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QUALITY AND SENSORY ATTRIBUTES OF EGGS FROM DIFFERENT CHICKEN GENOTYPES IN PAKISTAN

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ABSTRACT

This study was conducted with the aim of comparing the quality and sensory attributes of eggs from different chicken genotypes in Pakistan (Fayoumi, White Leghorn, Aseel, Rhode Island Red, Naked Neck, and White Plymouth Rock). For quality analysis, 10 eggs from each chicken genotype were randomly collected and subjected to egg quality analysis. For sensory evaluation, another sample of 10 eggs of each genotype was boiled and presented to a well-trained panel of 20 experts and evaluated on 15 points hedonic scale. The data were analyzed through one-way ANOVA using a completely randomized design and means were compared through Duncan's Multiple Range test using SAS 9.4. Eggs of Fayoumi breed showed significantly higher ($P \leq 0.05$) specific gravity, Haugh unit score, and yolk color score as compared to other breeds. Similarly, among different breeds, eggs of Rhode Island Red breed had the highest albumen percentage, while yolk percentage was significantly higher ($P \leq 0.05$) in eggs of Aseel, Naked Neck, and Fayoumi breeds. Eggs from White Leghorn hens received the highest ($P \leq 0.05$) sensory ratings regarding yolk and albumen taste, mouthfeel, flavor and overall acceptance. Eggs of Aseel had the lowest ratings for the color of albumen, while, eggs of White Plymouth rock hens had a very strong aroma of albumen. Overall results of the present study suggest that eggs from Fayoumi have better internal quality and White Leghorn have better organoleptic/sensory attributes.

Keywords: Chicken genotypes, egg quality, sensory attributes.

INTRODUCTION

Rapidly increasing world population is leading towards increased demand for animal protein foods (Henchion *et al.,* 2017) and more importantly, nowadays, foods are not intended to only satisfy hunger, but also to prevent nutrition-related diseases and improve the physical and mental well-being of consumers (Siró *et al.,* 2008). Chicken eggs are a source of proteins, fats and certain health beneficial micronutrients (Faria *et al.,* 2001; Miranda *et al.,* 2015). Eggs offer a moderate caloric value (150 kcal/100 g), and the proteins of excellent quality and biological value with great culinary versatility (Roberts, 2010; Carrillo *et al.,* 2012).

Egg quality refers to a group of traits that influence the use of eggs as food stuff (Schwaegele, 2003). Egg quality is a multifactorial character and influenced by genotype or breed, age and health of the hen, nutrition and management related factors (Chatterjee *et al.,* 2007; Islam and Dutta, 2010; Jones *et al.,* 2010; Momoh *et al.,* 2010; Isidahomen *et al.,* 2013). Among many quality characteristics, external factors including cleanliness, freshness, egg weight and shell quality are important in consumer's acceptability of shelled eggs (Sonaiya and Swan, 2004). The quality of egg albumen is often measured as a function of the height of the inner thick albumen, for example the Haugh unit (Haugh, 1937), or more correctly as the height alone (Silversides and Villeneuve, 1994). The influence of genetics on albumen height has been known for many years (Johnson and Merrit, 1955). Yolk color is used as a quality determination factor, mainly dependent on the diet and can be easily manipulated (Hunton, 1995). The consumer in general and egg breaking industry, in particular, are very much concerned regarding egg components shares. The proportion of yolk and albumen is largely determined by the age and genotype of the hen (Akbar *et al.,* 1983; Ahn *et al.,* 1997).

There is a commonly held belief among consumers that brown shelled eggs from indigenous breeds are of higher quality and taste than those of imported or commercial chicken breeds (Johnston *et al.,* 2011). However, to our knowledge, especially in Pakistan, the number of studies examining the overall quality and sensory attributes of eggs from different chicken breeds are very less. Thus, the present study was undertaken to compare quality and sensory attributes of eggs from six different chicken genotypes (breeds) found in Pakistan.

MATERIALS AND METHODS

Design and Hens. The study was conducted at Department of Poultry Production, University of Veterinary and Animal Sciences (UVAS), Lahore-Pakistan. Five hens (40 – 50 weeks of age) of each breed

(Aseel, Fayoumi, Naked Neck [NN], Rhode Island Red [RIR], White Leghorn [WLH], and White Plymouth Rock [WPR]) were maintained at the Indigenous Chicken Genetic Resource Center (ICGRC), UVAS, Lahore. All birds were reared under similar management, nutritional and environmental conditions on litter floor. After ten days of adaptation period, twenty (20) eggs of each breed were collected randomly and subjected to egg quality and sensory analysis.

