DECLARATION

I hereby declare that the thesis entitled "**EGG QUALITY OF NATIVE CHICKEN UNDER BACKYARD SYSTEM AND WHITE LEGHORN LAYERS UNDER INTENSIVE SYSTEM OF REARING"** is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title, of any other University or Society.

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CERTIFICATE

Certified that the thesis entitled "**EGG QUALITY OF NATIVE CHICKEN UNDER BACKYARD SYSTEM AND WHITE LEGHORN LAYERS UNDER INTENSIVE SYSTEM OF REARING"** is a record of research work done independently by Saritha Thankachan (2009-13-128)**,** under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship or associateship to her.

Mannuthy

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CERTIFICATE

We, the undersigned members of the Advisory Committee of Saritha Thankachan**,** a candidate for the degree of Master of Veterinary Science in Poultry Science, agree that this thesis entitled **"EGG QUALITY OF NATIVE CHICKEN UNDER BACKYARD SYSTEM AND WHITE LEGHORN LAYERS UNDER INTENSIVE SYSTEM OF REARING"** may be submitted by Saritha Thankachan**,** in partial fulfillment of the requirement for the degree.

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SARITHA THANKACHAN

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1. INTRODUCTION

Poultry is one of the fastest growing segments of the agricultural sector in India today. With annual production of 56 billion eggs, India is now the third biggest egg producer in the world. In India, poultry production shows distinctly a different system pronounced by high population of native fowls. The broiler and layer production play a significant role to raise the economic status of rural masses, improve their level of nutrition and also generate employment avenues.

A large number of fowls of different sizes, shapes and color, resembling the jungle fowls are found all over India. Birds with Chittagong, Aseel, Langshan or Brahma blood are bigger in size and better in meat quality than the common fowls. There are only four pure breeds of Chicken indigenous to India. They are Aseel, Chittagong, Busra and Kadaknath. The common country hen, the desi, is the best mother for hatching, a good forager but a poor layer.

White Leghorns are among the most popular commercial strains of layer chickens worldwide. Leghorns are excellent layers of white eggs with a superior feed-to-egg conversion ratio. Leghorns rarely exhibit broodiness and are thus well suited for uninterrupted egg laying.

In kerala, rural poultry farming is characterized by rearing native chicken in small numbers in the backyard of houses. The food resources for rural poultry production are obtained by the birds scavenging in and around house and consisting of household waste, edible food items in the immediate environment, together with

small amounts of grains provided by the householders. Native chicken has contributed immensely to the backyard poultry production in the state. It is reported in the livestock census report (2005) that the total population of the fowls in Kerala was 109.92 lakhs consisting of 77.36 lakhs desi fowl and 32.56 lakhs improved fowls. Indigenous poultry are well adapted to harsh environment of free range and they produce eggs and meat at least possible cost. Although the productivity of the indigenous chicken is low, the demand for desi eggs is very high and these eggs fetch premium price in the market too.

Poultry meat and egg are important diet of an average family. Egg has a high biological value (93.7) when compared to milk (84.5) and fish (76.0) and it provides cheep and high quality protein. As far as consumption of eggs by human is concerned, chicken eggs are increasingly recognized as an important source of nutrients, including micro minerals and information on their trace mineral composition is being sought after. There are many factors that influence the purchase and consumption of eggs from the various systems. Many consumers in our state believe that eggs originating from free range or organic farms taste better, have a higher nutritional value and can be beneficial for human health. However, this perception is not based on any measurements about the specific qualities of free-range eggs over conventional eggs.

Egg quality can be considered as the main criterion determining the pricing pattern in table and hatching eggs. Egg quality has been defined by Stadelman (1977) as the characteristics of an egg that affect its acceptability to the consumers. The net economic merit of any laying flock cannot be determined, by taking into

account the total number of eggs produced alone; but also the egg weight and other egg quality traits. The literature pertaining to indigenous chicken eggs with respect to its external and internal quality is very scanty. These information will be a perquisite for improvement and commercial exploitation of these traits in the future. Very few scientific studies have been directed towards characterizing the local stock of chicken under traditional management conditions like backyard system of rearing chicken. Government of Kerala census reports reveal desi fowl population as 134.9 lakhs in the year 1996,110.2 lakhs in the year 2000 and 77.3 lakhs in the year 2003, registering a decline of 18.3% in the year 2000 and a reduction of 29.8% in the year 2003 (Anon, 2004). Therefore, it is appropriate that studies on conservation of desi fowls in Kerala are to be started immediately.

Under the above circumstances, the present study is planned with the following objectives:-

1) To evaluate the egg quality characteristics of native chicken under backyard system
2) To compare the egg quality characteristics of native chicken with that of White Leghorn layers reared under intensive system

2. REVIEW OF LITERATURE

2.1. EGG QUALITY PARAMETERS

2.1. 1. External Egg Quality of Native Chicken

Kumar *et al.* (1971) determined the egg quality traits of RIR, desi, RIR x desi and desi x RIR pullets. The average values for egg weight and shape index for desi birds recorded in the study were 47.04 ± 0.38 g and 72.42 ± 0.37 respectively.

Mahapatra *et al.* (1982) determined the egg quality of 240 eggs each from different desi breeds like Karaknath, Aseel Kagar and Aseel Peela. The egg weight and shape index for Karaknath were 40.08 g and 73.78 respectively and the corresponding values for Aseel kagar desi hens were 48.32 g and 73.65 and for Aseel Peela hens, the values were 46.52 g and 75.08 respectively.

Ashraf *et al.* (2003) estimated the egg quality parameters of a locally evolved Lyallpur Silver Black breed of chicken and documented egg weight as 47.23 ± 0.34 g.

Fayeye *et al.* (2005) conducted a study to evaluate Fulani-ecotype chicken for egg traits and documented the mean values for egg weight, egg length and egg width 40.73 g, 34.91 mm and 23.59 mm respectively.

Parmar *et al.* (2006) studied the egg quality characteristics of Kadaknath breed in eggs collected from two field survey centers [Jhabua-I (Meghnagar) and Jhabua-II (Jobat)] of Jhabua district (Madhya Pradesh) and documented the mean shape index pooled for both the centres as 73.93.

Santhosh *et al.* (2006) found the means of external egg quality traits such as egg weight and shape index of Vanaraja chicken at 40 weeks of age were 60.79 ± 0.78 g and 75.45 ± 0.57 respectively.

Iqbal and Pampori (2008) documented that the quality of egg was found good with shape index 73.54 and egg weight 46.10 g for indigenous chicken of Kashmir.

Kumar *et al.* (2008) conducted a study on shank feathered and clean shank strains of local hill fowl to evaluate the external and internal egg quality parameters and recorded the egg weight, egg width, egg length and shape index in shank feathered strain of local hill fowl as 49.82 ± 0.37 g, 4.03 ± 0.02 cm, 5.55 ± 0.03 cm, 72.80 ± 0.65 per cent respectively. The corresponding figures for clean shank strain of local hill fowl were 56.77 ± 0.56 g, 4.53 ± 0.03 cm, 5.88 ± 0.03 cm, 77.10 ± 0.35 per cent.

Mohan *et al.* (2008a) studied the production parameters and general performance characteristics of Aseel peela desi hens under the normal system of rearing and recorded the egg weight as 40.00 ± 1.05 g.

Mohan *et al.* (2008b) reported the average egg weight at 21 weeks in Kadaknath desi hens under normal rearing system was 32.50 ± 0.7 g.

Niranjan *et al.* (2008) found the egg quality traits of Vanaraja and Gramapriya chicken and the values obtained for egg weight, egg length, egg width and shape index were 53 g, 54.5 mm, 41.4 mm and 76.2 respectively for Vanaraja and the corresponding values for Gramapriya are 51 g, 54 mm, 42 mm and 78.

Singh and Kumar (2008) reported the egg weight of native fowl of Garhwal, Himalayas as 36.80 ± 0.6 g.

Girishkumar (2009) estimated the egg quality of native chicken of Northern Kerala, and the mean values for egg weight, egg length, egg breadth and shape index were recorded as 41.81 ± 0.46 g, 51.90 ± 0.36 mm, 37.95 ± 0.16 mm and 73.37 ± 0.47 respectively.

Singh *et al.* (2009) evaluated the egg quality traits of local hill fowl in Pithoragarh district and found that the overall average of light brown shell color was 65 percent, followed by cream, brown and tintiled color, which was 25, 9 and 1 per cent, respectively. The average values for egg weight, egg width, egg length and shape index were found to be 52.03 ± 0.90 g, 4.13 ± 0.03 cm, 5.53 ± 0.03 cm and 74.87 ± 0.54 per cent in eggs of local hill fowl, respectively.

Yadav *et al.* (2009) conducted a study on 50 eggs of chicken maintained under backyard system in Bareilly district to evaluate the external egg quality parameters and documented the egg weight and shape index as 52.95 ± 0.59 g and 74.23 ± 0.61 respectively.

2.1.2. External Egg Quality of White Leghorn

Padhi *et al.* (1998) determined the egg quality of White Leghorn chicken and the values obtained for egg weight and shape index were 62.86 ± 1.80 g and 73.56 ± 1.22 respectively.

Shrestha *et al.* (2004) conducted a study in White Leghorn to assess the effect of different space density groups and the overall mean values obtained for various egg quality traits were 74.7 ± 0.56 and 50.3 ± 0.45 g for shape index and egg weight respectively.

Santhosh *et al.* (2006) in a study found the means of egg quality traits such as egg weight and shape index of White leghorn chicken were 54.29 ± 0.73 g and 73.55 ± 0.52 respectively.

Aydin *et al.* (2008), determined the egg quality parameters in 27 week old laying hens (Hyline-5 White) and documented the egg weight as 52.93 ± 0.41g

At A.I.C.R.P. on Poultry Research Station, Mannuthy, the egg weight of IWN and IWP strains of White Leghorn were documented. At 28 weeks of age the

average egg weight was found to be 50.02 g in IWN and 50.42 g in IWP and at 40 weeks of age the values were 55.22 and 55.02 g respectively (Anon, 2010).

2.1.3. Internal Egg Quality of Native Chicken

Kumar *et al.* (1971) determined the egg quality traits of RIR, desi, RIR x desi, desi x RIR pullets. The average values for yolk index, yolk color, Haugh unit and shell thickness (inch) in desi birds were 0.48, 11.17, 75.91 and 0.012 respectively.

Mahapatra *et al.* (1982) determined the egg quality of 240 eggs each from different desi breeds like Karaknath, Aseel Kagar and Aseel Peela. The albumen index, Haugh unit, yolk index and shell thickness of Karaknath were 0.07, 76.76, 0.43 and 0.33 mm respectively and the corresponding values for Aseel kagar desi hens were 0.09, 83.37, 0.41 and 0.34 mm respectively and for Aseel Peela hens, the values are 0.09, 84.74, 0.41 and 0.33 mm respectively.

Sunde (1992) observed the color of yolk can be altered easily through diet.

Ashraf *et al.* (2003) estimated the egg quality parameters of a locally evolved Lyallpur Silver Black breed of chicken and documented the internal egg quality traits such as Haugh Unit 102.24 ± 0.73, Yolk index 0.45 ± 0.01 and egg shell thickness 0.38 ± 0.01 mm.

Tumova *et al.* (2004) estimated the yolk weight, albumen weight and shell weight in eight Hisex brown laying hens in a study and documented the values as 16.64 g, 41.21 g and 7.22 g respectively.

Fayeye *et al.* (2005) conducted a study to evaluate Fulani-ecotype chicken for egg traits and the mean values for egg traits were 20.25 g, 4.92 mm, 75.53 respectively for albumen weight, albumen height and Haugh unit and 13.03 g,

14.27 mm, 24.68 mm respectively for yolk weight, yolk height and yolk width; 5.12 g and 0.58 mm for shell weight and shell thickness respectively.

Tantia *et al.* (2005) studied the egg quality of Ghagus breed of chicken and documented the values for albumen quality as albumen per cent, albumen height, albumen width, albumen index and Haugh Unit as 56 per cent, 4.83 ± 0.18 mm, 70.30 ± 3.5 mm, 0.07 ± 0.001 and 76.79 ± 2.93 respectively. The yolk quality parameters yolk per cent, yolk height, yolk width and yolk index as 37 per cent, 15.20 ± 0.38 mm, 39.20 ± 0.86 mm and 0.39 ± 0.001 respectively. The shell thickness and shell per cent were recorded as 0.35 ± 0.01 mm and 11 per cent respectively.

Vijh *et al.* (2005b) studied the egg quality parameters of Kalasthi breed of chicken and found the albumen weight, albumen per cent, albumen height, albumen width, albumen index and Haugh unit as 21.84 g, 51 per cent, 4.28 ± 0.29 mm, 78.29 ± 2.4 mm, 0.05 ± 0.00 and 68.81 ± 2.19 respectively. The yolk weight, yolk per cent, yolk height, yolk width and yolk index as 16.05 g, 37 per cent, 14.83 ± 0.57 mm, 42.75 ± 1.08 mm and 0.35 ± 0.02 respectively. The shell thickness, shell weight and shell per cent as 0.37 ± 0.001 mm, 5.02 ± 0.3 g and 12 per cent respectively.

Parmar *et al.* (2006) studied the egg quality characteristics of Kadaknath breed in eggs collected from two field survey centers [Jhabua-I (Meghnagar) and Jhabua-II (Jobat)] of Jhabua district (Madhya Pradesh) and found the mean values for egg quality parameters pooled for both the centres as shell thickness 0.31mm, albumen index 0.07, Haugh unit 73.77, yolk index 0.37, yolk weight 14.77g and albumen weight 20.74 g.

Santhosh *et al.* (2006) found the mean of egg quality traits such as shell thickness, albumen index, yolk index and Haugh unit of Vanaraja chicken at 40

weeks of age were 0.43 ± 0.01 mm, 0.08 ± 0.004, 0.37 ± 0.01 and 80.26 ± 1.44 respectively.

Iqbal and Pampori (2008) documented that the quality of egg and found good with Haugh unit 71, albumen index 0.07, yolk index 0.46, shell thickness 0.36 mm and shell weight 4.63g for indigenous chicken of Kashmir.

Kumar *et al.* (2008) conducted a study on shank feathered and clean shank strains of local hill fowl to evaluate the internal egg quality parameters. The albumen weight (26.87 ± 0.40 g), albumen height (6.23 ± 0.21 mm), albumen index (0.09 ± 0.004), yolk weight (16.30 ± 0.23 g), yolk height (17.06 ± 0.17 mm), yolk index (0.45 ± 0.01), shell weight (6.28 ± 0.11 g), shell thickness (0.41 ± 0.003 mm) and Haugh unit score (80.03 ± 0.92) were observed in shank feathered strain of local hill fowl. The values observed for clean shank strain of local hill fowl were albumen weight (31.95 ± 0.43 g), albumen height (5.94 ± 0.23 mm), albumen index (0.08 ± 0.003), yolk weight (18.41 ± 0.33 g), yolk height (17.50 ± 0.22 mm), yolk index (0.42 ± 0.01), shell weight (6.48 ± 0.05 g), shell thickness (0.42 ± 0.01 mm)and Haugh unit score (77.72 ± 1.13).

Mohan *et al.* (2008a) studied the production parameters and general performance characteristics of Aseel peela desi hens under the normal system of rearing and recorded the shell weight as 5.10 ± 0.24 g, shell thickness as 0.38 ± 0.06 mm and Haugh unit score as 82.17 ± 3.96.

Mohan *et al.* (2008b) reported the average shell weight as 4.95 ± 0.19 g, shell thickness as 0.36 ± 0.05 mm and the Haugh unit score as 80.82 ± 3.71 at 21 weeks in kadakanath desi hens under normal rearing system.

Niranjan *et al.* (2008) found the egg quality traits of Vanaraja and Gramapriya chicken and the values obtained for shell weight and shell thickness were 5.28 g and 0.39 respectively mm for vanaraja and 5.27 g and 0.39 mm respectively for Gramapriya. The yolk quality parameters yolk color, yolk weight,

yolk height, yolk width and yolk index were 8.01, 17.4 g, 16.9 mm, 39.4 mm and 0.44 respectively for vanaraja and the corresponding values for Gramapriya were 7.67, 17.1 g, 16.8 mm, 37.4 mm and 0.45. Haugh unit, albumen weight and albumen height were 79.4, , 30.3 g and 5.94 mm respectively for Vanaraja and the corresponding values for Gramapriya are 74.6, 28.6 g and 5.5 mm.

Girishkumar (2009) estimated the egg quality of native chicken of northern Kerala, and the mean values for albumen weight, albumen percent, albumen index and Haugh unit score were 24.35 ± 0.37 g, 58.23 ± 0.38 per cent, 0.05 ± 0.001 and 64.41 ± 0.97 respectively. The yolk weight, yolk percent and yolk index were found to be 13.21 ± 0.21 g, 31.72 ± 0.37 per cent and 0.32 ± 0.01 respectively. The shell thickness, shell weight and shell percent were 0.38 ± 0.01 mm, 4.18 ± 0.06 g and 10.01 ± 0.10 per cent respectively.

Kumar *et al.* (2009) compared the intensity of yolk color with the color numbers in the Roche yolk color fan and reported a high yolk color for eggs collected from the rural range reared bird (9.88 ± 0.24) when compared to cage reared commercial layer (6.6 ± 0.15), $p \leq 0.05$.

Singh *et al.* (2009) evaluated the egg quality traits of local hill fowl in district Pithoragarh and found that the albumen weight, albumen height, albumen width, albumen index and Haugh unit score were 28.15 ± 0.71 g, 5.34 ± 0.12 mm, 71.15 ± 0.24 mm, 0.087 ± 0.03 and 73.52 ± 1.73 respectively in local hill fowl. The yolk weight, yolk height, yolk width and yolk index were 17.61 ± 0.35 g, 15.98 ± 0.22 mm, 41.69 ± 0.53 mm and 0.39 ± 0.08 respectively. The shell weight and shell thickness were 6.33 ± 0.15 g and 0.43 ± 0.002 mm.

Yadav *et al.*, (2009) conducted a study on eggs of chicken maintained under backyard system in Bareilly district to evaluate the internal egg quality parameters and documented the shell weight 6.57 ± 0.15 g, yolk weight 16.88 ± 0.30 g, albumen weight 29.19 ± 0.46 g, shell thickness 0.42 ± 0.01 mm, yolk index 0.40

± 0.01, albumen index 0.09 ± 0.01 and Haugh unit 75.48 ± 0.94. It was further observed that shell, yolk and albumen weight was 12.40, 31.89 and 55.08 per cent of the total egg weight, respectively.

