81
K				1	-0.67	0.83	-0.87	-0.89	-0.91	0.73	-0.9	0.9	-0.91	0.64	-0.88	0.6

**** represents sig. diff (p<0.05), **(p<0.01), ***(p<0.001).*** G- GENOTYPE, IGF – IGF-1 POLYMORPHISM, TR–TRAITS, EW– EGG WEIGHT, EL– EGG LENGTH, ED– EGG WIDTH, S – SHELL WEIGHT, ST– SHELL THICKNESS, SI– SHAPE INDEX, AH– ALBUMEN HEIGHT, AW– ALBUMEN WEIGHT, YW– YOLK WEIGHT, HU– HAUGH UNIT, SR– SHELL RATIO, YR– YOLK RATIO, AR– ALBUMEN RATIO, FZ – FRIZZLE, NK-NAKED NECK, N-NORMAL, SA-SASSO, K-KUROILER

Discussion

The quality of an egg affects how it is acceptable to the final consumer. It also predicts its price for both hatching and table eggs (Stadelman, 1977; Rajaravindra et al., 2015). This is influenced by several factors one of which is the genotype of the bird. These egg quality traits are determined by a large number of genes and can be improved by selective breeding (Oke, 2004; Tumova et al., 2009; Obike et al., 2014). The following factors are taken into account during the selecting process: egg weight, length, width, and thickness of its shell (Parmar et al., 2006). The majority of the parameters assessed in this study were significantly ($p < 0.05$) influenced by genotype, with the exception of shell weight, yolk ratio, and albumen ratio. Contrary to reports by Kgwatala *et al.* (2016) and Alkan et al. (2010), which found a substantial difference in egg shell weight between several strains of Tswana chicken and lines of Japanese quails, respectively, this is the case with the egg weight of the eggs.

The size of the chicken is what gives the Kuroiler breed its supremacy in terms of egg weight, length, and width. The size of a chicken's egg and its weight are positively associated, which indicates that the larger the egg, the heavier the chicken. Due to their impact on embryonic development and chick hatchability, these have a stronger impact on egg quality and reproductive fitness in chickens (Islam et al., 2001). The data from this study are comparable to those from

Serkalem et al. (2019) agro-ecological study of production attributes in domestic and foreign hens. Although the majority of the traits in this analysis showed slightly higher numbers.

ESI, the shape index of the egg is defined as the average of the egg width and length, it remains an indicator in terms of uniformity in the egg-size. A higher shape index augur uniformity of the eggs. This plays a part during the incubation period especially with the movement of the embryo for the utilization of nutrients during the direction of turning (Hristakieva et al., 2017). The Frizzled feather (FUNAAB Alpha) had the highest egg shape index, this establishes a report of better egg uniformity in the bird relating to healthy production and hatchability. Similar results were reported by Rajaravindra et al. (2015) in PB-2 chickens at different ages but higher than Hristakieva et al. (2017) for 34–46 weeks old turkey layers.

Egg albumen constitutes about 58.5% of the absolute egg weight, hence exhibiting a majority effect on its inner quality. In this study, the albumen height and weight displayed a varied significant ($P < 0.05$) effect across the chicken genotype, Sekeroglu and Altuntas (2009) reported that the overall weight of an egg appreciates alongside its albumen height. A high albumen height was observed in this study, which was in accordance with Olawumi and Ogunlade (2008) findings although, it is lower than Yakubu et al. (2008) reported. The Sasso breed had better Haugh unit due to the higher albumen height observed in this study, thus indicating better internal egg quality than the others. There was a high and positive ($p < 0.001$) correlation between the Haugh unit and albumen height, this is in line with the result of Rafea (2019) although there was an inverse correlation between haugh unit and egg weight in this study, no significant ($p > 0.05$) correlation was recorded. The albumen height and Haugh unit measures the viscosity of an egg's albumen. The values obtained in this study are higher than the standard (HU = 70) as reported by North (1978); Olawumni *et al.* (2020).

Selection based on genetic factors had been considered as a practical approach for improving animal's production in breeding program. There exists a direct relationship between IGF-1 gene polymorphism with the reproductive indices such that the reproductive trait of chicken increases with IGF-1 gene polymorphism. The effect of IGF-1 polymorphism on egg length and weight in this report is in accordance with previous records of Wu et al. (2014, 2016); Gabillard et al. (2003); Revol et al. (2005), who revealed that the IGF-1axis applies a major play over growth and reproduction values in animals, indicating the presence of both axes during early development. This study suggests that IGF-1exhibits similar modal activities in the growth hormone/insulin like growth factor axes, thus regulating reproductive traits in chicken. Similar findings were recorded by Shimizu et al. (2008), Wu et al. (2016) for different mammals and chicken populations. The absence effects of *IGFI* gene polymorphisms on some reproductive traits noticed in the study can be imputed to dissimilarities in gene structure and unequal linkage in the chicken's publication.

The result from the study observed that the IGF-1polymorphism had no significant effect on its egg-quality traits except the egg length and width. This is not in accordance with the result of Lei et al. (2005) and Tang et al. (2010), in their findings they discovered that the SNP within the promoter region), is significantly associated with the following: body weight, egg production, shell weight and quality. This study reports that the *PstI* digested PCR products of the IGF-1gene reveals three (3) polymorphic fragments and this was in consistent with the findings of Esmailnejad and Nikbakht (2017), although it was not in line with the findings of Nagaraja et al. (2000). The genotypic and allelic frequency observed in this study showed the population to be in Hardy-Weinberg equilibrium. The different population genetic backgrounds and the breeding objectives might be the main cause of the differences observed among the chicken population.

Conclusion

In conclusion, all egg-quality parameters, with the exception of shell weight, yolk, and albumen ratio, were significantly influenced by chicken genotype. While the Sasso chicken is preferable in terms of protein quality due to its high albumen height, the Kuroiler chicken performed better in all observed attributes for this study compared to other birds. Except for egg length and width, the IGFI gene polymorphism did not significantly affect the egg features in this investigation. Egg length and width had high values in the AC chickens, coupled with many linked traits. However, the FUNAAB Alpha chicken with normal feathers outperformed the competition in terms of higher correlation values for the qualities that were examined. The IGF-1 gene may be suggested as a genetic marker for selection to increase the length and width of the eggs of the breeds employed in this study based on these findings.

Declarations

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