Egg Quality. 10 eggs form each breed were collected and egg shell thickness was measured in triplicate from one egg i.e., the average thickness of fragments of blunt, equator, and sharp end without shell membrane, with the help of micrometer screw gauge (Aerospace®). Specific gravity of eggs was measured following the procedures of Sreenivasaiah (2006). For this purpose, 276, 298, 320, 342, 365, 390, 414, 438 and 462 g of salt was added in different plastic buckets in 3-liter water to obtain the requisite specific gravity ranging from 1.060 to 1.100 at intervals of 0.005.

The Haugh unit score was calculated using albumen height and egg weight according to Haugh (1937). The height of the thick albumen was taken at three different places through spherometer and averaged.

$$\text{Haugh Unit} = 100[\text{Log}(H + 7.57) - (1.7)(W^{0.37})]$$

H = Observed height of the albumen in mm, W = Weight of egg (g)

Albumen index was calculated using the formula described by Doyon *et al*. (1986).

$$Albumen\ Index = \frac{Albumen\ height}{(albumen\ length + albumen\ width)^2} \times 100$$

The weight (g) of egg shell, albumen and yolk were recorded to calculate their percentage with respect to the whole egg. For yolk weight, the yolk was separated from albumen with the help of a spoon. DSM Yolk color fan was used to record yolk color score. After taking all readings the yolk and albumen were poured in a petri dish separately and the pH was measured individually with the help of Aditeg pH meter (PH-98107).

Sensory Testing: For sensory/organoleptic evaluation, 10 eggs from each treatment were tagged (treatment name on the egg) and boiled at same time in kettle for 8 minutes (Parpinello *et al.,* 2006), cooled through placing them under tap water, peeled, yolk separated, sliced in four parts, coded for random sampling, and presented to panelist.

Egg samples (separate albumen and yolk) from each breed were randomly presented to a well-trained panel of experts consisting of 20 people (Faculty members and Postgraduate students of Department of Poultry Production who were willing to consume eggs and had no egg allergies). Before evaluation, the panelists participated in a training session that reviewed the testing procedure and egg evaluation techniques. Panelists were introduced to different evaluation techniques (e.g., smelling and tasting eggs). Evaluation of the different testing procedures was discussed. Panelists were asked to rate color, taste, flavor, mouthfeel, aroma, and overall acceptance of each egg sample on 15 points hedonic scale (Hayat *et al.,* 2014) to measure egg sensory attributes (0=not intense, 4=slightly intense, 8=moderately intense, 12=largely intense, and 15=extremely intense).

The data were analyzed by ANOVA with Completely Randomized Design (CRD; Steel *et al.,* 1997). The post-hoc analysis was conducted using Duncan's Multiple Range (DMR) test (Duncan, 1955) using SAS version 9.4 (SAS Institute, 2013).

RESULTS AND DISCUSSION

In the present study, among external egg quality traits, egg specific gravity was found to be significantly ($P \leq 0.05$) different among different genotypes, while shell percentage and thickness remained comparable (Table 1). Egg specific gravity was found to be the highest in eggs of Fayoumi and WLH followed by NN and RIR eggs and the lowest in Aseel and WPR eggs (Table 1). Egg specific gravity is a non-destructive and reliable parameter to observe shell strength (Swanson *et al.,* 1961). An egg having the specific gravity of 1.080 or above is considered as having better shell quality (Mauldin, 2002). However, in the present study, only the eggs of Fayoumi and WLH had values higher than 1.080. Mauldin (2002) indicated the age of the hen and egg storage as major factors influencing egg specific gravity, but, in the present study both the factors are similar among different breeds. Probably the differences in the specific gravity of the inner egg contents among different breeds resulted in variationsin overall egg specific gravity (Sloan *et al*., 2000). In accordance with our study, some other studies (Jones *et al.,* 2010; Momoh *et al.,* 2010) also reported significant variation among different breeds for egg specific gravity. In contrast, Tharrington *et al.* (1999) reported non-significant differences among different historic strains of White Leghorn layers for egg specific gravity and shell percentage.

Among different albumen quality parameters, significant differences ($P \leq 0.05$) were observed in albumen percentages and Haugh unit scores among eggs from different breeds, but no differences were detected in albumen index and pH (Table 1; Table 2). Eggs of RIR and WLH showed the highest albumen percentage followed by those of WPR, Fayoumi, and NN. Eggs of Aseel birds showed the lowest albumen percentage (Table 1). The differences among breeds for albumen % could be attributed to their genetic variation as it is an inherited trait and affected by several genes (Popova-Ralcheva *et al.,* 2009). In line with the results of present study, Islam and Duta (2010) compared eggs from indigenous, Cobb 500, Fayoumi, RIR and, Sonali breeds and reported that albumen percentage was highest in RIR and lowest in Fayoumi eggs. Moreover, Haunshi *et al.* (2011) also reported higher percentage of albumen in the Kadaknath breed eggs than those of Aseel's.