Haunshi *et al.* (2011) conducted a study to characterize 2 important native chicken breeds from India and compare them on production and egg quality. They found a higher albumen *(P* < 0.001) and shell *(P* < 0.009) percentages in the Kadaknath were observed, whereas the Aseel breed had a higher yolk index *(P* < 0.004), higher yolk percentage *(P* < 0.001), and higher yolk-to-albumen ratio *(P* < 0.001).

2.1.4. Internal Egg Quality of White Leghorn

A study was undertaken by Salahuddin and Howlider (1991) to evaluate the differences of external and internal quality characters of eggs of White Leghorn, RIR, native Naked Neck, Starcross and Fayomi layers in winter, rainy and summer seasons of Bangladesh. The Breed x Season interactions were significant for egg weight and shell thickness, but not for other traits.

Padhi *et al.* (1998) in a study, determined the egg quality of White Leghorn and the values obtained for egg weight as 62.86 ± 1.80 g, shape index as 73.56 ± 1.22, albumen index as 0.11 ± 0.01, yolk index as 0.43 ± 0.01, shell thickness as 0.31 ± 0.01 mm, Haugh unit as 84.52 ± 3.65, yolk per cent as 26.86 ± 0.69 per cent, albumen per cent as 63.1 ± 2.94 per cent and shell per cent as 10.00 ± 0.44 per cent respectively.

Verma *et al.*(1998) in a study documented the egg quality parameters of single comb White Leghorn layers as shape index 73 ± 0.29, albumen index 0.07 ±

0.002, yolk index 0.38 ± 0.02, Haugh unit 73.5 ± 0.78, yolk color index 8.63 ± 0.06 and egg shell thickness 0.32 ± 0.06 mm.

Shrestha *et al.* (2004) conducted a study in White Leghorn to assess the effect of different space density groups and the overall mean values obtained for various egg quality traits were 0.13 ± 0.01 for albumen index, 0.46 ± 0.01 for yolk index, 0.43 ± 0.01 mm for shell thickness, 6.4 ± 0.08 g for shell weight, 15.1 ± 0.22 g for yolk weight and 29.0 ± 0.44 g for albumen weight.

Santhosh *et al.* (2006) found the means of internal egg quality traits such as shell thickness, albumen index, yolk index and Haugh unit of White leghorn chicken were 0.34 ± 0.02 mm, 0.08 ± 0.003, 0.37 ± 0.01 and 81.85 ± 1.42 respectively.

Aydin *et al.* (2008), determined the egg quality parameters in 27 week old laying hens (Hyline-5 White) and documented the yolk weight as 12.49 ± 0.33 g per egg, albumen weight as 33.32 ± 0.33 g per egg, shell weight as 7.12 ± 0.15 g per egg, yolk per cent as 23.6 ± 0.56 per cent, albumen per cent as 62.95 ± 0.59 per cent, shell per cent as 13.45 ± 0.24 per cent and shell thickness as 0.34 ± 0.01 mm respectively.

Giriraj *et al.* (2008b) conducted an experiment to evaluate the egg quality traits at 28, 32, 36 and 40 weeks of age in the reciprocal crosses of White Leghorn strains N and P, reared under deep litter system. There were no significant differences observed for the shape index, yolk index, albumen index, Haugh unit score and shell thickness between the genetic groups at 28, 32, 36 and 40 weeks of age.

At A.I.C.R.P. on Poultry Research Station, Mannuthy, the egg quality traits of IWN and IWP strains of White Leghorn were documented. The mean values for IWN was found to be albumen height as 7.90 ± 0.13 mm, albumen index as 0.11 ±

0.002, yolk height as 16.90 ± 0.10 mm, yolk index as 0.40 ± 0.003, shell thickness as 0.33 ± 0.003 mm and Haugh unit score 88.8 ± 0.77. The egg quality values for IWP were 6.30 ± 0.18 mm for albumen height , 0.08 ± 0.003 for albumen index, 15.71 ± 0.37 mm for yolk height, 0.37 ± 0.01 for yolk index, 0.33 ± 0.01 mm for shell thickness and 81.27 ± 0.84 for Haugh unit score respectively (Anon, 2010).

2.1.5. Fatty acids in Egg Yolk

The high value for omega 3 fatty acids found with the range-fed hens was presumed to arise because the hens were consuming green leafy vegetables, fresh and dried fruits, insects, and worms (Simopoulos and Salem, 1992).

Ahn *et al.* (1999) determined the fatty acid profile in egg yolk of eight, 79-wk-old White Leghorn hens. The per cent of fatty acids were found to be as follows. Myristic acid (0.16 per cent), Palmitic acid (22.82 per cent), Palmitoleic acid (1.86 per cent), Stearic acid (11.06 per cent), Oleic acid (32.36 per cent), Linoleic acid (24.68 per cent), Linolenic acid (1.45 per cent), Arachidonic acid (3.64 per cent), Docosahexaenoic acid (1.96 per cent).

Ayerza and Coates (2000) in their study estimated the fatty acid composition of egg yolk in H&N laying hens, white and brown. The values obtained for white laying hens for Myristic acid, Palmitic acid, Palmitoleic acid, Stearic acid, Oleic acid, Linoleic acid, Linolenic acid, Arachidonic acid and docosahexaenoic acid were 0.33 per cent, 27.13 per cent, 3.86 per cent, 8.87 per cent, 39.28 per cent, 12.93 per cent, 0.21 per cent, 3.39 per cent and 1.00 per cent respectively and the corresponding values for brown laying hens were 0.36 per cent, 26.63 per cent, 4.22 per cent, 7.86 per cent, 42.07 per cent, 12.65 per cent, 0.20 per cent, 2.79 per cent and 0.73per cent .

Kazmierska *et al.* (2005) determined the fatty acid content in egg yolks of different species by gas chromatography GC/MS (Agilent Technologies) and

estimated the values of Hexadecanoic acid (22.97 per cent), Palmitoleic acid (2.59 per cent), Stearic acid (8.54 per cent), Oleic acid (41.36 per cent), Linoleic acid (10.72 per cent), α-linoleic acid (0.30 per cent), Arachidonic acid (1.54 per cent) and Docosahexaenoic acid (0.56 per cent).

Suksombat *et al.* (2006) estimated the fatty acid composition in six, 27 week old layers and the per cent of fatty acids estimated as follows. Myristic acid (0.26 per cent), Palmitic acid (22.72 per cent), Palmitoleic acid (1.39 per cent), Stearic acid (8.83 per cent), Oleic acid (34.71 per cent), Linoleic acid (26.31 per cent), Linolenic acid (1.29 per cent), Eicosatrienoic acid (0.19 per cent), Arachidonic acid (2.04 per cent), Docosahexaenoic acid (1.98 per cent), Saturated Fatty acids (31.81 per cent), MUFA (36.10 per cent) and PUFA (31.82 per cent).

Yin *et al.* (2008) estimated the fatty acid profile of White Leghorn layers in a study and recorded the per cent of different fatty acids as follows. Myristic acid (0.53 per cent), Myristoleic acid (0.12 per cent), Palmitic acid (29.40 per cent), Palmitoleic acid (0.55 per cent), Stearic acid (13.86 per cent), Oleic acid (20.47 per cent), Linoleic acid (21.13 per cent), Linolenic acid (1.22 per cent), Arachidonic acid (1.18 per cent), Docosahexaenoic acid (0.10 per cent), Saturated fatty acids (36.84 per cent), Monounsaturated fatty acids (31.21 per cent) and Polyunsaturated fatty acids (31.30 per cent).

Oliveira *et al.* (2010) investigated the effects of different dietary lipids on the fatty acid profiles of eggs produced by 20 and 54 weeks old Dekalb laying hens and concluded that the quantity of fatty acids present in the egg yolk may be altered according to the source of lipids in the diets.

2.1.6. Yolk cholesterol

Ingr *et al*. (1987) estimated the yolk cholesterol content in eggs of White Hisex laying hybrid from three specialized commercial farms averaged 1230, 1330

and 1230 mg per 100 g of yolk over an 11 months laying period and reported the average cholesterol content of Babcock B-380, Moravia SSL, Shaver Starcross 288, and Hisex HX-1, varied from 1200 to 1360 mg per 100 g of yolk. Throughout the egg-laying period, the yolk cholesterol content fluctuated rather irregularly and showed great variability with the variation coefficient of 9.7 to 18.2 per cent.

Jiang *et al*. (1991) observed 14.6 mg/g yolk in White Leghorn hens in a study.

Campo (1995) reported the egg yolk cholesterol content in White Leghorn was 16.30 ± 0.26 mg per g and the eggs from the Vasca (Spanish breed) contained 19.09 ± 0.26 mg per g yolk.

Verma *et al*. (1998) in a study documented the egg yolk cholesterol of single comb White Leghorn layers as 14.4 ± 0.48 mg per g of yolk.

Ayerza and Coates (2000) in their study estimated the yolk cholesterol in H&N white and brown laying hens and found to be 1.4 per cent of total yolk.

Jayasree (2000) reported the yolk cholesterol in Naked Neck breed of chicken as 14.46 mg per g of yolk at 40 weeks of age.

Chowdhury *et al*. (2002) conducted an experiment to evaluate the potential for dietary garlic to influence egg yolk cholesterol concentrations and documented the yolk cholesterol concentration in laying hens fed with control feed as 13.7 mg per gram of yolk.

Tumova *et al.* (2004) estimated the yolk cholesterol in Hisex brown laying hens in a study as 13.64 mg/g of yolk.

Kazmierska *et al.* (2005) determined the cholesterol content in egg yolks of different bird species using standard method with a gas chromatograph and found the yolk cholesterol content of chicken as 13.91 mg/g yolk

Aydin *et al.* (2008) determined the egg yolk cholesterol in 27 week old laying hens (Hyline-5 White) and recorded as 14.65 ± 0.26 mg/g of yolk.

Mohan *et al.* (2008a) reported the yolk cholesterol in Aseel peela desi hens reared under normal system as 210.11 ± 8.10 mg/egg

Yin *et al.* (2008) estimated the yolk cholesterol of White Leghorn layers in a study to be 13.3 mg per g of egg yolk.

Girishkumar (2009) estimated the yolk cholesterol content in egg yolk of native chicken of Northern Kerala, and found to range from 12.08 to 16.51 with an overall mean of 14.67 ± 0.25 mg per g.

2.1.7. Mineral composition in egg

Manson *et al.* (1993) determined the mineral composition of the albumen and yolk of White-Leghorn strain using X-ray fluorescent spectrometry and found that there was considerable variation between individuals in the mineral concentration in their eggs. Coefficients of variation ranged between 3.8per cent for sodium to 19.9per cent for calcium in the albumen, and between 4.3 per cent for phosphorus to 11.8 per cent for iron in the yolk.

Inal *et al.* (2001) in a study found that the Zinc level in egg yolk of Hisex Brown laying hens which were fed with a standard layer diet was higher (23.5mg/Kg) than those of the birds which were fed with a commercial layer diet that was not supplemented with trace minerals and vitamins.

Kilic *et al.* (2002) determined the lead, copper, zinc, calcium, magnesium and iron in fresh egg samples by Electrothermal and Flame Atomic Absorption Spectrometry (ETAAS–FAAS) with Zeeman-effect background correction.

Giannenas *et al.* (2009) determined the trace mineral composition in eggs from chicken fed with courtyard and conventional diet using Inductively Coupled Plasma Mass Spectrometry and obtained a significantly higher value for Zinc (ng/g) in egg yolk of courtyard eggs (21196 ± 908) when compared with conventional eggs (20676 ± 923). A significantly lower value obtained for Manganese (ng/g) in egg yolk of courtyard eggs (705 ± 41) when compared with conventional eggs (836 ± 79). No significant difference obtained between Copper content (ng/g) in egg yolk of courtyard (1282 ± 108) and conventional eggs (1357 ± 111).Significant difference noticed between Zinc content (ng/g) in egg albumen of courtyard(1385 ± 141) and conventional eggs (1003 ± 54). The Manganese content (ng/g) in egg albumen of courtyard eggs was found to be 35 ± 3.5 and for conventional eggs 33 ± 4.1. The Copper content (ng/g) in egg albumen of courtyard eggs and conventional eggs were 254±34 and 212±24 ng/g respectively.

2.2. PRODUCTION PARAMETERS IN NATIVE CHICKEN AND WHITE LEGHORN

2.2.1. Age at First Egg in Native chicken

The age at first egg for improved strains of desi chicken recorded at Indian Veterinary Research institute, Izatnagar was 214 days (Anon, 1967).

Acharya and Kumar (1971) compared the age at first egg of RIR, desi, desi x RIR and RIR x desi pullets. They reported the values as 201.8 ± 7.9, 204.3 ± 4.4, 216 ± 1.9 and 217.6 ± 1.9 for RIR x desi, desi x desi, desi x RIR and RIR x RIR respectively

Thomas and Rao (1988) recorded the age of sexual maturity of Kadaknath breed of indigenous chicken as 189.20 days; the egg production up to 300 days of age as 49.79 eggs and the average egg weight as 43.05 g.

Dutta (1996) indicated that the age of sexual maturity in Miri, an indigenous breed of chicken reared by the Miri tribes of Assam as 164 ± 1.62 days in free range.

Singh *et al.* (2000) reported the age at which Aseel birds start laying ranges from 28.41 to 31.19 weeks with an overall of 28.94 weeks.

Mandal *et al*. (2006) reported the average age at first egg of colored non-descript birds reared by rural poultry farmers in Bareilly district of Uttar Pradesh was 7.6 months and the weight of eggs ranged from 35 to 40 g.

Mohan *et* al. (2008b) reported the average age of first egg in Kadaknath desi hens under normal rearing system as 162 days.

Singh and Kumar (2008) reported the age at sexual maturity of Native fowl of Garhwal Himalayas as 176.20 ± 2.76 days.

Kalita *et al*. (2009) conducted a study to estimate the different production and reproduction performance of indigenous chicken in certain districts of Assam under rural condition and found the sexual maturity of indigenous chicken to vary from 160.63 ± 4.61 to 177.27 ± 4.88 days.

Girishkumar (2009) reported the mean age at first egg of Native chicken of Northern Kerala as 177.60 ± 4.81days.

Ajithbabu (2010) reported the average age at first egg in Gramalekshmi and Gramasree hens under backyard system of rearing as 177.1 and 179.7 days respectively.

2.2.2. Age at first egg in White Leghorn

Laxmi *et al.* (2010) reported the Age at first egg in IWH strain of White Leghorn was 141.71 ± 0.41 days.

At A.I.C.R.P. on Poultry Research Station, Mannuthy, the Age at First egg of IWN and IWP strains of White Leghorn was reported to be 136.55 and 131.98 days respectively (Anon, 2010).

2.2.3. Egg production in Native chicken

At I.V.R.I., Izatnagar, the egg production of desi was recorded as 38 eggs in first 100 days for improved strains of desi (Anon, 1967).

Acharya and Kumar (1971) compared the hen housed egg production and hen day egg production of desi and RIR and found significant differences between the breeds.

Aggarwal *et* al. (1971) reported the hen day egg production (per cent) in desi, Naked Neck, Black Bengal and Aseel birds as 32.6 per cent, 17.9 per cent, 34.3 per cent and 14.6 per cent respectively.

The local deshi chicken are genetically poor producers having a range of live weight of 1 to 1.2 kg and laying from 42 to 45 small sized eggs (35-40 g) annually under existing scavenging management (Huque and Haque,1990).

Dutta (1996) reported the hen day egg production (per cent) of indigenous miri birds in free range as 46.02 ± 0.7.

In a study by Mandal *et* al. (2006) among rural poultry farmers of Bareilly district of Uttar Pradesh, all the poultry farmers reported that the average egg production per hen per year was 50 eggs.

Kumar and Kumar (2007) reported the annual egg production of local Hill fowl of Uttarakhand as 90 to 150 eggs.

Das *et* al. (2008) reported the annual egg production of Desi chicken of Bangladesh as 35 to 40.

Singh and Kumar (2008) reported the annual egg production in native fowl pullets of Garhwal Himalayas as 168.20 ± 6.27eggs.

Doley *et al.* (2009) conducted an experiment to study the productive and reproductive traits in indigenous chickens of North-Eastern region of India under intensive, semi-intensive and extensive rearing systems to compare the economy of production. Significant ($P \leq 0.05$) differences in age at sexual maturity (ASM) and hen housed egg production (HHEP) were observed under different rearing systems. Rearing of indigenous chicken was found to be economical under extensive system.

Kalita *et al.* (2009) conducted a study to estimate the different production and reproduction performance of Indigenous chicken in certain districts of Assam under rural condition and found the egg production per laying cycle and annual egg production ranges from 11.18 ± 0.48 to 15.49 ± 0.45 and 59.90 ± 1.86 to 70.09 ± 2.25 numbers, respectively. The egg weight ranges from 36.68 ± 1.23 to 40.00 ± 1.20 g.

Girishkumar (2009) reported the mean egg number up to 40 weeks of age on hen day and hen housed basis in native chicken of northern Kerala was 34.59 and 33.06 and egg production per cent in terms of hen day and hen housed up to 40 weeks were 24.71 and 23.61.

Ajithbabu (2010) reported the Hen day and hen housed egg production of Gramalekshmi hens as 42.28 and 38.63 respectively and that of Gramasree hens as 40.82 and 38.60 respectively. The hen day and hen housed egg production per cent for Gramalekshmi hens were 35.53 and 32.46 respectively and that of Gramasree hens were 34.3 and 32.44 respectively.

2.2.4. Egg Production in White Leghorn

Chowdhury *et al*. (1983) reported the average egg production of White Leghorn chicken as 13.3 eggs per month per hen.

Dutta (1996) reported the hen day egg production (per cent) of White Leghorn chicken in cage system as 59.66 ± 1.9.

An experiment was conducted by Giriraj *et al*. (2008a) to evaluate the production traits in reciprocal crosses of two White Leghorn strains under deep litter system and the data revealed that the age at first egg and 50 per cent egg production were early in N × P strain cross. The overall mean hen housed per cent (HHP) from 21 to 40 weeks of age were 86.66 ± 3.l9 and 85.06 ± 3.04 per cent in N × P and P × N strain crosses, respectively. The hen housed number (HHN) for N × P strain cross was 121.32 and it was 118.82 in P × N strain cross. The differences for HHP and HHN were not significant between the genetic crosses.