Similarly, Haugh unit score was found to be significantly ($P \leq 0.05$) higher in eggs of Aseel, Fayoumi, RIR, and NN breeds as compared to WLH and WPR (Table 2). Haugh unit is considered as a measure of the quality of the albumen (Eisen *et al.,* 1962) and according to United States Department of Agriculture (USDA) eggs having Haugh unit score of 72 and above can be classified as AA grade (USDA, 2002). Eggs from all the breeds in the present study had Haugh unit score above 72. In accordance with the results of the present study Hanusova *et al.* (2015) reported significant differences in Oravaka and RIR eggs for Haugh unit score and albumen percentage. Wu *et al.* (2005) also described that Haugh unit values showed significant variation among different genotypes; Bovans White had higher Haugh unit values than Dekalb White. According to Monira *et al.* (2003) Haugh unit was the highest in White Plymouth Rock, intermediate in White Leghorn and Barred Plymouth Rock and the lowest in Rhode Island Red.

Table 1. Shell and Albumen quality of different chicken genotypes

Breeds	Shell thickness (mm)	Shell (%)	Egg specific gravity	Albumen (%)	Albumen Index
Aseel	0.33±0.002	11.51±0.48	1.073 ± 0.003^{c}	46.37 ± 0.78^{d}	7.94±0.15
Fayoumi	0.33±0.001	12.6±0.30	1.086 ± 0.002^{a}	52.04 ± 0.74^{c}	7.59±0.09
White Leghorn	0.34±0.003	12.44±0.29	1.084 ± 0.001^{ab}	57.07 ± 1.17^{ab}	7.77±0.10
NN*	0.35±0.002	12.1±0.31	1.078 ± 0.003^{b}	51.32 ± 1.59^{c}	7.79±0.13
RIR**	0.35±0.002	12.52±0.57	1.076 ± 0.0006^{b}	59.58 ± 1.19^{a}	7.99±0.08
WPR***	0.34±0.002	11.17±0.36	1.069 ± 0.002^{c}	54.45 ± 1.10^{bc}	7.83±0.18

Values are mean ± SE (n = 10 each) and those with different superscripts (a, b, c and d) are significantly different ($P \leq 0.05$)
*NN=Naked Neck, **RIR=Rhode Island Red, ***WPR=White Plymouth Rock

Table 2. Albumen and Yolk quality parameters of different chicken genotypes

Breeds	Albumen pH	Haugh Unit	Yolk %	Yolk pH	Yolk Index	Yolk color
Aseel	7.98±0.16	85.07 ± 1.25^{a}	35.71 ± 1.73^{a}	6.40±0.20	41.13±0.22	4.3 ± 0.26^{c}
Fayoumi	7.79±0.09	86.17 ± 0.46^{a}	35.2 ± 0.85^{a}	6.27±0.11	41.32±0.19	8.1 ± 0.40^{a}
White Leghorn	8.33±0.09	80.5 ± 0.81^{b}	31.31 ± 1.11^{bc}	6.28±0.14	40.93±0.21	7.2 ± 0.41^{ab}
NN*	8.15±0.20	84.92 ± 0.89^{a}	35.2 ± 1.20^{a}	6.63±0.21	41.61±0.50	2 ± 0.29^{d}
RIR**	7.89±0.07	86.24 ± 0.84^{a}	29.96 ± 1.08^{c}	6.21±0.07	41.63±0.29	6.9 ± 0.45^{b}
WPR***	7.85±0.22	82.31 ± 0.94^{b}	34.47 ± 1.24^{ab}	6.57±0.28	41.94±0.37	7.4 ± 0.42^{ab}

Values are mean ± SE (n = 10 each) and those with different superscripts (a, b, c and d) are significantly different ($P \leq 0.05$).
*NN=Naked Neck, **RIR=Rhode Island Red, ***WPR=White Plymouth Rock

Significantly higher ($P \leq 0.05$) yolk percentages were observed in eggs of Aseel, Fayoumi and NN breeds, followed by those from WPR, WLH and the lowest in RIR eggs (Table 2). Moreover, yolk color was found to be significantly higher ($P \leq 0.05$) in eggs of the Fayoumi breed, followed by RIR, Aseel, and NN. Whilst eggs of WLH, and WPR breed lied between Fayoumi and RIR eggs and didn't differ significantly from the both (Table 2). However, yolk pH did not show any significant variation among eggs from different breeds. In the present study, eggs from rural origin breeds had higher yolk percentages as compared to commercial breeds (WLH and WPR) as these rural breeds had relatively smaller eggs and previous studies (Suk and Park, 2001) also reported higher proportion of yolk in breeds having smaller eggs. However, yolk color is considered to be dependent on the hen diet (Hunton, 1995). Moula *et al.* (2009) also reported that yolk percentage and pH vary significantly among breeds as they found the higher value of these parameters in eggs from Ardennaise and Famennoise hens compared to eggs from Lohmann Brown hens. Likewise, Haunshi *et al.* (2011) also found higher yolk weight in Aseel eggs than in eggs from Kadaknath hens. Isidahomen *et al.* (2013) concluded that yolk weight was significantly higher in eggs from exotic chickens (Dominant Blue) when compared with the local chicken genotypes (normal feather, frizzle feather, and the naked neck). Eggs from Rhode Island Red hens were of darker yolk color than those of Oravka hens (Hanusova *et al.,* 2015). Some other studies (Islam *et al.,* 2001; Rajkumar, 2009) also reported that yolk color varies significantly among different genotypes.