At A.I.C.R.P. on Poultry Research Station, Mannuthy, the Hen Day egg production of IWN and IWP strain of White Leghorn was reported as 128.01 and 125.10 respectively and the Hen Housed egg production as 127.2 and 124.47 respectively. The survivors production for N and P strains was reported as 128.44 and 125.95 respectively (Anon, 2010).

2.2.5. Livability and Mortality

Talha *et al*. (2001) reported that the disease is considered to be the prime cause of mortality in commercial chickens in Bangladesh.

Mcainsh *et al*. (2004) reported that diseases and predation were the major causes of death among local chickens of Zimbabwe. The main predators were birds of prey, wild cats and domestic dogs, but also snakes and rats were reported to eat chickens.

Ajithbabu (2010) reported that the death due to predation was higher than other causes in Gramasree and Gramalakshmi chicken layers under backyard system.

The mortality rate reported at A.I.C.R.P. Poultry Research Station, Mannuthy was 3.72 per cent for IWN strain and 4.01 per cent for IWP strain during the laying period (16 to 40weeks). During laying stage, the mortality was mainly due to pasteurellosis, colibacillosis, Bangkok Haemorrhagic disease (BHD), peritonitis, and uterine prolapsed (Anon, 2010)

2.3. FEED INTAKE IN NATIVE CHICKEN AND WHITE LEGHORN

2.3.1. Feeding management and scavenging pattern in Native chicken

Mandal *et al.* (2006) reported that during scavenging, the birds generally fed on kitchen waste, earthworms, grasshoppers, ants, green grasses, leafy vegetables, seeds etc. In addition to scavenging, all the poultry owners offered a handful of broken wheat rice, bajra, maize etc. to their birds.

Vijh *et al.* (2005a) reported that no specific feed was supplied to the Miri birds and the birds scavenge in the surroundings.

Vijh *et al.* (2005b) found that scavenging with supplementation of kitchen waste was the most common feeding system practiced in case of Kalasthi birds; in addition grains like paddy and bajra were also fed.

Kumar and Kumar (2007) documented that some farmers of Local Hill Fowls of Uttarakhand followed supplementary feeding in addition to grazing by providing about 25 to 30 g of feedstuffs like *kadan, manduwa, jhangora*, wheat, rice and maize per day.

Vij *et al.* (2007), observed that Tellichery chicken in Kerala roams and eats whatever available in the form of grains, seeds, vegetation, insects, etc. however, no commercial poultry feed is being fed.

Most rural families of Bangladesh provide a small amount of feed twice a day; once in the morning when the birds leave their night shelter and again in the evening when they return home. The scavengeable feedstuffs consumed by native chicken of Bangladesh varied from 9 to 27 g per bird per day (Das *et al.*, 2008).

2.3.2. Feed intake in White Leghorn

Verma *et al.* (1998) in a study documented the average feed intake of single comb White Leghorn layers per bird per day as 104 ± 0.89g.

In a field level testing of performance of White Leghorn ILM90 birds in a poultry farm, Namakkal, the average feed intake was found to be 110-112 g per bird per day (Anon, 2010).

Ahmad *et al*. (2010) studied the performance of White Leghorn birds under different light sources and found the mean FCR values per dozen of eggs in groups A (fluorescent), B (compact fluorescent), and C (incandescent) were 1.22 ± 0.009, 1.21 ± 0.008 and 1.19 ± 0.009, respectively.

Zahoor-ul-Hassan *et al*. (2010) conducted a study in 40 week old White Leghorn breeder hens by feeding Ochratoxin A in different levels of inclusion for three weeks. The FCR obtained in control group (feed free of Ochratoxin A) were 2.40, 2.01 and 2.00 at 1st, 2nd and 3rd weeks of age respectively.

3. MATERIALS AND METHODS

A comparative study on egg quality traits of Native chicken from households in Ollukkara division of Thrissur Corporation and White Leghorn layers of AICRP on Poultry Research station, at Department of Poultry Science, College of Veterinary and Animal Sciences, Mannuthy was carried out. The Native chicken was reared under backyard system of rearing and the White Leghorn layers under intensive system of rearing. The eggs for the analysis were collected during 21 to 40 weeks of age, which is divided into five periods having four weeks each and twenty eggs were collected during each period. A survey study was conducted in households, in which, the production performance of birds was recorded. The questionnaire for this purpose prepared based on 'Descriptor list for poultry' given in FAO Animal Production and Health Paper (FAO, 1983) with modifications is given at the end of this chapter. The production characters of total 60 White Leghorn hens were studied.

3.1. EGG QUALITY PARAMETERS

One hundred eggs each were collected from 21 to 40 weeks of age from both the Native Chicken reared under backyard and White Leghorn layers reared under intensive system of rearing and subjected for egg quality studies.

3.1.1. External Egg Quality Parameters

Egg weight was recorded using an electronic weighing balance of sensitivity 0.0001g.

Egg length and breadth were measured using Vernier calipers for calculating Shape Index. The egg shape index was calculated by dividing egg breadth by egg length and expressed in percentage.

3.1.2. Internal Egg Quality Parameters

The eggs were broken out onto a leveled glass plate for albumen height, albumen width, yolk height, yolk width, albumen index and yolk index.

The albumen and yolk width was calculated using a vernier caliper. The albumen width was determined by averaging the minimum and maximum of the broken-out egg with Vernier calipers.

The albumen and yolk height were measured using Ames tripod Haugh unit micrometer (B.C. Ames Co.,Waltham, MA). Measurements of the albumen height were done on the thick albumen, not touching the yolk and avoiding the chalazae. The micrometer placement was approximately 6 mm from the yolk and the edge of the thick albumen. The measurements were taken with yolk in the natural position when the egg was broken out.

Albumen index was calculated by dividing the albumen height by albumen width (Heiman and Carver, 1936). Yolk index was calculated by dividing the height of the yolk by its width (Funk, 1948).

Haugh Unit Score (HU) was computed as per the formula, $HU = 100 \log (H+7.57-1.7W^{0.37})$, where H is the albumen height in millimeters and W, the weight of the egg in grams (Haugh, 1937).

The color index for yolk color was noted using the yolk color fan having index values from one to fifteen.

The shell weight was taken individually after drying the empty shells in hot air oven at 130^0C for five hours. The shell thickness was the average of shell thickness measured at broad and narrow ends and middle piece using a screw gauge.

Yolk weight was taken after removing the adhered albumen from the yolk. Albumen weight was calculated after subtracting the yolk weight and shell weight from the whole egg weight. Shell, albumen and yolk weight percentages were also calculated.

3.1.3. Estimation of Fatty Acids in Egg Yolk

The different fatty acids present in egg yolk which include the saturated fatty acids and the unsaturated fatty acids were estimated from six eggs each of Native chicken and White Leghorn layers at 40 weeks, using Gas Chromatography method (Wang *et al.*, 2000). The unsaturated fatty acids include monounsaturated as well as the polyunsaturated fatty acids (Omega-3, Omega-6, Omega-7, and Omega-9 fatty acids).

3.1.4. Estimation of Yolk Cholesterol

The cholesterol content of egg yolk of six eggs each, from both Native chicken and White Leghorn layers at 40 weeks of age were estimated by Wybenga and Pileggi method (Wybenga *et al*., 1970).

3.1.5. Estimation of Minerals in Egg

The minerals present in egg albumen and yolk of six eggs each of Native chicken and White Leghorn layers were estimated using AAS (Atomic Absorbtion Spectrophotometry) after doing the wet digestion of the egg sample.

3.2. EGG PRODUCTION PARAMETERS

3.2.1. Egg Production

Twenty households each rearing a minimum of three non-descript native chicken nearing maturity with their hatch dates known, reared under backyard system were identified from the area of survey. Those farmers willing to cooperate in daily egg production data collection were given egg production performance sheets to mark the daily egg production of these identified hens. The egg recording was continued from these birds till they reach 40 weeks of age. At the completion of the egg recording, the egg production from 21 to 40 weeks of age was divided into five periods of four weeks each. The egg production of White Leghorn layers were also recorded for every four weeks period from 21 to 40 weeks of age. The number of birds at the start of 21st week of age was considered as housed birds to calculate the hen-housed egg production. The mean egg production for every period was calculated on both hen-day and hen-housed basis. The mean egg production in terms hen-housed and hen-day basis was calculated for egg number up to 40 weeks. The survivor egg number was also calculated at the end 40 weeks of age. From the egg production data, age at first egg was estimated.

3.2.2. Livability pattern

During the course of the study, the mortality, if any and their causes were documented. The livability per cent was calculated for the period from 21 to 40 weeks of age.

3.3. FEEDING MANAGEMENT

3.3.1. Feeding Management in Native Chicken

The details collected on feeding management included the supplemental feeding, time of feeding and type and quantity (per bird) of feed being used.

3.3.2. Feeding Management in White Leghorn

The formulation of compounded feed is done as per the specifications of BIS (1992). The composition of layer ration is presented in Table 1.The feed intake of White Leghorn was estimated and the Feed Conversion Ratio was calculated on dozen eggs basis.

3.4. STATISTICAL ANALYSIS

Data collected on various parameters were statistically analyzed as per the methods described by Snedecor and Cochran (1994).

Table 1. Feed Formulation for White Leghorn (Based on BIS Specification, 1992).

Ingredients of Layer mash	**Quantity per 100 Kg Feed (Kg)**
Yellow maize	35
Rice polish	16
Wheat bran	12
Gingelly oil cake	8
Soyabean meal	10
Dried fish	10
Mineral mixture	2
Salt	0.25
Shell grit	6
Dicalcium phosphate	0.75
Total	**100**
Feed Additives	**Quantity per 100 Kg Feed (g)**
Vitamin AB_2D_3K	12.5
Vitamin B-Complex	12.5
Trace mineral mixture	50
Liver tonic powder	25
Choline chloride (60%)	100
Toxin binder	100

Questionnaire - A

A. Name and Address of Farmer:

B. Type of Rearing :

C. Number of female birds:

D. Feeding Management

1. In free ranging : No supplemental feeding/ with supplemental feeding
2. Time of feeding :
3. Feed given

	Name	Quantity/day/bird
Concentrate		
Kitchen waste		
Grains		
Others		

Egg Production Performance Sheet

Sl.No.	Date of hatch	1	2	3	4	5	6	7	8	9																
1																										
2																										
3																										

4. RESULTS

4.1. EGG QUALITY PARAMETERS

The egg quality parameters of Native chicken and White Leghorn layers were determined from 21-40 weeks of age. Twenty eggs collected at every four weeks interval, during the period were utilized to assess the different traits.

4.1.1. External Quality of Egg

Egg weight

The mean egg weight of Native chicken was 33.35±0.50, 37.64±0.16, 39.68±0.10, 41.42 ± 0.14 and 44.40 ±0.35 g at 21, 25, 29, 33 and 37 weeks of age respectively. At the corresponding ages, the egg weight in White Leghorn was 43.26±0.76, 47.11±0.77, 49.88±0.47, 51.24±0.72 and 56.20±0.54 g. The overall mean egg weight of Native chicken was 39.35±0.39 g and that of White Leghorn was 49.54±0.52 g. At all the ages studied, the egg weight (Table 2) was significantly lower in Native chicken when compared to that of White Leghorn ($P \leq 0.05$).

The individual egg weight ranged from 27.91 to 47.28g in Native chicken and 38.63 to 59.89 g in White Leghorn. The frequency distribution of egg weight presented in the Table 3 revealed that in Native chicken, the distribution of egg weight was 2, 12, 41, 38 and 7 per cent in the weight classes of 27-30, 30-35, 35-40, 40-45 and 45-50 g respectively. Whereas, in the case of White Leghorn, eggs in the weight classes of 35-40, 40-45, 45-50, 50-55 and 55-60 g were 2, 16, 35, 30 and 17 per cent respectively.

Table 2. Period wise External Quality Parameters of Native Chicken (NC) and White Leghorn (WL).

Period (weeks)		Egg Weight (g)	Egg Breadth (mm)	Egg Length (mm)	Shape Index
21	NC	33.35 [b] ±0.50	35.71 [b] ±0.33	47.81 [b] ±0.40	74.75 ±0.69
	WL	43.26 [a] ±0.76	38.49 [a] ±0.76	52.25 [a] ±0.45	73.72 ±1.45
25	NC	37.64 [b] ±0.16	37.51 [b] ±0.68	49.38 [b] ±0.59	76.23 ±1.76
	WL	47.11 [a] ±0.77	40.37 [a] ±0.51	53.64 [a] ±0.46	75.39 ±1.21
29	NC	39.68 [b] ±0.10	37.56 [b] ±0.21	50.50 [b] ±0.33	74.46 ±0.75
	WL	49.88 [a] ±0.47	41.63 [a] ±0.72	54.21 [a] ±0.35	76.89 ±1.52
33	NC	41.42 [b] ±0.14	38.15 [b] ±0.11	51.06 [b] ±0.21	74.75 ±0.44
	WL	51.24 [a] ±0.72	41.07 [a] ±0.21	54.04 [a] ±0.43	76.07 ±0.56

37	NC	44.40 [b] ±0.35	38.78 [b] ±0.17	52.93 [b] ±0.43	73.38 ±0.78
	WL	56.20 [a] ±0.54	42.14 [a] ±0.17	55.98 [a] ±0.37	75.34 ±0.58
Overall mean	NC	39.35 [b] ±0.39	37.55 [b] ±0.19	50.36 [b] ±0.25	74.7 ±0.44
	WL	49.54 [a] ±0.52	40.74 [a] ±0.27	54.02 [a] ±0.22	75.48 ±0.51
Range of values	NC	27.91-47.28	32.64-49.84	41.81-56.41	63.04-99.90
	WL	38.63-59.89	32.12-55.02	49.22-60.38	62.47-94.26

[a,b] means having different superscript within a column differed significantly within a period ($P \leq 0.05$)

Table 3. The Frequency Distribution of Eggs Based on Individual Egg Weight (100 Eggs)

	Number of Eggs	
Egg Weight(g)	Native Chicken	White Leghorn
<30	2	0
30-35	12	0
35-40	41	2
40-45	38	16
45-50	7	35
50-55	0	30
55-60	0	17
	100	100

Egg Breadth

The mean egg breadth of Native chicken was 35.71±0.33, 37.51±0.68, 37.56±0.21, 38.15±0.11 and 38.78±0.17 mm at 21, 25, 29, 33 and 37 weeks of age respectively. At the corresponding ages, the egg breadth in White Leghorn was 38.49±0.76, 40.37±0.51, 41.63±0.72, 41.07±0.21 and 42.14±0.17 mm (Table 2). The mean values for egg breadth was found to be significantly lower in Native chicken in all the ages ($P \leq 0.05$).

The individual egg breadth in Native chicken ranged from 32.64 to 49.84 mm and in White Leghorn ranged from 32.12 to 55.02 mm. The overall mean egg breadth was found to be significantly lower ($P \leq 0.05$) in Native chicken (37.55±0.19 mm) when compared with that of White Leghorn (40.74±0.27 mm).

Egg Length

The mean egg length noticed in Native chicken during 21, 25, 29, 33 and 37 weeks of age were 47.81±0.40, 49.38±0.59, 50.50±0.33, 51.06±0.21 and 52.93±0.43 mm respectively and the corresponding values for White Leghorn were 52.25±0.45, 53.64±0.46, 54.21±0.35, 54.04±0.43 and 55.98 ±0.37mm (Table 2). It was found that in all the ages the egg lengths were significantly lower in Native chicken when compared to that of White Leghorn ($P \leq 0.05$).

The individual egg length in Native chicken ranged from 41.81 to 56.41 mm and in White Leghorn ranged from 49.22 to 60.38 mm. The overall mean value for egg length in Native chicken was 50.36±0.25 mm and that of White Leghorn was 54.02±0.22 mm. The egg length was significantly lower in Native chicken when compared to White Leghorn ($P \leq 0.05$).

Shape Index

The mean values for shape index calculated for 21, 25, 29, 33 and 37 weeks of age in Native chicken were 74.75±0.69, 76.23±1.76, 74.46±0.75, 74.75±0.44 and 73.38±0.78 respectively and the values were 73.72±1.45, 75.39±1.21, 76.89±1.52, 76.07±0.56 and 75.34±0.58 respectively for White Leghorn (Table 2).

The individual values for shape index ranged from 63.04 to 99.90 for Native chicken and 62.47 to 94.26 in White Leghorn. The overall mean value for Native chicken and White Leghorn was found to be 74.7±0.44 and 75.48±0.51 respectively. No significant difference noticed between the breeds in any of the periods.

4.1.2. Internal Egg Quality Parameters

4.1.2.1. Albumen Quality

Albumen Height

The mean albumen height at 21, 25, 29, 33 and 37 weeks of age in Native chicken were 4.82±0.25, 4.08±0.15, 4.26±0.20, 4.11±0.23 and 4.35±0.19 mm respectively and the values were 7.82±0.27, 7.69±0.19, 6.14±0.23, 6.19±0.26 and 4.21±0.22 mm respectively in White Leghorn (Table 4). The albumen height was significantly lower in Native chicken at 21, 25, 29 and 33 weeks of age ($P \leq 0.05$); but no significant difference was observed at 37 weeks of age.

The individual values for albumen height in Native chicken ranged from 2.1 to 6.8 mm and in White Leghorn ranged from 2.7 to 10.8 mm. The overall mean value of Albumen height of Native chicken and White Leghorn were 4.32±0.09 and 6.41±0.17 mm respectively. The difference was statistically significant ($P \leq 0.05$).

Table 4. Period wise Albumen Quality Parameters of Native Chicken (NC) and White Leghorn (WL)

Period/weeks		Albumen Height (mm)	Albumen Width (mm)	Albumen Index	Albumen Weight (g)	Albumen Per Cent	Haugh Unit Score
21	NC	4.82 [b] ±0.25	80.05[a] ±2.80	0.06 [b] ±0.004	18.18 [b] ±0.39	54.63 [b] ±1.12	78.21 [b] ±1.91
	WL	7.82 [a] ±0.27	63.61[b] ±0.86	0.12 [a] ±0.01	28.77 [a] ±0.60	66.47 [a] ±0.47	92.72 [a] ±1.37
25	NC	4.08 [b] ±0.15	83.39[a] ±1.76	0.05 [b] ±0.01	20.74 [b] ±0.42	55.07 [b] ±1.02	70.75 [b] ±1.30
	WL	7.69 [a] ±0.19	71.35[b] ±0.68	0.11 [a] ±0.003	30.80 [a] ±0.62	65.33 [a] ±0.40	91.13 [a] ±0.94
29	NC	4.26 [b] ±0.20	82.94[a] ±1.82	0.05 [b] ±0.003	22.28 [b] ±0.38	56.15 [b] ±0.92	70.88 [b] ±1.77
	WL	6.14 [a] ±0.23	75.08[b] ±1.16	0.08[a] ±0.004	31.23 [a] ±0.40	62.59 [a] ±0.28	80.75 [a] ±1.46
33	NC	4.11 [b] ±0.23	85.06 ±1.99	0.05 [b] ±0.003	22.84 [b] ±0.43	55.12 [b] ±0.96	68.38 [b] ±2.14
	WL	6.19 [a] ±0.26	80.12 ±1.42	0.08 [a] ±0.02	31.89 [a] ±0.49	62.24 [a] ±0.37	80.47 [a] ±1.62
37	NC	4.35 ±0.19	87.02[b] ±1.55	0.05 ±0.003	25.41 [b] ±0.34	57.21 [b] ±0.59	69.27 [a] ±1.71
	WL	4.21 ±0.22	92.52[a] ±1.45	0.05 ±0.003	34.10 [a] ±0.57	60.62 [a] ±0.63	61.57 [b] ±2.19

Overall mean	NC	4.32 [b] ±0.09	83.73[a] ±0.92	0.05 [b] ±0.001	21.92 [b] ±0.29	55.65 [b] ±0.42	71.47 [b] ±0.86
	WL	6.41 [a] ±0.17	76.54[b] ±1.09	0.09 [a] ±0.003	31.36 [a] ±0.29	63.45 [a] ±0.29	81.33 [a] ±1.31
Range of values	NC	2.1-6.8	64.08-108.19	0.02-0.10	13.81-29.22	44.00-66.71	46.54-90.77
	WL	2.7-10.8	58.2-104.67	0.03-0.18	25.68-38.54	55.48-70.13	43.00-104.91

[a,b] means having different superscript within a column differed significantly within a period (P≤0.05)

Albumen Width

The mean albumen width at 21, 25, 29, 33 and 37 weeks of age in Native chicken were 80.05±2.80, 83.39±1.76, 82.94±1.82, 85.06±1.99 and 87.02±1.55 mm respectively and the values were 63.61±0.86, 71.35±0.68, 75.08±1.16, 80.12±1.42 and 92.52±1.45 mm respectively in White Leghorn (Table 4). The albumen width was significantly higher in Native chicken at 21, 25 and 29 weeks of age (P≤0.05); but no significant difference was observed at 33 weeks of age. At 37 weeks of age the value was significantly lower in Native chicken compared to White Leghorn

The individual values for Albumen width in Native chicken ranged from 64.08 to 108.19 mm and that in White Leghorn ranged from 58.20 to 104.67 mm. The overall mean value of Albumen width of Native chicken (83.73±0.92 mm), found to be significantly higher (P≤0.05) than that of White Leghorn (76.54±1.09 mm).

Albumen Index

The mean values for albumen index of Native chicken were 0.06±0.004, 0.05±0.01, 0.05±0.003, 0.05±0.003 and 0.05±0.003 at 21, 25, 29, 33 and 37 weeks of age respectively. At the corresponding ages, the albumen index in White Leghorn was 0.12±0.01, 0.11±0.003, 0.08±0.004, 0.08±0.02 and 0.05±0.003 (Table 4). The albumen index was significantly lower in Native chicken when compared to White Leghorn at all weeks studied, except at 37 weeks of age ($P \leq 0.05$).

The individual albumen index noticed in Native chicken ranged from 0.02 to 0.10 in Native chicken and in White Leghorn ranged from and 0.03 to 0.18 respectively. The overall mean of albumen index observed in Native chicken was 0.05±0.001 and that in White Leghorn was 0.09 ±0.003 and the difference was found to be statistically significant ($P \leq 0.05$).

Albumen Weight

The average albumen weight observed in Native chicken at 21, 25, 29, 33 and 37 weeks of age was 18.18±0.39, 20.74±0.42, 22.28±0.38, 22.84±0.43 and 25.41±0.34 g respectively and that in White Leghorn was 28.77±0.60, 30.80±0.62, 31.23±0.40, 31.89±0.49 and 34.10±0.57g at the corresponding ages. At all the ages studied the albumen weight (Table 4) was significantly lower in Native chicken when compared to that of White Leghorn ($P \leq 0.05$).

The individual albumen weight ranged from 13.81 to 29.22 g in Native chicken and in White Leghorn, ranged from 25.68 to 38.54g. The overall mean albumen weight was 21.92±0.29 g in Native chicken and 31.36±0.29 g in White Leghorn and the difference was statistically significant ($P \leq 0.05$).

Albumen Per Cent

The average albumen per cent in Native chicken at 21, 25, 29, 33 and 37 weeks of age was 54.63±1.12, 55.07±1.02, 56.15±0.92, 55.12±0.96 and 57.21±0.59 per cent respectively and that in White Leghorn the values were 66.47±0.47, 65.33±0.40, 62.59±0.28, 62.24±0.37 and 60.62±0.63 per cent at the corresponding ages (Table 4). At all the ages studied the albumen per cent was significantly lower in Native chicken when compared to that of White Leghorn ($P \leq 0.05$).

The individual albumen per cent ranged from 44 to 66.71 in Native chicken and from 55.48 to 70.13 in White Leghorn. The overall mean albumen per cent was 55.65±0.42 per cent in Native chicken and 63.45±0.29 per cent in White Leghorn and the difference was statistically significant (P≤0.05).

Haugh Unit Score

The Haugh Unit Scores obtained in Native chicken at 21, 25, 29, 33 and 37 weeks of age were 78.21±1.91, 70.75±1.30, 70.88±1.77, 68.38±2.14 and 69.27±1.71 respectively in Native chicken and 92.72±1.37, 91.13±0.94, 80.75±1.46, 80.47±1.62 and 61.57±2.19 in White Leghorn (Table 4). The Haugh Unit Score was significantly lower in Native chicken compared to White Leghorn at 21, 25, 29 and 33 weeks of age; whereas it was found to be significantly higher in Native chicken at 37 weeks of age (P≤0.05).

The individual Haugh Unit Scores ranged from 46.54 to 90.77 in Native chicken and in White Leghorn ranged from 43.0 to 104.91. The overall mean value was 71.47±0.86 in Native chicken and 81.33±1.31 in White Leghorn and the difference was statistically significant (P≤0.05).

4.1.2.2. Yolk Quality

Yolk Height

The average yolk heights at 21, 25, 29, 33 and 37 weeks of age were 13.24±0.36, 13.94±0.24, 14.20±0.30, 14.18±0.38 and 14.15±0.20 mm in Native chicken (Table 5). The yolk heights noticed in White Leghorn at corresponding weeks of age were 16.28±0.22, 16.71±0.71, 16.06±0.18, 15.93±0.19 and 14.40±0.19 mm. The yolk heights in Native chicken were found to be significantly lower in all weeks of age studied, except at 37 weeks of age (P≤0.05).

The individual yolk heights in Native chicken and White Leghorn ranged from 9.1 to 16.8 and 12.6 to 18.9 mm respectively. The overall mean yolk height in Native

chicken was 13.94±0.14 mm and that of White Leghorn was 15.87±0.11 mm and the difference was statistically significant (P≤0.05).

Table 5. Period Wise Yolk Quality Parameters of Native Chicken (NC) and White Leghorn(WL)

Periods (weeks)		Yolk Height (mm)	Yolk Width (mm)	Yolk Index	Yolk Weight (g)	Yolk Per Cent	Yolk Color Index
21	NC	13.24 [b] ±0.36	38.52 [a] ±0.82	0.35 [b] ±0.01	11.42 [a] ±0.49	34.12 [a] ±1.20	7.80 [a] ±0.33
	WL	16.28 [a] ±0.22	34.38 [b] ±0.40	0.48 [a] ±0.01	10.31 [b] ±0.20	23.85 [b] ±0.32	6.35 [b] ±0.29
25	NC	13.94 [b] ±0.24	39.69 [a] ±0.69	0.35 [b] ±0.04	12.94 [a] ±0.37	34.39 [a] ±1.03	7.70 [a] ±0.47
	WL	16.71 [a] ±0.16	37.75 [b] ±0.32	0.44[a] ±0.01	11.98 [b] ±0.19	25.49 [b] ±0.40	5.65 [b] ±0.13
29	NC	14.20 [b] ±0.30	39.19 ±0.61	0.37[b] ±0.05	13.19 [b] ±0.33	33.25 ±0.83 [a]	8.20 [a] ±0.35
	WL	16.06 [a] ±0.18	39.38 ±0.27	0.41 [a] ±0.01	14.14 [a] ±0.14	28.37 [b] ±0.30	5.55 [b] ±0.21
33	NC	14.18 [b] ±0.38	41.66 ±0.60	0.34 [b] ±0.01	14.27± 0.34	34.47 [a] ±0.85	8.00 [a] ±0.41
	WL	15.93 [a] ±0.19	41.63± 0.33	0.38 [a] ±0.01	14.95 ±0.28	29.16 [b] ±0.35	4.10 [b] ±0.07
37	NC	14.15 ±0.20	40.97 [b] ±0.44	0.35 [a] ±0.01	14.19 [b] ±0.31	31.94 [a] ±0.63	8.81 [a] ±0.34

	WL	14.40 ±0.19	44.52 [a] ±0.43	0.32 [b] ±0.01	16.50 [a] ±0.20	29.41 [b] ±0.45	4.90 [b] ±0.16
Overall mean	NC	13.94 [b] ±0.14	40.02± 0.30	0.35 [b] ±0.01	13.21 ±0.19	33.62 [a] ±0.42	8.11 [a] ±0.17
	WL	15.87 [a] ±0.11	39.53± 0.38	0.41 [a] ±0.01	13.57 ±0.24	27.26 [b] ±0.27	5.31 [b] ±0.11
Range of values	NC	9.1- 16.8	32.25- 48.22	0.19- 0.45	7.41- 16.84	23.02- 46.06	5.00- 11.00
	WL	12.6- 18.9	31.21- 48.31	0.28- 0.55	9.05- 17.96	20.95- 33.18	4.00- 9.00

[a,b] means having different superscript within a column differed significantly within a period (P≤0.05)

Yolk Width

The yolk width noticed in Native chicken during 21, 25, 29, 33 and 37 weeks of age was 38.52±0.82, 39.69±0.69, 39.19±0.61, 41.66±0.60 and 40.97±0.44 mm respectively and the yolk widths noticed at corresponding ages in White Leghorn were 34.38±0.40, 37.75±0.32, 39.38±0.27, 41.63±0.33 and 44.52±0.43 mm (Table 5). It was noticed that at 21 and 25 weeks of age the yolk width was significantly higher in Native chicken when compared to White Leghorn (P≤0.05). At 37 weeks of age the yolk width was found to be significantly lower in Native chicken than White Leghorn. No significant difference was noticed at 29 and 33 weeks of age.

The individual yolk widths in Native chicken and White Leghorn ranged from 32.25 to 48.22 mm and 31.21 to 48.31 mm respectively. The overall yolk width was 40.02±0.30 mm in Native chicken and 39.53±0.38 mm in White Leghorn. No significant difference observed between the means.

Yolk Index

The yolk index calculated for 21, 25, 29, 33 and 37 weeks of age was 0.35±0.01, 0.35±0.04, 0.37±0.05, 0.34±0.01 and 0.35±0.01 respectively in Native chicken and 0.48±0.01, 0.44±0.01, 0.41±0.01, 0.38±0.01 and 0.32±0.01 respectively in White Leghorn (Table 5). The yolk indices in all weeks of age studied were significantly lower in Native chicken ($P \leq 0.05$), except at 37 weeks of age where it is significantly higher.

The yolk index of Native chicken ranged from 0.19 to 0.45 and that of White Leghorn ranged from 0.28 to 0.55. The overall yolk index was found to be 0.35±0.01 in Native chicken and 0.41±0.01 in White Leghorn. The overall yolk index was lower in Native chicken and the difference was found to be statistically significant ($P \leq 0.05$).

Yolk Weight

The average yolk weight noticed in Native chicken was 11.42±0.49, 12.94±0.37, 13.19±0.33, 14.27±0.34 and 14.19±0.31 g at 21, 25, 29, 33 and 37 weeks of age. The corresponding values in White Leghorn were 10.31±0.20, 11.98±0.19, 14.14±0.14, 14.95±0.28 and 16.50±0.20 g (Table 5). The values were significantly higher in Native chicken than in White Leghorn at 21 and 25 weeks of age; whereas significantly lower values were observed in Native chicken at 29 and 37 weeks of age ($P \leq 0.05$).

The yolk weight in Native chicken ranged from 7.41 to 16.84 g and in White Leghorn it ranged from 9.05 to 17.96 g respectively. The overall yolk weight in Native chicken and White Leghorn were 13.21±0.19 g and 13.57±0.24 g respectively.

Yolk per cent

The yolk per cent noticed in Native chicken at 21, 25, 29, 33 and 37 weeks of age was 34.12±1.20, 34.39±1.03, 33.25±0.83, 34.47±0.85 and 31.94±0.63 per cent respectively and the corresponding values in White Leghorn were 23.85±0.32, 25.49±0.40, 28.37±0.30, 29.16±0.35 and 29.41±0.45 per cent (Table 5). At all the ages of study, the yolk per cent in Native chicken was found to be significantly higher ($P \leq 0.05$).

The yolk per cent ranged from 23.02 to 46.06 in Native chicken and in White Leghorn it ranged from 20.95 to 33.18. The overall yolk percent in Native chicken and

White Leghorn were 33.62±0.42 and 27.26 ±0.27 per cent respectively and it was found significantly lower in White Leghorn (P≤0.05).

Yolk Color Index

The average yolk color indices observed in 21, 25, 29, 33 and 37 weeks of age in Native chicken were 7.80±0.33, 7.70±0.47, 8.20±0.35, 8.00±0.41 and 8.81±0.34 respectively in Native chicken and 6.35±0.29, 5.65±0.13, 5.55±0.21, 4.10±0.07 and 4.90±0.16 respectively in White Leghorn. At all the ages studied, the color index (Table 5) was significantly higher in Native chicken when compared to that of White Leghorn (P≤0.05).

The yolk color indices observed in Native chicken ranged from 5-11 and 4-9 in White Leghorn. The overall mean value for yolk color index in Native chicken was 8.11±0.17 and in White Leghorn it was found to be 5.31±0.11 and the difference was statistically significant (P≤0.05).

4.1.2.3. Shell Quality

Shell Thickness

The shell thickness noticed in 21, 25, 29, 33 and 37 weeks of age was 0.32±0.01, 0.31±0.01, 0.32±0.01, 0.34±0.01 and 0.34±0.01 mm respectively in Native chicken and the corresponding values in White Leghorn were 0.33±0.01, 0.34±0.003, 0.32±0.01, 0.31±0.01 and 0.34±0.01 mm (Table 6). The shell thickness was significantly lower at 25 weeks of age in Native chicken; but found to be significantly higher at 33 weeks of age (P≤0.05).

The shell thickness in Native chicken ranged from 0.25 to 0.46 mm and in White Leghorn ranged from 0.26 to 0.40 mm. The overall shell thickness of Native chicken eggs and White Leghorn layer eggs were 0.33±0.004 and 0.33 ±0.003 mm. No significant difference observed between the means.

Table 6. Period Wise Shell Quality Parameters of Native Chicken (NC) and White Leghorn (WL)

Periods (weeks)		Shell Thickness (mm)	Shell Weight (g)	Shell Per cent
21	NC	0.32 ±0.01	3.74 [b] ±0.11	11.25 [a] ±0.33
	WL	0.33 ±0.01	4.18 [a] ±0.11	9.68 [b] ±0.21
25	NC	0.31 [b] ±0.01	3.96 [b] ±0.08	10.54 [a] ±0.22
	WL	0.34[a] ±0.00	4.33 [a] ±0.09	9.19 [b] ±0.10
29	NC	0.32 ±0.01	4.21 [b] ±0.11	10.60 [a] ±0.27
	WL	0.32 ±0.01	4.51 [a] ±0.07	9.05 [b] ±0.13
33	NC	0.34[a] ±0.01	4.31 ±0.09	10.41 [a] ±0.23
	WL	0.31[b] ±0.01	4.40 ±0.08	8.60 [b] ±0.12
37	NC	0.34 ±0.01	4.81 [b] ±0.10	10.84 [a] ±0.24
	WL	0.34 ±0.01	5.60 [a] ±0.22	9.97 [b] ±0.38

Overall mean	NC	0.33 ±0.00	4.21 [b] ±0.05	10.73 [a] ±0.12
	WL	0.33 ±0.00	4.61 [a] ±0.07	9.30 [b] ±0.11
Range of values	NC	0.25-0.46	3.10-5.54	8.48-14.38
	WL	0.26-0.40	3.40-8.48	7.06-14.95

[a,b] means having different superscript within a column differed significantly within a period (P≤0.05)

Shell Weight

The average shell thickness noticed in 21, 25, 29, 33 and 37 weeks of age was 3.74±0.11, 3.96±0.08, 4.21±0.11, 4.31±0.09 and 4.81±0.10 g respectively. The shell weights observed in White Leghorn at corresponding ages were 4.18±0.11, 4.33±0.09, 4.51±0.07, 4.40±0.08 and 5.60±0.22 g (Table 6). The shell weight was significantly lower in Native Chicken (P≤0.05) at all ages of study except at 33 weeks of age.

The shell weight ranged in Native Chicken and White Leghorn ranged from 3.1 to 5.54 g and 3.4 to 8.48 g respectively. The overall mean shell weight in Native chicken was 4.21±0.05 g and that in White Leghorn was 4.61±0.07 g and the difference was statistically significant (P≤0.05).

Shell Per Cent

The shell weights observed in Native chicken were 11.25±0.33, 10.54±0.22, 10.60±0.27, 10.41±0.23 and 10.84±0.24 per cent respectively at 21, 25, 29, 33 and 37

weeks of age and the corresponding values in White Leghorn were 9.68±0.21, 9.19±0.10, 9.05±0.13, 8.60±0.12 and 9.97±0.38 per cent (Table 6). At all the ages of study, the shell per cent in Native chicken was found to be significantly higher in Native chicken when compared to White Leghorn (P≤0.05).