The sensory analysis suggested that White Leghorn eggs were scored significantly higher ($P \leq 0.05$) in terms of yolk taste, yolk flavor, and yolk mouthfeel and Aseel eggs scored the lowest in the same categories (Table 3). Aseel eggs were also rated the lowest for albumen color intensity. Albumen taste, flavor, and mouthfeel were observed to be the highest in White Leghorn eggs and the lowest in Aseel eggs. Albumen aroma was significantly ($P \leq 0.05$) higher in eggs from WPR hens followed by those from WLH, RIR, Fayoumi, Aseel and the lowest in NN eggs. Moreover, White Leghorn and RIR eggs had higher overall albumen acceptance rate as compared to the rest of the genotypes (Table 4).

Table 3. Organoleptic evaluation of yolks from eggs from different breeds of hens

Breeds	Color	Taste	Aroma	Flavor	Mouthfeel	Overall acceptance
Aseel	7.43±0.72	7.7±0.77^{c}	6.5±0.79	6.6±0.79^{c}	7.9±0.56^{b}	8.5±0.74
Fayoumi	7.3±0.59	8.5±0.61^{bc}	7.3±0.82	7.3±0.71^{bc}	8.3±0.77^{b}	8.7±0.61
White Leghorn	9.3±0.70	10.7±0.73^{a}	8.1±0.77	10.6±0.64^{a}	10.8±0.61^{a}	10.7±0.52
NN*	8.4±0.64	10±0.61^{ab}	5.9±0.95	9.3±0.76^{ab}	9±0.69^{ab}	9.3±0.63
RIR**	7.6±0.60	9.1±0.55^{abc}	6.9±0.81	8.6±0.61^{abc}	8.8±0.61^{ab}	10±0.63
WPR***	8.5±0.61	9.2±0.69^{abc}	8.5±0.72	9.3±0.59^{ab}	9.7±0.71^{ab}	9.3±0.62

Values are mean ± SE (n = 10 each) and those with different superscripts (a, b, c and d) are significantly different ($P \leq 0.05$).
*NN=Naked Neck, **RIR=Rhode Island Red, ***WPR=White Plymouth Rock

Table 4. Organoleptic evaluation of albumin from eggs from different breeds of hens

Breeds	Color	Taste	Aroma	Flavor	Mouthfeel	Overall acceptance
Aseel	5.1±0.66^{b}	7.1±0.87^{b}	5.9±0.75^{bc}	6.1±0.65^{c}	7.7±0.64^{b}	8.2±0.62^{b}
Fayoumi	7.1±0.41^{a}	7.8±0.71^{b}	6.4±0.84^{abc}	7.8±0.66^{bc}	8.1±0.76^{b}	8.6±0.74^{b}
White Leghorn	8.8±0.64^{a}	10.7±0.61^{a}	8.3±0.76^{ab}	10.5±0.60^{a}	10.7±0.55^{a}	10.8±0.49^{a}
NN*	8.2±0.67^{a}	9.1±0.66^{ab}	5.7±0.93^{c}	8.3±0.82^{b}	8.9±0.65^{ab}	9.3±0.57^{ab}
RIR**	7.3±0.57^{a}	8.8±0.52^{ab}	7.3±0.79^{abc}	8.7±0.60^{ab}	8.4±0.71^{b}	9.5±0.64^{ab}
WPR***	7.3±0.67^{a}	8.6±0.64^{b}	8.6±0.72^{a}	9±0.52^{ab}	7.9±0.69^{b}	8.5±0.49^{b}

Values are mean ± SE (n = 10 each) and those with different superscripts (a, b, c and d) are significantly different ($P \leq 0.05$).
*NN=Naked Neck, **RIR=Rhode Island Red, ***WPR=White Plymouth Rock.

Conclusion: The present study demonstrates that genetic differences among breeds affect egg quality and sensory attributes. From a consumer point of view egg specific gravity and Haugh unit score depict freshness and quality of eggs and in the present study, the eggs from indigenous breeds showed better Haugh unit score and specific gravity as compared to those from commercial breeds. On the other hand, in the sensory evaluation, the yolk and albumen from white leghorn (commercial breed) got higher ratings, showing peoples overall likeliness for eggs from commercial breeds.

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