The shell per cent varied from 8.48 to 14.38 per cent in Native chicken and 7.06 to 14.95 per cent in White Leghorn. The overall shell per cent in Native chicken was 10.73±0.12 and that in White Leghorn was 9.30±0.11 and the difference was statistically significant (P≤0.05).

4.1.3. Fatty Acids in Yolk of Native Chicken and White Leghorn Eggs

Analysis of fatty acids present in six eggs each of Native chicken and White Leghorn birds was carried out by Gas Chromatography and the results are presented in Table 7 and 8.

The mean values of saturated long chain fatty acids i.e., Palmitic acid (16:0), Stearic acid (18:0), Arachidic acid (20:0) and Behenic acid (22:0) are presented in Table 7. The mean values of Palmitic acid, Stearic acid, Arachidic acid and Behenic acid were 32.35±1.31, 14.83±1.37, 0.55±0.10 and 4.92±0.55 per cent of total fatty acids respectively in Native chicken and 30.79±0.98, 13.29±0.60, 0.36±0.06 and 4.18±0.18 per cent of total fatty acids respectively in White Leghorn. The results revealed that the mean values of all the saturated fatty acids in Native chicken eggs were higher than that of White Leghorn eggs, but no statistical difference observed between the means.

The mean values of omega-9 fatty acid oleic acid (18:1) in Native chicken was found to be 31.24±0.88 and in White Leghorn eggs 31.52±0.49 per cent of total fatty acids (Table 7). The mean values of omega-7 fatty acid palmitoleic acid (16:1) in Native chicken and White Leghorn were found to be 4.11±0.82 and 5.77±1.37 per cent of total fatty acids respectively (Table 7). No statistical difference observed between the means.

The mean values of Omega-6 fatty acid Linoleic acid (18:2) in Native chicken eggs and White Leghorn eggs were 8.50±0.75 and 11.53±0.26 per cent of total fatty acids respectively (Table 7). On statistical analysis of the data, significant difference has been observed between the means (P≤0.05).

The mean values of omega-3 fatty acid Linolenic acid (18:3), Eicosapentaenoic acid (20:5) and Docosahexaenoic acid(22:6) were 0.83±0.17, 1.61±0.50 and 1.06±0.28 per cent of total fatty acids in Native chicken eggs and 0.61±0.07, 0.88±0.44 and 1.07±0.37 per cent of total fatty acids in White Leghorn eggs respectively (Table 7). No statistical difference observed between the means.

Table 7. Per Cent of Fatty Acids in Egg Yolk of Native Chicken and White Leghorn

Sl.no.	Fatty acids	Native Chicken	White Leghorn
1	Palmitic acid (16:0)	32.35 ± 1.31	30.79 ± 0.98
2	Stearic acid (18:0)	14.83 ± 1.37	13.29 ± 0.60
3	Arachidic acid (20:0)	0.55 ± 0.10	0.36 ± 0.06
4	Behenic acid (22:0)	4.92 ± 0.55	4.18 ±0.18
5	Palmitoleic acid (16:1)	4.11 ± 0.82	5.77 ± 1.37
6	Oleic acid (18:1)	31.24 ± 0.88	31.52 ± 0.49
7	Linoleic acid (18:2)	8.50 [b] ± 0.75	11.53 [a] ± 0.26
8	Linolenic acid (18:3)	0.83 ± 0.17	0.61 ± 0.07
9	Eicosapentaenoic acid (20:5)	1.61 ± 0.50	0.88 ± 0.44
10	Docosahexaenoic acid (22:6)	1.06 ± 0.28	1.07 ± 0.37

Mean values bearing different superscripts within the row differed significantly

Table 8. Overall Fatty Acids Composition and Cholesterol of Egg Yolk of Native Chicken and White Leghorn at 40 Weeks of Age

Sl.no.	Fatty acids	Native Chicken Eggs	White Leghorn Eggs
1	Saturated fatty acids (16:0-22:0)	52.65 [a] ± 0.61	48.62 [b] ± 1.44
2	Unsaturated fatty acids (16:1-22:6)	47.35 [b] ± 0.60	51.38 [a] ± 1.52
3	Omega-3 fatty acids (18:3-22:6)	3.50 ± 0.74	2.56 ± 0.83
4	Monounsaturated fatty acids (16:1-18:1)	35.35 ±1.53	37.29 ±1.71
5	Polyunsaturated fatty acids (18:2-22:6)	12.00	14.09

		±1.44	±0.91
6	Omega6:Omega3 Ratio	2.89[b] ± 0.48	6.01[a] ±0.99
7	Saturated :Unsaturated Ratio	1.11[a] ±0.02	0.95[b] ±0.05
6	Yolk Cholesterol (mg/g of yolk)	15.93 ± 0.98 (13.96-20.6)	16.52 ± 0.84 (14.72-19.21)

Mean values bearing different superscripts within the row differed significantly (P≤ 0.05). Values in parenthesis indicate the range.

Saturated fatty acids

The mean value of total saturated fatty acids (Table 8) was found to be significantly higher in Native chicken eggs (52.65± 0.61 per cent) when compared with that of White Leghorn chicken eggs (48.62± 1.44 per cent) (P≤0.05).

Unsaturated fatty acids

The total unsaturated fatty acids was 47.35±0.60 per cent of total fatty acids in Native chicken eggs and 51.38±1.52 per cent of total fatty acids in White Leghorn chicken eggs (Table 8). The mean values differed significantly (P≤0.05).

Monounsaturated fatty acids

The mean values of monounsaturated fatty acids oleic acid (18:1) and palmitoleic acid (16:1) put together were lower in Native chicken when compared with that of White Leghorn eggs and the values were 35.35±1.53 per cent of total fatty acids in Native chicken and 37.29±1.71 per cent of total fatty acids in White Leghorn (Table 8).

Polyunsaturated fatty acids

The mean values of total polyunsaturated fatty acids in Native chicken eggs and White Leghorn Chicken eggs were 12.00 ±1.44 and 14.09±0.91 per cent of total fatty acids respectively (Table 8).

Omega-3 fatty acids

The mean values of omega-3 fatty acids when put together has been found to be higher in Native chicken eggs when compared with that of White Leghorn eggs. The mean values of total Omega-3 fatty acids present in Native chicken eggs and White Leghorn eggs was 3.50±0.74 and 2.56±0.83 per cent of fatty acids respectively (Table 8).

Omega-6: omega-3 fatty acid Ratio

The mean values of ratios of omega-6: omega-3 was calculated as 2.89±0.48 in Native chicken eggs and 6.01±0.99 in White Leghorn chicken eggs (Table 8). A significantly lower value was obtained for Native chicken when compared with that of White Leghorn ($P \leq 0.05$).

Saturated and unsaturated fatty acids ratio

The mean values of ratio between saturated and unsaturated fatty acids were found to be 1.11±0.02 in Native chicken and 0.95±0.05 in White Leghorn (Table 8). The ratio was found to be significantly higher in Native chicken when compared with the White Leghorn ($P \leq 0.05$).

4.1.4. Egg Yolk Cholesterol

The yolk cholesterol content (mg/g of yolk) of six eggs of Native chicken eggs ranged from 13.96 to 20.6 with a mean value of 15.93 ± 0.98. The yolk cholesterol content (mg/g of yolk), of White Leghorn chicken eggs ranged from 14.72 to 19.21, with a mean value of 16.52 ± 0.84 (Table 8) No significant difference observed between the means.

4.1.5. Egg Minerals

The mineral composition in egg albumen and yolk determined for six eggs each from Native chicken & White Leghorn using AAS (Atomic Absorption Spectrophotometry) and are presented in table 9 and 10 respectively.

4.1.5.1. Egg albumen Minerals

The mineral composition in egg albumen of Native chicken and White Leghorn is presented in Table 9.

Table 9. The Mineral Composition of Egg Albumen in Native Chicken and White Leghorn at 40 Weeks of Age

Sl.no.	Minerals (ppm)	Native Chicken Eggs	White Leghorn Eggs
1	Iron	2.10 [b] ± 0.50 (1.11-4.38)	4.76 [a] ± 0.99 (1.66-8.00)
2	Copper	0.38 ±0.01 (0.36-0.42)	0.39 ± 0.05 (0.29-0.60)
3	Zinc	1.59 [a] ± 0.22 (0.91-2.45)	0.66 [b] ± 0.06 (0.48-0.73)
4	Manganese	0.73 ± 0.20 (0.37-1.69)	0.60 ± 0.12 (0.33-1.06)

5	Calcium mg %	0.0090 ± 0.0031 (0.0031-0.0092)	0.0069 ± 0.001 (0.0025-0.0097)
6	Magnesium mg %	0.0103 ± 0.0007 (0.0085-0.0113)	0.0104 ± 0.0008 (0.0069-0.0116)

Mean values bearing different superscripts within the row differed significantly (P≤ 0.05).Values in parenthesis indicates the range.

Iron

The iron content in egg albumen of Native chicken ranged from 1.11 to 4.38 ppm and that of White Leghorn ranged from 1.66 to 8.00 ppm. The Mean values for iron content in Native chicken and White Leghorn eggs were 2.10 ± 0.50 and 4.76± 0.99 ppm respectively. There was significant difference between the means of Native chicken and White Leghorn eggs (P≤0.05).

Copper

The copper content in egg albumen of Native chicken and White Leghorn ranged from 0.36 to 0.42 ppm and 0.29 to 0.60 ppm respectively with the mean values 0.38 ± 0.01 and 0.39± 0.05 ppm respectively.

Zinc

The zinc content in egg albumen of Native chicken and White Leghorn ranged from 0.91 to 2.45 ppm and 0.48 to 0.73 ppm respectively. The mean value of Zinc content in egg albumen of Native chicken (1.59±0.22) was significantly higher than that of White Leghorn(0.66±0.06) ($P \leq 0.05$).

Manganese

The Manganese content in Native chicken egg albumen ranged from 0.37 to 1.69 ppm, with a mean value of 0.73±0.20 ppm. The Manganese content in White Leghorn egg albumen ranged from 0.33 to 1.06 ppm, with a mean value of 0.6±0.12 ppm.

Calcium

The calcium content in egg albumen of Native chicken ranged from 0.0031 to 0.0092 mg per cent, with a mean value of 0.0090±0.0031 mg per cent. The calcium content in egg albumen of White Leghorn ranged from 0.0025 to 0.0097 mg per cent, with a mean value of 0.0069±0.001 mg per cent.

Magnesium

The Magnesium content in egg albumen of Native chicken and White Leghorn ranged from 0.0085 to 0.0113 mg per cent and 0.0069 to 0.0116 mg per cent respectively, with mean values of 0.0103±0.0007 and 0.0104± 0.0008 mg per cent respectively.

4.1.5.2. Egg Yolk Minerals

The mineral composition in egg yolk of Native chicken and White Leghorn is presented in Table 10.

Iron

The iron content in Native chicken egg yolk ranged from 38.56 to 51.92 and in White Leghorn ranged from 42.99 to 74.50 ppm. The mean values for Native chicken & White Leghorn were 46.31 ± 2.19 and 54.33 ± 4.43 ppm respectively.

Copper

The copper content in Native chicken and White Leghorn egg yolks ranged from 0.83 to 1.48 and 1.29 to 1.74 ppm respectively. The mean values for Native chicken & White Leghorn eggs were 1.18 ± 0.10 and 1.49 ± 0.08 ppm respectively and the means differed significantly ($P< 0.05$).

Zinc

The Zinc content in Native chicken and White Leghorn egg yolk ranged from 26.08 to 35.70 and 30.21 to 42.90 ppm respectively with mean values 31.32 ±1.43 and 35.92 ± 2.03 ppm respectively.

Sl.no.	Minerals (ppm)	Native Chicken Eggs	White Leghorn Eggs
1	Iron	46.31 ± 2.19 (38.56-51.92)	54.33 ± 4.43 (42.99-74.50)
2	Copper	1.18 [b] ± 0.10 (0.83-1.48)	1.49 [a] ± 0.08 (1.29-1.74)
3	Zinc	31.32 ± 1.43 (26.08-35.70)	35.92 ± 2.03 (30.21-42.90)
4	Manganese	0.88 ± 0.18 (0.44-1.57)	1.06 ± 0.21 (0.38-1.65)
5	Calcium mg %	0.1020 ± 0.0076 (0.0818-0.1352)	0.1249 ± 0.0106 (0.0800-0.155)

6	Magnesium mg %	0.0088 [b] ± 0.0005 (0.0068-0.0010)	0.0125 [a] ± 0.0008 (0.0102-0.0154)

Mean values bearing different superscripts within the row differed significantly ($P \leq 0.05$). Values in parenthesis indicate the range.

Manganese

The Manganese content in egg yolk of Native chicken & White Leghorn ranged from 0.44 to 1.57 and 0.38 to 1.65 ppm respectively the mean values were 0.88 ±0.18 and 1.06±0.21 ppm respectively.

Calcium

The calcium content in egg yolk of Native chicken & White Leghorn ranged from 0.0818 to 0.1352 and 0.08 to 0.155 mg per cent respectively, and the mean values were 0.1020±0.0076 and 0.1249 ± 0.0106 mg per cent respectively.

Magnesium

The Magnesium content in egg yolk of Native chicken ranged from 0.0068 to 0.0010 mg per cent with a mean value of 0.0088 ± 0.0005 mg per cent and that of White Leghorn ranged from 0.0102 to 0.0154 mg per cent, with a mean value of 0.0125 ± 0.0008 mg per cent. The mean values differed significantly ($P<0.05$).

4.2. EGG PRODUCTION RELATED PARAMETERS

The data on egg recording study of Native chicken and White Leghorn layers was analysed and the mean values of egg production are given in Table no. 11.

4.2.1. Hen Housed (HH) and Hen Day (HD) Egg Production

The egg recording was conducted from 21 to 40 weeks of age. The entire 20 weeks duration was divided into five periods of four weeks each (28 days) and the production during each period has been presented in Table11.

The Hen Housed egg production for periods I, II, III, IV and V were 1.18, 8.82, 9.44, 11.74 and 10.47 eggs respectively in Native chicken and 21.43, 25.63, 25.30, 26.00 and 24.90 eggs respectively in White Leghorn. The Hen Housed egg production in per cent basis for different periods were 4.23, 31.49, 33.72, 41.93 and 37.40 respectively in Native chicken and the corresponding values for White Leghorn were 76.55, 91.55, 90.36, 92.86 and 88.92.

The Hen Day egg production for periods I, II, III, IV and V in Native chicken were 1.18, 8.92, 9.56, 11.98 and10.69 respectively and the corresponding values in White Leghorn were 21.43, 25.63, 25.70, 26.00 and 24.90. The Hen Day egg production in per cent basis for different periods were 4.23, 31.87, 34.13, 42.78 and 38.17 respectively in Native chicken and the corresponding values for White Leghorn were 76.55, 91.55, 91.78, 92.86 and 88.92.

The study revealed that the mean egg number up to 40 weeks of age on Hen Housed (HH) and Hen Day (HD) basis in Native chicken was 40.23 and 41.86, while that of White Leghorn layers was 121.57 and 123.60 respectively. The egg production per cent in terms of Hen Housed and Hen Day up to 40 weeks for Native chicken were 28.74 and 29.90 respectively (Table 11) and for White Leghorn the values were 86.83 and 88.28 respectively.

The egg number up to 40 weeks of age in terms of survivor egg production (Table 11) was 41.91 for Native chicken and 125.35 for White Leghorn chicken.

The results showed that the eggs production in terms of Hen Day, Hen Housed and survivors was higher in White Leghorn than in Native chicken. The production in terms of both Hen Day and Hen Housed was highest at fourth period (33-36weeks).

4.2.2. Age at First Egg

The Age at First Egg in Native chicken ranged from 157 to 229 days with an overall mean of 185.62±2.70. The Age at First Egg in White Leghorn ranged from 125 to 161 days, with an overall mean of 141.25±0.93 (Table 11).

Table 11. Period-Wise Egg Production, ASM, Survivors Egg Number of Native Chicken (NC) and White Leghorn (WL)

Periods/Weeks		I (21-24)	II (25-28)	III (29-32)	IV (33-36)	V (37-40)	Overall (EN40)
Hen Housed Egg Production (HHEP)	NC	1.18	8.82	9.44	11.74	10.47	40.23
	WL	21.43	25.63	25.3	26	24.9	121.57
Hen Housed Egg Production per cent basis	NC	4.23	31.49	33.72	41.93	37.4	28.74
	WL	76.55	91.55	90.36	92.86	88.92	86.83
Hen Day Egg Production (HDEP)	NC	1.18	8.92	9.56	11.98	10.69	41.86
	WL	21.43	25.63	25.7	26	24.9	123.6
Hen Day Egg Production per cent basis	NC	4.23	31.87	34.13	42.78	38.17	29.9
	WL	76.55	91.55	91.78	92.86	88.92	88.28
ASM (days)		NC (185.62±2.70)			WL (141.25±0.93)		
Survivors Egg Number		NC (41.91)			WL (125.35)		

Table no. 12. Livability and Cause of death in Native Chicken and White Leghorn

Periods	Native Chicken		White Leghorn	
	Livability Per cent	Mortality Per cent	Livability Per cent	Mortality Per cent
I	100	-	100	0
II	98.33	1.67 (1 P*)	100	0
III	98.31	1.69 (1 P*)	96.67	3.33 (2 A*)
IV	94.83	5.17 (3 P*)	100	0
V	96.36	3.64 (1 P*) (1 A*)	100	0

Overall	88.33	11.67 (6 P*) (1 P*)	96.67	3.33 (2 A*)

*Cause of Death P: Predators A: Ailment

Value in Parenthesis indicates number of dead birds

4.2.3. Livability Pattern

The Livability per cent of Native chicken and White Leghorn for different periods are presented in Table 12. The number of birds died during period I (21-24 weeks) was zero in both the breeds and so 100 per cent livability noticed. The number of birds died during II, III, IV and V periods were 1 (1.67 per cent), 1 (1.69 per cent), 3 (5.17 per cent) and 2 (3.64 per cent) in Native chicken group; with the livability per cent 98.33, 98.31, 94.83 and 96.36 respectively. Only 2 birds died (3.33 per cent) during period III (29-32 weeks) in White Leghorn group (96.67 per cent livability); with no mortality in other period. The livability per cent at the end of 40 weeks was 88.33 for Native chicken and 96.67 for White Leghorn (mortality per cent 11.67 and 3.33 per cent respectively).

The cause of death in Native chicken reported by the farmers was predators like mongoose, dogs and foxes. The exact cause of death of individual birds was not known. No history of diseases noticed in case of dead birds, except in one case where signs of respiratory distress noticed. The cause of death in two White Leghorn birds was ailments (peritonitis and pasteurellosis).

4.3. FEED INTAKE IN NATIVE CHICKEN AND WHITE LEGHORN

4.3.1. Feeding Management in Native Chicken

The feeding management in 20 households was studied during the survey (Table 13). All the 20 households provide kitchen waste to their birds. In addition, supplemental feeding was practiced in almost all houses, except two. Fifty per cent of the households provided broken rice (ten); whereas 35 per cent provided wheat (seven) and five per cent provide commercial poultry feed (one).

Among the 18 households giving supplemental feeding to their birds, two households provided feed during morning (11.11 per cent); five during noon (27.78 per cent); three during evening (16.67 per cent); and seven during morning and evening (38.8 per cent). No special timing followed by one household (5.56 per cent).

Based on the quantity of feed provided per bird, two households provided about 10 to 20 grams of feed(11.11 per cent); eleven households about 20 to 30 grams of feed (61.11 per cent); two households about 30 to 40 grams of feed (11.11 per cent); and three households more than 40 grams of feed (16.67 per cent).

4.3.2. Feed Intake in White Leghorn Layers

The period of study of 20 weeks was divided into five periods of four weeks each and the total feed consumption of the entire flock in different periods was quantified. It was found to be 188.7, 184.25, 182.94, 178.58 and 197.55 kilograms for periods from one to five (Table 14). The total feed intake of entire flock during 20 weeks (21-40 week) was found to be 932.00 kilograms. From this, the average feed intake per bird per day was calculated. The average feed intake per bird per day during 1^{st}, 2^{nd}, 3^{rd}, 4^{th} and 5^{th} period was 112, 110, 111, 110 and 122 g. The overall mean feed intake per bird per day was found to be 113 g.

Feed Conversion Ratio (FCR) in White Leghorn

The total feed consumption by the entire flock was quantified and the average Feed Conversion Ratio (FCR) was calculated on per dozen egg basis. The FCR for the five periods are presented in the Table.14 and the values were 1.76, 1.44, 1.45, 1.42 and 1.63. The overall Feed Conversion Ratio obtained was 1.53.

Table 13. Feeding Management in Native Chicken

Parameters	Classes	No. of Households	Per cent
Supplemental feeding	No supplemental feed	2	10
	Broken rice	10	50
	Wheat	7	35
	Poultry Feed	1	5
	Total	20	100
Time of feeding	Morning	2	11.11
	Noon	5	27.78
	Evening	3	16.67
	morning &evening	7	38.89
	No special timing	1	5.56
	Total	18	100.00
Quantity of feed per bird per day	10 to 20g	2	11.11
	20 to 30	11	61.11
	30 to40	2	11.11
	>40g	3	16.67
	Total	18	100.00

Table 14. Feed Intake in White Leghorn Layers during Different Periods

Period/Weeks	I (21-24 weeks)	II (25-28 weeks)	III (29-32 weeks)	IV (33-36 weeks)	V (37-40 weeks)	Overall
Total Feed Consumed(Kg)	188.70	184.25	182.94	178.58	197.55	932.00
Total Egg Number	1286	1538	1518	1508	1444	7294
FCR per dozen eggs	1.76	1.44	1.45	1.42	1.64	1.53
Average Feed Intake per bird per day (g)	112	110	111	110	122	113

5. DISCUSSION

5.1. EGG QUALITY PARAMETERS

The egg quality parameters of Native chicken and White Leghorn presented in Tables 2 to 6 revealed that the external as well as internal quality of eggs differed significantly between Native chicken and White Leghorn in all parameters except shape index, yolk width, yolk weight and shell thickness.

5.1.1. External Quality of Eggs

Egg Weight

The mean egg weight of Native chicken was 33.35, 37.64, 39.68, 41.42 and 44.40 g at 21, 25, 29, 33 and 37 weeks of age respectively with the overall mean egg weight of 39.35 g in Native chicken presented in Table 2. This finding is in close agreement with the mean egg weight of 40.02 g in Karaknath, 40.00 g in Aseel peela and 40.73 g in Fulani-ecotype chicken reported by Mahapatra *et al.* (1982), Mohan *et al.* (2008a) and Fayeye *et al.* (2005) respectively. The egg weight recorded in the present study at 33 weeks of age in Native chicken is similar to the egg weight of 41.81 g reported by Girishkumar (2009) in Native chicken of northern Kerala.

At 21, 25, 29, 33 and 37 weeks of age, the egg weight (Table 2) in White Leghorn was 43.26, 47.11, 49.88, 51.24 and 56.20 g respectively. At all the ages studied, the egg weight was significantly lower in Native chicken compared to that of White Leghorn ($P \leq 0.05$). The egg weight recorded at 29 weeks of age in White Leghorn was 49.88 g and it was in partial agreement with the egg weight of 50.02 g in IWN strain and 50.42 g in IWP strain at 28 weeks of age reported at A.I.C.R.P. Poultry Research Station, Mannuthy. In the present study, the mean

egg weight of 56.20 g recorded at 37 weeks of age is slightly higher than the egg weight of 55.22 g in IWN strain and 55.02 g in IWP strain of White Leghorn at 40 weeks of age reported by Anon (2010).

The overall mean egg weight for the period from 21 to 37 weeks of age was 49.54 g in White Leghorn and 39.35 g in Native chicken. It was lower by 10.19 g in Native chicken and the reduction in size was about 20 per cent compared to that of White Leghorn ($P \leq 0.05$) and the difference was statistically significant. Moreover, the data pertaining to the individual egg weight showed lower range of values (27.91 to 47.28 g) in Native chicken compared to higher range of values (38.63 to 59.89 g) in White Leghorn. These results indicated that the egg size is small in Native chicken and the results pertaining to the frequency distribution of egg weight support this finding.

The lower egg weight in Native chicken could be due to the genetic differences and low plane of nutrition of Native chicken under free range system of rearing. The lower body weight of Native chicken also may be another reason for low egg weight. The positive correlation between egg weight and body weight in chicken layers is well established. . Higher egg weight in White Leghorn could be due to higher albumen per cent (Padhi *et al.,* 1998)

The frequency distribution of egg weight presented in the Table 3 revealed that in Native chicken, the size of 14 per cent eggs were very small having egg weight below 35 g. The major contribution of 79 per cent eggs were of small size ranging from 35 to 45 g and 7 per cent eggs were in the range of medium size 45 to 50 g. Whereas, in White Leghorn, very small eggs below 35 g was absent and 18 per cent eggs fall in the range of 35 to 45 g and 82 per cent of eggs fall within the range of 45 to 60 g egg weight. Thus, it was evident that the egg weight in Native chicken was very low and only 7 per cent eggs showed egg weight above 45 g in Native chicken, but in White Leghorn, 82 per cent eggs were having egg weight above 45 g.

Egg Breadth

The mean egg breadth of Native chicken was 35.71, 37.51, 37.56, 38.15, and 38.78 mm at 21, 25, 29, 33 and 37 weeks of age respectively. At the corresponding ages, the egg breadth in White Leghorn was 38.49, 40.37, 41.63, 41.07 and 42.14 mm (Table 2). The mean values for egg breadth was found to be significantly lower in Native chicken in all the ages ($P \leq 0.05$) studied. The breadth of individual eggs in Native chicken ranged from 32.64 to 49.84 mm and in White Leghorn ranged from 32.12 to 55.02 mm. The overall mean breadth was found to be lower by 3.19 mm in Native chicken (37.55 mm) and was significant ($P \leq 0.05$) compared to that of White Leghorn (40.74 mm). The breadth of 37.95 mm of eggs documented by Girishkumar (2009) for Native chicken of northern Kerala was very close to the mean value (37.55 mm) recorded in Native chicken in the present study.

Egg Length

The mean egg length noticed in Native chicken during 21, 25, 29, 33 and 37 weeks of age were 47.81, 49.38, 50.50, 51.06 and 52.93 mm respectively and the corresponding values for White Leghorn were 52.25, 53.64, 54.21, 54.04 and 55.98 mm (Table 2). It was found that in all the ages the egg lengths were significantly lower in Native chicken when compared to that of White Leghorn ($P \leq 0.05$). The individual egg length in Native chicken ranged from 41.81 to 56.41 mm and in White Leghorn ranged from 49.22 to 60.38 mm. The overall mean value for egg length in Native chicken was 50.36 mm and that of White Leghorn was 54.02 mm. The egg length was significantly lower by 3.66 mm in Native chicken when compared to White Leghorn ($P \leq 0.05$). The mean length of 51.90

mm in eggs obtained from Native chicken of northern Kerala (Girishkumar, 2009) was higher than the value of 50.36 mm obtained in present study.

Shape Index

The length and breadth of eggs were significantly lower in Native chicken than that of White Leghorn. Hence the shape index of egg was almost similar Native chicken and White Leghorn; thereby the shape index was not significant.

The mean values for shape index at 21, 25, 29, 33 and 37 weeks of age in Native chicken were 74.75, 76.23, 74.46, 74.75 and 73.38 respectively and the corresponding values in White Leghorn were 73.72, 75.39, 76.89, 76.07 and 75.34 (Table 2).

The individual values for shape index ranged from 63.04 to 99.90 for Native chicken and 62.47 to 94.26 in White Leghorn. The overall mean value of shape index was 74.7 in Native chicken eggs and 75.48 in White Leghorn eggs and it was statistically comparable each other.

The results obtained in the present study are more or less similar to the the mean values of shape index recorded for Native breeds Karaknath (73.78), Aseel Peela (75.08), Aseel Kagar (73.65), Kadaknath (73.93), indigenous chicken of Kashmir (73.54), Native chicken of northern Kerala (73.37) and Vanaraja (76.18) reported by various authors Mahapatra *et al.* (1982), Parmar *et al.* (2006) Iqbal and Pampori (2008), Girishkumar, (2009) and Niranjan *et al.,* (2008) respectively.

The mean values of shape index in White Leghorn (73.56, 73.55) reported by Padhi *et al.*, (1998), Santhosh *et al.* (2006) and Giriraj *et al.* (2008b) were also similar to that recorded in the present study.

5.1.2. Internal Quality of Egg

The internal quality parameters of Native chicken and White Leghorn eggs presented in Tables 4 to 6 revealed significant difference between Native chicken and White Leghorn eggs in all parameters except, yolk width, yolk weight and shell thickness.

5.1.2.1. Albumen Quality of Egg

Albumen Height

The height of albumen at 21, 25, 29, 33 and 37 weeks of age were 4.82, 4.08, 4.26, 4.11 and 4.35 mm respectively and were almost uniform between weeks in Native chicken eggs. At all these ages, the values were higher in White Leghorn eggs (7.82, 7.69, 6.14, 6.19 mm respectively) except at 37 weeks of age wherein, the height of albumen was only 4.21 mm. The albumen height was significantly lower in Native chicken eggs at 21, 25, 29 and 33 weeks of age ($P \leq 0.05$) than in White Leghorn eggs (Table 4). Significantly lower height coupled with higher length of albumen resulted in significantly lower albumen index.

Height of albumen in Native chicken eggs ranged from 2.1 to 6.8 mm and that in White Leghorn eggs ranged from 2.7 to 10.8 mm with overall mean of 4.32 and 6.41 mm respectively. The overall mean was lower by 2.09 mm in Native chicken eggs and this difference was statistically significant ($P \leq 0.05$). The height of albumen indicated a true picture about the thickness of albumen in White Leghorn egg.

Height of albumen in Fulani ecotype chicken eggs (4.92 mm) and that in Ghagus chicken eggs (4.83 mm) reported by Fayeye *et al*. (2005) and Tantia *et al*. (2005) concur the present findings. In IWP strain of White Leghorn eggs, height of albumen (6.30 mm) recorded at A.I.C.R.P. Poultry Research Station, Mannuthy (Anon, 2010) were in close agreement with the values recorded in present study.

Albumen width

Length of albumen presented in Table 4 showed wide variations in White Leghorn eggs at different ages from 21 to 37 weeks of age and the values averaged 63.61, 71.35, 75.08, 80.12 and 92.52 mm respectively at 21, 25, 29, 33 and 37 weeks of age. Width of Albumen in 100 eggs showed lower range of values from 58.20 to 104.67 mm, and thereby, the overall mean for the above period was low (76.54 mm) in White Leghorn eggs.

Native chicken eggs showed relatively less variation between weeks in respect of albumen width and the values averaged 80.05, 83.39, 82.94, 85.06 and 87.02 mm at 21, 25, 29, 33 and 37 weeks of age, respectively. Width of albumen at three stages in 21, 25 and 29 weeks of age was significantly higher. On the contrary, at 37 weeks of age, it was significantly lower in Native chicken eggs compared to that of White Leghorn eggs ($P \leq 0.05$) at the respective age.

In Native chicken eggs, during the period 21-37 weeks of age, the individual values of width of albumen ranged from 64.08 to 108.19 mm with higher values at both extreme compared to that of White Leghorn eggs (58.20 to 104.67 mm). Thereby, the overall mean in Native chicken eggs (83.73 mm) was significantly higher by 7.19 mm ($P \leq 0.05$) than that of White Leghorn egg (76.54 mm). The higher width of albumen might be due to the variations in mineral composition of albumen in Native chicken eggs.

Albumen Index

In the present study, even though the albumen indices in the individual eggs studied were ranged from 0.02 to 0.10 in Native chicken, the overall mean value was only 0.05. The overall mean value of albumen index was lower by 0.04 in Native chicken eggs compared to that of White Leghorn eggs and this difference was statistically significant ($P \leq 0.05$).

The mean value of albumen index was 0.06 at 21 weeks of age and subsequently 0.05 at 25, 29, 33 and 37 weeks of age in Native chicken. In White

Leghorn eggs, the mean value of albumen indices was very high (0.12 and 0.11) at 21 and 25 weeks of age and moderately high (0.08) at 29 and 33 weeks of age (Table 4).

The albumen index was significantly lower in Native chicken compared to White Leghorn at all weeks studied, except at 37 weeks of age ($P \leq 0.05$) wherein, albumen index was 0.05 in Native chicken and White Leghorn eggs, is in full agreement with Vijh *et al*. (2005b) who reported albumen index of 0.05 in Kalasthi eggs.

The higher value of albumen index (0.07) was reported by Parmar *et al*. (2006), Iqbal and Pampori (2008) and Tantia *et al*. (2005a) in eggs of Kadaknath, indigenous chicken of Kerala and Ghagus chicken, respectively. Higher values might be due to the differences in genetic makeup of the stock and feeding pattern adopted in the study.

Higher range of values (0.03 to 0.18) as well the higher value of overall mean (0.09) in White Leghorn eggs agree with the higher value (0.11) reported by Padhi *et al*.(1998). The albumen index reported at A.I.C.R.P. Poultry station, Mannuthy (Anon, 2010) in White Leghorn eggs (0.08) is in close agreement with the results recorded in the present study.

Albumen Weight

The average albumen weight observed in Native chicken eggs at all the ages 21, 25, 29, 33 and 37 weeks (18.18, 20.74, 22.28, 22.84 and 25.41 g) were lower than that of White Leghorn eggs (28.77, 30.80, 31.23, 31.89 and 34.10 g) at the respective ages. At all the ages studied, the weight of albumen (Table 4) was significantly lower in Native chicken compared to that of White Leghorn eggs ($P \leq 0.05$) at a particular age. The weight of albumen in individual eggs (13.81 to 29.22 g in Native chicken) as well as the overall mean and the egg weight clearly indicated beyond doubt that the quantum of albumen was definitely on the higher side in White Leghorn eggs (25.68 to 38.54 g).

The overall mean albumen weight was 21.92 g in Native chicken eggs and 31.36 g in White Leghorn. The analysis of results proved that the absolute weight of albumen was higher by 9.44 g in White Leghorn egg compared to that of Native chicken egg and the difference was statistically significant (P≤0.05). The data pertaining to egg weight presented in Table 2 revealed that egg weight was significantly higher by 10.19 g in White Leghorn. These results evidently suggest that higher albumen weight is the base for higher egg weight in White Leghorn eggs. In the present study, statistically comparable yolk weight in White Leghorn and Native chicken support the above finding.

The weight of albumen in eggs of Fulani ecotype chicken (20.25g), Kadaknath (20.74 g) and Kalasthi chicken (21.84 g) reported by Fayeye *et al*. (2005), Parmar *et al*. (2006), Vijh *et al*. (2005b) and that of 29.00 g in White Leghorn eggs reported by Shrestha *et al*. (2004) support the results obtained in the present study.

Albumen Per Cent

The albumen per cent in relation with egg weight in Native chicken was almost similar at different ages at 21, 25, 29, 33 and 37 weeks (54.63, 55.07, 56.15, 55.12 and 57.21 per cent). Whereas, in White Leghorn, the values were much higher at every week studied to the extent of 66.47, 65.33, 62.59, 62.24 and 60.62 per cent of its egg weight at the above ages. At all these ages, the albumen percentages (Table 4) were significantly low in Native chicken eggs compared to that of White Leghorn eggs (P≤0.05). These results indicated higher albumen deposition by 7.80 per cent of eggs, in addition to higher egg weight in White Leghorn. Higher albumen in White Leghorn eggs is related with the higher plane of nutrition and its superiority in the genetic makeup of the stock.

The albumen in eggs ranged from 44.00 to 66.71 per cent in Native chicken and from 55.48 to 70.13 per cent in White Leghorn with an overall mean of 55.65 per cent in Native chicken and 63.45 per cent in White Leghorn, lower

by 7.80 per cent in Native chicken was statistically significant (P≤0.05). These results indicated low deposition of albumen in Native chicken eggs.

The albumen content in indigenous stock of Kalasthi breed and Ghagus breed of chicken eggs (51.0 and 56.0 per cent) reported by Vijh *et al*. (2005b) and Tantia *et al*. (2005) and that reported by Padhi *et al*. (1998) in White Leghorn eggs (63.1 per cent) are in close agreement with the values obtained in the present study.

Haugh Unit Score

The Haugh Unit Scores obtained in Native chicken at 21, 25, 29, 33 and 37 weeks of age were 78.21, 70.75, 70.88, 68.38 and 69.27 in Native chicken and 92.72, 91.13, 80.75, 80.47 and 61.57 in White Leghorn (Table 4) respectively. The Haugh Unit Score was significantly low in Native chicken compared to that of White Leghorn eggs at 21, 25, 29 and 33 weeks of age. Whereas, it was significantly high in Native chicken eggs at 37 weeks of age (P≤0.05). The individual Haugh Unit Scores ranged from 46.54 to 90.77 and 43.0 to 104.91 with an overall mean of 71.47 and 81.33 in Native chicken and White Leghorn respectively. The overall mean value was lower by 9.86 and the difference was statistically significant (P≤0.05). Higher Haugh Unit scores represent the quality of albumen in White Leghorn eggs indicated superior qualitative and quantitative function of albumen in relation with its egg weight.

The Haugh unit score of 71 in eggs of chicken indigenous to Kerala and a value of 68.81 in eggs of Kalasthi breed reported by Iqbal and Pampori (2008) and Vijh *et al*. (2005b) respectively and HU for White Leghorn eggs (81.27) at A.I.C.R.P. research station, Mannuthy (Anon, 2010) were in close agreement with the values recorded in the present study.

5.1.2.2. Yolk Quality of Egg

Yolk Height

The average yolk heights at 21, 25, 29, 33 and 37 weeks of age were 13.24, 13.94, 14.20, 14.18 and 14.15 mm in Native chicken (Table 5). The yolk heights noticed in White Leghorn at corresponding weeks of age were 16.28, 16.71, 16.06, 15.93 and 14.40 mm. The yolk heights in Native chicken were found to be significantly lower in all weeks of age studied, except at 37 weeks of age ($P \leq 0.05$).

The individual yolk heights in Native chicken and White Leghorn ranged from 9.1 to 16.8 and 12.6 to 18.9 mm respectively. The overall mean yolk height in Native chicken was 13.94 mm and that of White Leghorn was 15.87 mm. The yolk height was lower in Native chicken by 1.93 mm and the difference was statistically significant ($P \leq 0.05$). The lower yolk height in Native chicken could be due to the comparative smaller size in Native chicken.

A closer value of 14.27 mm was recorded by Fayeye *et al.,* 2005 for Fulani ecotype chicken; and a little higher values by Vijh *et al.,* 2005b for Kalasthi breed of chicken (14.83 mm) and by Tantia *et al.* (2005) for Ghagus breed of chicken (15.20 mm). The value recorded at A.I.C.R.P. poultry research station, Mannuthy for IWN strain of White Leghorn (15.71 mm) was in close agreement with that obtained for White Leghorn in present study.

Yolk Width

The yolk width noticed in Native chicken during 21, 25, 29, 33 and 37 weeks of age were 38.52, 39.69, 39.19, 41.66 and 40.97 mm respectively and the yolk widths noticed at corresponding ages in White Leghorn were 34.38, 37.75, 39.39, 41.63 and 44.52 mm (Table 5). It was noticed that at 21 and 25 weeks of age the yolk width was significantly higher in Native chicken when compared to White Leghorn ($P \leq 0.05$). At 37 weeks of age the yolk width was found to be significantly lower ($P \leq 0.05$) in Native chicken than White Leghorn. No significant difference was noticed at 29 and 33 weeks of age.

The individual yolk widths in Native chicken and White Leghorn ranged from 32.25 to 48.22 mm and 31.21 to 48.31 mm respectively. The overall mean value was 40.02 mm in Native chicken and 39.53 mm in White Leghorn.

Slightly lower values were recorded for Gramapriya (37.4 mm) and Vanaraja(39.4 mm) by Niranjan *et al.(*2008); Ghagus breed of chicken(39.21 mm) by Tantia *et al.(* 2005) and slightly higher values were reported for Kalasthi breed (42.75 mm) by Vijh *et al.* (2005a) and for local hill fowl (41.69 mm) by Singh *et al.(* 2009).

Yolk Index

The yolk index calculated for 21, 25, 29, 33 and 37 weeks of age were 0.35, 0.35, 0.37, 0.34 and 0.35 respectively in Native chicken and 0.48, 0.44, 0.41, 0.38 and 0.32 respectively in White Leghorn (Table 5). The yolk indices in all weeks of age studied were significantly lower in Native chicken ($P \leq 0.05$), except at 37 weeks of age.

The yolk index of Native chicken ranged from 0.19 to 0.45 and that of White Leghorn ranged from 0.28 to 0.55. The overall mean value was found to be 0.35 in Native chicken and 0.41 in White Leghorn. The overall mean of yolk index in Native chicken was lower by 0.06 and the difference was found to be statistically significant ($P \leq 0.05$).

The values recorded by Parmar *et al.(* 2006) for Kadaknath breed(0.37); Vijh *et al.(* 2005b) for Kalasthi breed (0.35); Tantia *et al.,* (2005) for Ghagus breed (0.39); Girishkumar (2009) for Native chicken of Northern Kerala (0.32); Singh *et al.,* 2009 for local hill fowl(0.39) was closer to the results obtained in present study.

The values reported for White Leghorn by Padhi *et al.* (1998), (0.43) and at A.I.C.R.P. poultry research station, Mannuthy for IWN strain (0.40) were in close conformity with the results obtained in present study. Also slightly lower

values of 0.38 by Verma *et al. (*1998) and at A.I.C.R.P. poultry research station, Mannuthy for IWP strain (0.37) were documented.

Yolk Weight

The average yolk weight noticed in Native chicken was 11.42, 12.94, 13.19, 14.27 and 14.19 g at 21, 25, 29, 33 and 37 weeks of age. The corresponding values in White Leghorn were 10.31, 11.98, 14.14, 14.95 and 16.50 g (Table 5).The values were significantly higher in Native chicken at 21 and 25 weeks of age; whereas significantly lower in Native chicken at 29 and 37 weeks of age($P \leq 0.05$).

The yolk weight in Native chicken ranged from 7.41 to 16.84 g and in White Leghorn it ranged from 9.05 to 17.96 g respectively. The overall yolk weight in Native chicken and White Leghorn were 13.21 g and 13.57 g respectively.

The yolk weights of Fulani ecotype chicken (13.03 g) by Fayeye *et al. (*2005) and of native chicken of Northern Kerala (13.21 g) by Girishkumar *et al.,* (2009) was in agreement with the values obtained in present study.

Yolk Per Cent

The yolk per cent noticed in Native chicken at 21, 25, 29, 33 and 37 weeks of age was 34.12, 34.39, 33.25, 34.47 and 31.94 per cent respectively and the corresponding values in White Leghorn were 23.85, 25.49, 28.37, 29.16 and 29.41 per cent (Table 5). At all the ages of study, the yolk per cent in Native chicken was found to be significantly higher ($P \leq 0.05$). These results are in agreement with Marion *et al. (*1965) and Padhi *et al. (*1998) who observed negative correlation between yolk per cent and egg weight.

The yolk per cent ranged from 23.02 to 46.06 in Native chicken and in White Leghorn it ranged from 20.95 to 33.18. The overall mean value for yolk

percent in Native chicken and White Leghorn were 33.62 and 27.26 per cent respectively and it was significantly lower by 6.36 per cent in White Leghorn.

The value recorded by Girishkumar, (2009) for Native chicken of Kerala (31.72 per cent) and that obtained for White Leghorn (26.86 per cent) by Padhi *et al.,(*1998) were similar to the values obtained in present study for native chicken and White Leghorn respectively.

Yolk Color Index

The average yolk color indices observed in 21, 25, 29, 33 and 37 weeks of age in Native chicken were 7.80, 7.70, 8.20, 8.00 and 8.81 respectively in Native chicken and 6.35, 5.65, 5.55, 4.10 and 4.90 respectively in White Leghorn. At all the ages studied, the color index (Table 5) was significantly higher in Native chicken when compared to that of White Leghorn ($P \leq 0.05$).

The yolk color indices observed in Native chicken ranged from 5-11 and 4-9 in White Leghorn. The overall mean value in Native chicken was 8.11 and in White Leghorn it was found to be 5.31. It was lower by a value of 2.80 and the difference was statistically significant ($P \leq 0.05$). The yolk color value reported by Niranjan *et al.,* 2008 in Vanaraja (8.01) and Gramapriya (7.67) were closer to the present values in native chicken. Verma *et al. (*1998) reported a higher value (8.63) for White leghorn. Sunde(1992) observed the color of yolk can be altered easily through diet. Kumar *et al.* (2009) compared the intensity of yolk color and reported a high yolk color for eggs collected from the rural range reared bird (9.88) when compared to cage reared commercial layer (6.6). The finding was in agreement with the present study.

5.1.2.3. Shell Quality parameters

Shell Thickness

The shell thickness noticed in 21, 25, 29, 33 and 37 weeks of age were 0.32, 0.31, 0.32, 0.34 and 0.34 mm respectively in Native chicken and the corresponding values in White Leghorn were 0.33, 0.34, 0.32, 0.31 and 0.34 mm (Table 6). The shell thickness was significantly lower at 25 weeks of age in Native chicken; but found to be significantly higher at 33 weeks of age ($P \leq 0.05$).

The shell thickness in Native chicken ranged from 0.25 to 0.46 mm and in White Leghorn ranged from 0.26 to 0.40 mm. The overall shell thickness of both Native chicken and White Leghorn eggs was 0.33 mm.

The values obtained for Kadakanath (0.31 mm) by Parmar *et al.,(*2006) Karaknath (0.33 mm), Aseel Peela desi hens (0.33 mm), Aseel kagar desi hens (0.34 mm) by Mahapatra *et al.(* 1982) were in close agreement with that obtained in native chicken. The values obtained for White Leghorn by Padhi *et al.,* (1998) (0.313 mm); Verma *et al.* (1982) (0.32 mm); for IWN (0.334 mm) and IWP strain of White Leghorn (0.333mm) at A.I.C.R.P. poultry research station, Mannuthy were in agreement with the results of present study.

Shell Weight

The average shell thickness noticed in 21, 25, 29, 33 and 37 weeks of age was 3.74, 3.96, 4.21, 4.31and 4.81 g respectively. The shell weights observed in White Leghorn at corresponding ages were 4.18, 4.33, 4.51, 4.40 and 5.60 g (Table 6). The shell weight was significantly lower in Native chicken ($P \leq 0.05$) at all ages of study except at 33 weeks of age.

The shell weight in Native chicken and White Leghorn ranged from 3.1 to 5.54 g and 3.4 to 8.48 g respectively. The overall mean shell weight in Native chicken was 4.21g and that in White Leghorn was 4.61 g. The shell weight was 0.40 g lower in Native chicken when compared to White Leghorn and the difference was statistically significant ($P \leq 0.05$).

The shell weights recorded by Iqbal and Pampori, (2008) for indigenous chicken of Kashmir (4.63 g); Girishkumar, (2009) for Native chicken of Northern Kerala (4.18 g); Mohan *et al.,* (2008b) for Kadaknath desi hens(4.95 g) were in close conformity with the present results. A little higher value was reported for White leghorn by Shrestha *et al.,* 2004(6.4 g).

Shell Per Cent

The shell weights observed in Native chicken were 11.25, 10.54, 10.60, 10.41 and 10.84 per cent respectively at 21, 25, 29, 33 and 37 weeks of age and the corresponding values in White Leghorn were 9.68, 9.19, 9.05, 8.60 and 9.97 per cent (Table 6). At all the ages of study, the shell per cent in Native chicken was found to be significantly higher in Native chicken when compared to White Leghorn ($P \leq 0.05$).

The shell per cent varied from 8.48 to 14.38 per cent in Native chicken and 7.06 to 14.95 per cent in White Leghorn. The overall shell per cent in Native chicken was 10.73 and that in White Leghorn was 9.30. The shell per cent in native chicken was higher in Native chicken by 1.43 per cent and the difference was statistically significant ($P \leq 0.05$).

The shell per cent reported in Ghagus breed (11 per cent) by Tantia *et al.* (2005a) and in Native chicken of Northern Kerala (10.01 per cent) by Girishkumar (2009) were closer to the values in present study. Also, a little higher value in Kalasthi breed (12 per cent) was reported by Vijh *et al.* (2005b). Padhi *et al.* (1998) reported a similar value of 10 per cent in White Leghorn.

5.1.3. Fatty Acids Present in Egg Yolk

Saturated Fatty Acids

Of the total fatty acids present in yolk, the mean values of saturated fatty acids viz., Palmitic, Stearic, Arachidic and Behenic acids were 32.35, 14.83, 0.55

and 4.92 per cent in eggs of Native chicken and 30.79, 13.29, 0.36 and 4.18 per cent in eggs of White Leghorn, respectively (Table 7). The percentages of these fatty acids did not show very wide variation between Native chicken and White Leghorn indicating that the composition of these fatty acids was very stable in chicken layers. Lower values of Palmitic acid (29.40 and 27.13 per cent) have been reported in eggs of White Leghorn by Yin *et al*. (2008) and Ayerza and Coates (2000). The Stearic acid value (13.86 per cent) in White Leghorn eggs reported by Yin *et al*. (2008) support the present findings.

The mean value of total saturated fatty acids put together was 52.65 per cent in Native chicken and 48.62 per cent in White Leghorn (Table 8) and the value were higher in Native chicken by 4.03 per cent and this difference was statistically significant ($P \leq 0.05$). Comparatively lower values of total saturated fatty acids (31.81 per cent) were reported for 27 week old layers by Suksombat *et. al*.(2006) and 36.84 per cent reported by Yin *et al*. (2008) in White Leghorn layers without specifying the age of hens. The greater variation in the per cent of fatty acids could be due to the difference in the diet of birds. Beynen (2004) stated that the fatty acid composition in the egg fat change with the type of the diet fed to layers.

Unsaturated Fatty Acids

The total per cent of unsaturated fatty acids (UFA) was 47.35 in Native chicken eggs and 51.38 in White Leghorn eggs (Table 8) with a higher value of 4.03 per cent in the latter and the difference was statistically significant ($P \leq 0.05$).

Monounsaturated Fatty Acids

The mean values of monounsaturated fatty acids (Omega 9 and 7) of the total fatty acids were 35.35 per cent in Native chicken eggs and 37.29 per cent in White Leghorn eggs (Table 8). The mean value of oleic acid (18:1) and

palmitoleic acid (16:1) put together was lower in Native chicken eggs compared with that of White Leghorn eggs.

The mean value of omega-9 fatty acid, in Native chicken and White Leghorn egg was exactly similar (31.24 and 31.52 per cent). The values reported Ahn *et al*. (1999) and Suksombat *et al*. (2006) in White Leghorn eggs was on higher side (32.36 and 34.71per cent).

The mean values of omega -7 fatty acid, the palmitoleic acid (16:1) in Native chicken egg was 4.11 per cent and 5.77 per cent in White Leghorn egg. Palmitoleic acid content in white and brown hens (4.22 and 3.86) reported by Ayerza and Coates (2000) were close to the values recorded in the present study. Very lower values (2.59 per cent) were also reported by Kazmierska *et al*. (2005).

The total monounsaturated fatty acids in egg yolk (36.10 per cent) reported by Suksombat *et al*. (2006) was in close agreement with the present study. But Yin *et al*. (2008) reported comparatively lower values (31.21 per cent) in White Leghorn eggs.

Polyunsaturated fatty acids

The mean value of total polyunsaturated (Omega-6 and 3) fatty acids were 12.00 per cent in Native chicken egg and 14.09 per cent in White Leghorn egg (Table 8).

The mean value of Omega-6 fatty acid, the Linoleic acid (18:2) was 8.50 per cent in Native chicken and 11.53 per cent in White Leghorn. The per cent of Linoleic acid was 3.03 per cent lower in Native chicken and the difference was statistically significant ($P \leq 0.01$). Higher values (12.93 and 12.65 per cent) were reported by Ayerza and Coates (2000) in eggs of white and brown hens and lower values (10.72 per cent) was reported for chicken layers by Kazmierska *et al.* (2005). Of the total fatty acids present in the egg, the mean values of Omega-3 fatty acids i.e., Linolenic, Eicosapentaenoic and Docosahexaenoic acids were

0.83, 1.61 and 1.06 per cent in Native chicken eggs and 0.61, 0.88 and 1.07 per cent in White Leghorn eggs, respectively. Higher values of 1.45, 1.29 and 1.22 per cent Linolenic acid were reported by Ahn *et al*. (1999), Suksombat *et al*. (2006) and Yin *et al*. (2008) respectively in White Leghorn eggs. Lower values of 0.21 per cent in white hen eggs and 0.20 per cent in brown hen eggs were also reported by Ayerza and Coates (2000)

The per cent Docosahexaenic acid in white hen egg (1.00 per cent) was in close conformity with the present value whereas a little lower value was reported in brown hen egg (0.73 per cent) by Ayerza and Coates (2000). Comparatively higher values were reported by Ahn *et al*. (1999) in White leghorn egg (1.96 per cent) and by Suksombat *et al*. (2006) in layers (1.98 per cent).

In the present study, the mean values of total Omega-3 fatty acids present in Native chicken and White Leghorn egg were 3.50 and 2.56 per cent respectively. Higher values of omega-3 fatty acids put together in eggs of Native chicken is advantageous compared to that of White Leghorn egg and it requires further studies in more number of samples before arriving at a concrete conclusion.

Even though the difference was not statistically significant, may be of a relatively smaller sample size.

The high value of omega- 3 fatty acids observed in eggs of Native chicken can be attributed to the feeding system. With the range-fed hens consuming green leafy vegetables, fresh and dried fruits, insects and worms, omega-3 fatty acids are presumably high in eggs (Simopoulos and Salem, 1992).

The ratio between omega-6: omega-3 fatty acid was calculated and it was better (2.89) in Native chicken egg and 6.01 in White Leghorn egg. These results revealed a difference of 3.12 in Native chicken egg and it was significantly lower in Native chicken eggs compared with that of White Leghorn ($P \leq 0.01$).

An imbalance of omega-6 and omega-3 poly unsaturated fatty acids (PUFA) in the diet is associated with an increased risk of cardiovascular diseases. The optimal dietary ratio of omega-6 to omega-3 PUFA is between 1:1 to 4:1. An

increased ratio of omega-6 :omega-3 leads to an increased frequency of heart diseases and stroke (Cox and Nelson 2008).The ratio in native chicken was found to be within the range of optimal dietary ratio, hence is more preferred in cardiac patients

The mean values of ratio between saturated and unsaturated fatty acids were found to be 1.11 in Native chicken eggs and 0.95 in White Leghorn. The ratio was found to be significantly higher in Native chicken eggs by a value of 0.16 when compared with the White leghorn eggs ($P \leq 0.01$).

5.1.4. Yolk Cholesterol

The yolk cholesterol estimated in six eggs at 40 weeks of age in Native chicken ranged from 13.96 to 20.6 mg per g of yolk with a mean value of 15.93 mg/g yolk (Table 8). This mean value is higher than those values reported by Jayasree (2000) in Naked Neck hens (14.46 mg) at 40 weeks of age and also in Native chicken of Northern Kerala (14.67 mg) reported by Girishkumar (2009).

The yolk cholesterol content studied in six eggs of White Leghorn at 40 weeks of age ranged from 14.72 to 19.21 mg per g of yolk with a mean value of 16.52 mg is exactly similar to to the value (16.3 mg) reported by Campo (1995) in White Leghorn. However, lower values of 14.6, 14.4 and 13.3 mg/g yolk were reported by Jiang *et al*. (1991), Verma *et al*. (1998) and Yin *et al*. (2008) respectively, could be due to the strain differences used for the study.

The total cholesterol content in Native chicken egg was found to be 210.44 mg per egg and in White Leghorn It was 224.18 mg per egg. Hence we could conclude that Native chicken eggs are a healthy choice when compared to White Leghorn eggs.

5.1.5. Minerals in Albumen and Yolk of Native chicken and White Leghorn

Iron

In Native chicken eggs, the iron content in albumen ranged from 1.11 to 4.38 ppm with a mean value of 2.10 ppm (Table 9) and the range values in the yolk were 38.56 to 51.92 ppm with a mean of 46.31 ppm (Table 10). The iron content in the yolk was 22 times higher than that of albumen. Kilic *et al.* (2002) reported higher values of iron in albumen (2.24 ppm) and yolk (62.1 ppm) of village chicken eggs. In the present study, the lower value of iron in Native chicken egg could be due to the lack of mineral availability under backyard system of rearing of Native chicken in this region. Shortage of scavenging area also can be attributed as another reason for low iron in albumen of Native chicken egg.

In White Leghorn eggs, the iron content in albumen showed higher range of values from 1.66 to 8.00 ppm with a significantly higher mean value of 4.76 ppm. Hence, the White Leghorn egg albumen is considered as the rich source of iron. It was higher by 2.66 ppm than that of native chicken eggs. In the yolk also, iron content showed higher range of values (42.99 to 74.50 ppm) with a mean value of 54.33 ppm. Higher values of iron in albumen and yolk of White Leghorn egg could be due to the supplementation of mineral mixture in the diet of White Leghorn hens.

Copper

In the present study, the copper content in albumen ranged 0.36 to 0.42 ppm with the mean value of 0.38 ppm in Native chicken eggs (Table 9). In White Leghorn eggs, the copper content in albumen 0.29 to 0.60 ppm with the mean value of 0.39 ppm. It appears that the copper content of albumen in native chicken was similar to that of White Leghorn eggs. However, values reported in courtyard eggs and conventional (0.254 and 0.212 ppm) by Giannenas *et al.* (2009) was lower and that reported by Kilic *et al.* (2002) for village eggs (0.79) was higher.

These differences might be related with the differences in rearing practices adopted in various studies.

The copper content in yolk (Table 10) was significantly lower (P≤ 0.05) in Native chicken eggs than that of White Leghorn eggs. The values were ranged from 0.83 to 1.48 and 1.29 to 1.74 ppm mean values of 1.18 and 1.49 ppm in native chicken and White Leghorn eggs respectively. The values reported by Giannenas *et al.* (2009) and Kilic *et al.* (2002) in courtyard eggs, conventional eggs and by for village eggs were almost similar (1.28, 1.36 and 1.38 ppm).

Zinc

The content of Zinc in the albumen ranged from 0.91 to 2.45 ppm and 0.48 to 0.73 ppm with a mean value of 1.59 and 0.66 ppm in Native chicken and White Leghorn eggs respectively and the mean value was significantly higher (P< 0.05) by 0.93 ppm in the former group (Table 9). Therefore, the the Native chicken egg albumen can be considered as the rich source of Zinc. The values reported by Giannenas *et al.* (2009) in conventional and courtyard eggs (1.00 and 1.39 ppm) are lower and are not in agreement with the results obtained in the present study.

The presence of Zinc in yolk ranged from 26.08 to 35.70 ppm and 30.21 to 42.90 ppm in Native chicken and White Leghorn eggs respectively with mean value of 31.32 and 35.92 ppm (Table 10). These results are in agreement with values reported by Kilic *et al.,* (2002) in village eggs (32.9) but higher than that reported by Giannenas *et al.,* (2009) in conventional and courtyard eggs (20.68 and 21.20 ppm).

Manganese

The mean values of Manganese were 0.73 and 0.60 ppm in albumen with range of values 0.37 to 1.69 and 0.33 to 1.06 ppm in Native chicken and White Leghorn respectively (Table 9). In the yolk, the values were ranged from 0.44 to 1.57 ppm and 0.38 to 1.65 ppm respectively with the mean value of 0.88 and 1.06

ppm respectively (Table 10). Lower values were reported by Giannenas *et al.,* (2009) in courtyard and conventional eggs (0.71and 0.84 ppm).

Calcium

The range of values of Calcium in albumen (Table 9) of Native chicken and White Leghorn (0.0031 to 0.0092 and 0.0025 to 0.0097 mg per cent) did not vary greatly, so also the mean values (0.0090 and 0.0069 mg per cent). Higher calcium content was reported by Kilic *et al.* (2002) in village eggs (0.0192). The calcium content in yolk (0.0818 to 0.1352 and 0.08 to 0.155 mg per cent) also did not vary greatly between Native chicken and White Leghorn eggs and the mean values were 0.1020 and 0.1249 mg per cent, respectively (Table 10). Comparatively lower value was reported by Kilic *et al*. (2002) in village eggs (0.0794 mg per cent).

Magnesium

The Magnesium content in egg albumen (Table 9) of Native chicken and White Leghorn layers ranged from (0.0085 to 0.0113 and 0.0069 to 0.0116 mg per cent) with mean values of 0.0103 and 0.0104 mg per cent respectively is in agreement with mean value (0.0101 mg per cent) reported by Kilic *et al.* (2002) in village eggs.

The Magnesium content in egg yolk (Table 10) of Native chicken ranged from White Leghorn chicken ranged from (0.0068 to 0.0010 and 0.0102 to 0.0154 mg per cent) with a mean value of 0.0088 and 0.0125 mg per cent and it was significantly lower by a value of 0.0037 mg per cent ($P \leq 0.05$). The magnesium content in village eggs reported by Kilic *et al*., (2002) was higher (0.0175 mg per cent).

In the albumen, Zinc was significantly higher in Native chicken eggs because of the sources of sprouting seeds, oysters, peanuts, mushrooms were easily accessible for scavenging birds under backyard system of rearing. Poor source of iron in the feed might be the reason for significantly lower iron content in egg white of Native chicken. However, the addition of mineral mixture in layer feed is advantageous for White Leghorn, could be the reason for the significantly higher amount of Iron in egg white and Copper and Magnesium in egg yolk of White Leghorn hens.

The trace minerals Iron, Zinc and Manganese in the egg yolk of Native chicken under backyard system were comparable with that of White Leghorns reared under intensive system. Mineral supplements are being added as a mixture in the feed under intensive system of rearing. Whereas, the Native chicken did not receive any mineral mixture in their feed and probably this is reflected in the mineral content of eggs. Despite the lack of supplementation of minerals to the Native chicken, the differences were relatively small in the case of Iron, Zinc, Manganese and Calcium deposition in the yolk. Therefore, the mineral nutrition of Native chicken is to be emphasised for further improvement in the production traits.

Based on the above findings, the mineral deposition in egg albumen and yolk can be interpreted in relation with the physical composition of eggs. The egg weight was 39.35 and 49.54 g in Native chicken and White Leghorn respectively and the significantly higher egg weight was contributed by significantly higher albumen content in White Leghorn eggs. The absolute weight of albumen in White Leghorn eggs revealed that the difference in weight was due to higher width of albumen. The weight of albumen averaged 25.68 and 38.54 g while the yolk weight averaged only 13.21 and 13.57 g in Native chicken and White Leghorn eggs respectively. Therefore it can be concluded that the intake of one Native chicken egg will contribute higher quantity of Zinc and the intake of White Leghorn egg will contribute higher quantity of iron.

5.2. EGG PRODUCTION IN NATIVE CHICKEN AND WHITE LEGHORN

5.2.1. Hen Housed and Hen Day Egg Production

In Native chicken, the egg production was 40.23 eggs per hen up to 40 weeks of age (28.70 per cent) on hen housed (HH) basis and 41.86 eggs per hen (29.90 per cent) on hen day basis (Table 11). Lower values for Hen Housed egg production reported by Girishkumar (2009) for Native chicken of northern Kerala (33.06 eggs, 23.61 per cent) and by Ajithbabu (2010) in Gramalekshmi (38.63 eggs 32.46 per cent) and in Gramasree (38.60 eggs and 32.44 per cent). The corresponding values on Hen Day (HD) basis reported by the above authors were 34.59, 42.28 and 40.82 eggs per hen with percentage egg production of 24.71, 35.53 and 34.30 respectively. Hen day production of 32.6 per cent in desi chicken and 34.3 per cent in Bengal black chicken was also reported by Aggarwal *et al.* (1971).

In White Leghorn, the egg production was 121.57 eggs per hen (86.83 per cent) up to 40 weeks of age in White Leghorn, on hen housed (HH) basis. The corresponding figures on hen day basis were 123.60 eggs with 88.20 per cent production. These findings are in close agreement with the values reported by Giriraj *et al.* (2008a) in NxP strain cross of White Leghorn (121.32 eggs with 86.66 per cent). But lower value was also reported by the same authors in PxN strain cross White Leghorn (118.82 eggs with 85.06 per cent). Higher egg production was also reported by Anon (2010) in IWN (127.2 eggs) and IWP (124.47 eggs) strains on HH basis and (128.01) and IWP (125.10) on HD basis, at A.I.C.R.P. Poultry Research Station, Mannuthy.

The egg number up to 40 weeks of age in terms of survivor egg production (Table 12) was 41.91 for Native chicken and 125.35 for White Leghorn chicken. The survivor's egg production for IWP strain (125.95) reported at A.I.C.R.P. Poultry Research Station, Mannuthy (Anon, 2010) was in close agreement with the value obtained in present study.

5.2.2. Age at first egg

The age at first egg (AFE) ranged from 157 to 229 days with mean value of 185.62 days in Native chicken (Table 12) is intermediary between the value of 189.20 days in Kadakanath, 176.20 days in Native chicken of Garhwal, Himalayas and 177.60 days in Native chicken of Northern Kerala reported by Thomas and Rao (1988), Singh and Kumar (2008) and Girishkumar (2009) respectively. The age at first egg in Gramalekshmi (177.1 days) and Gramasree (179.7 days) cross bred layers was lower under backyard system of rearing (Ajithbabu, 2010). While the values reported by Acharya and Kumar (1971) in desi chicken (204.3 days) and in improved strains of desi chicken (214 days) at I.V.R.I., Izatnagar (Anon, 1967) were higher than that recorded in the present study. The differences in these results might be due to the variations in feeding and management practices and type of birds used in the studies. Late maturity in Native chicken is natural and due to genetic architecture of the stock as well as lower plane of nutrition available for Native birds under backyard system of rearing.

The Age at First Egg (AFE) in White Leghorn ranged from 125 to 161 days with overall mean of 141.25 is in agreement reported by Laxmi *et al.* (2010) for IWH (141.71 days) and a better value in IWN (136.55 days) strain of White Leghorn at A.I.C.R.P. in Poultry Research Station, Mannuthy (Anon, 2010) was also reported. Better AFE in White Leghorn is due to improved selection procedure undergone in the population.

The negative correlation between egg production and AFE is well established in chicken layers. This Native population had low egg production (41.86 eggs HDEP up to 40 weeks) and therefore higher AFE is bound to occur.

5.2.3. Livability in Native chicken and White Leghorn

The livability pattern presented in Table 12 revealed that there was no mortality during the period 21-24 weeks of age and number of deaths subsequently in periods II to V was 1, 1, 3 and 2 with per cent mortality of 1.67, 1.69, 5.17 and 3.64 respectively, in Native chicken. The overall livability was 88.33 per cent in Native chicken (mortality per cent 11.67).

The cause of death (Table 13) in Native chicken in all cases reported by the farmers was predators like mongoose, dogs and foxes. The exact cause of death of individual birds was not known. No history of diseases noticed in case of dead birds, except in one case where signs of respiratory distress noticed. The scavenging nature of Native chicken away from the farmer's house was the reason for increased mortality due to predation. Out of six deaths in Native chicken only one was due to disease. This indicates that the Native chicken are more resistant to diseases than the other breeds. The cause of death in two White Leghorn birds was ailments (peritonitis and pasteurellosis).

In White Leghorn, two (2) birds died (3.33 per cent) during the period III (29-32 weeks of age) with no mortality in other periods. Therefore, overall livability during the period from 21 to 40 weeks of age was 88.33 per cent in Native chicken and 96.67 per cent in White Leghorn (mortality per cent 11.67 and 3.33 per cent respectively).

5.3. FEED INTAKE IN NATIVE CHICKEN AND WHITE LEGHORN

5.3.1. Feeding Management in Native chicken

The survey revealed that all the 20 households provide kitchen waste and left over feed to their birds. In addition, supplemental feeding for nutritional reasons is commonly being practiced in almost all houses, except two (Table 14). Fifty per cent of the households provided broken rice (ten); whereas 35% provided wheat (seven) and five per cent provide commercial poultry feed (one). Rice is the common feed in Kerala, so as in this area and therefore rice is the readily available grain in the households. Rice and wheat are easily available feed

items. It is also noted that out of 20 households, except one, none of the farmers used compound poultry feed. Mandal *et al.* (2006) reported that during scavenging, the birds generally fed on kitchen waste, earthworms, grasshoppers, ants, green grasses, leafy vegetables, seeds etc and in addition to scavenging, all the poultry owners offered a handful of broken wheat, rice, bajra, maize etc. to their birds which are the locally and commonly available feed stuffs. Also, Vijh *et al.* (2005b) found that scavenging with supplementation of kitchen waste was the most common feeding system practiced in case of native breed Kalasthi birds; in addition grains like paddy and bajra were also fed.

Among the 18 households giving supplemental feeding to their birds, two households provided feed during morning (11.11%); five during noon (27.78%); three during evening (16.67%); and seven during morning and evening (38.8%). No special timing followed by one household (5.56%). More per cent of households feed their birds twice a day. Das *et al.* (2008) in a study on rural families in Bangladesh, reported the practice of feeding birds twice a day, once in morning when birds leave night shelter and again in the evening when they return.

In general there is no rigid timing necessary in native chicken rearing unlike intensive system of rearing. This allows the households to take care of their birds at the leisure time.

Based on the quantity of feed provided per bird, two households provided about 10 to 20 grams of feed (11.11%); eleven households about 20 to 30 grams of feed (61.11%); two households about 30 to 40 grams of feed (11.11%) ; and three households more than 40 grams of feed (16.67%). More per cent of households provided about 20 to 30 g of feed. Kumar and Kumar (2007) documented that some farmers of Local Hill Fowls of Uttarakhand provided about 25 to 30 g of feedstuffs like kadan, manduwa, jhangora, wheat, rice and maize per day.

5.3.2. Feed intake in White Leghorn

The average feed intake per bird per day during 1st, 2nd, 3rd, 4th and 5th was 112, 110, 111, 110 and 122 g. The overall mean feed intake per bird per day was found to be 113 g (Table 15). The average feed intake obtained in a field level testing of performance of White Leghorn ILM90 birds in a poultry farm, Namakkal was 110-112g per bird per day, found to be in close agreement with the value obtained in present study (Anon, 2010). Verma *et al.* (1998) documented a lower value in single comb White Leghorn layers as 104 g per bird per day. The difference in the feed intake could be due to the difference in the strain. The feeding and management practices as well as the palatability of the feed could be other reasons.

The FCR for the five periods were presented in the Table.15 and the values were 1.76, 1.44, 1.45, 1.42and 1.63. The overall Feed Conversion Ratio obtained was 1.53. Higher FCR values were noted for 40 week old White Leghorn breeder hens by Zahoor-ul-Hassan et al. (2010) in a study and the values were 2.40, 2.01 and 2.00 at 1st, 2nd and 3rd weeks of age respectively. Better FCR values in present study could be due to the improvement in the strain.

6. SUMMARY

A comparative study of egg quality traits was carried out in eggs collected from Native Chicken reared under backyard system and White Leghorn layers reared under intensive system. The overall results obtained in the present study are furnished below.

1. The egg weight of Native Chicken (39.35 g) was significantly lower ($P \leq 0.05$) compared to that of White Leghorn (49.54 g). The breadth and length of eggs of Native Chicken averaged 37.55 and 50.36 mm and that of White Leghorn eggs averaged 40.74 and 54.02 mm respectively and both these parameters were significantly higher in WL eggs ($P<0.05$).
2. The egg shell quality indicated significantly lower shell weight (4.21 g) and significantly higher proportion of shell (10.73 per cent) in relation with its egg weight in Native Chicken compared to the corresponding values recorded in White Leghorn eggs (4.61 g and 9.30 per cent) ($P \leq 0.05$).
3. The height and width of albumen and albumen index of Native Chicken were 4.32 mm, 83.73 mm and 0.05 and that in White Leghorn were 6.41 mm, 76.54 mm and 0.09 respectively and these traits were significantly higher in WL eggs ($P<0.05$). The weight of albumen and its percentage in relation with egg weight and the Haugh unit score of Native Chicken were 21.92 g, 55.65 per cent and 71.47 and that in White Leghorn were 31.36 g, 63.45 per cent and 81.33 respectively. All the parameters were significantly lower in native Chicken ($P<0.05$).
4. The yolk height and yolk index in Native Chicken egg was 13.94 mm and 0.35 and the corresponding values in White Leghorn egg was 15.87 mm and 0.41 respectively. Even though the yolk width (40.02 vs 39.53 mm) was statistically comparable, the yolk height and yolk index were significantly lower in Native Chicken eggs ($P \leq 0.05$). Whereas, the yolk per cent (33.62) and yolk color index (8.11) was significantly higher in native Chicken egg than that of White Leghorn eggs (27.26 and 5.31)

(P≤0.05). Based on these findings, the yolk quality of Native Chicken egg is considered as superior.

5. Of the total fatty acids present in egg yolk, the proportion of saturated fatty acids in Native Chicken egg was significantly higher (52.63 vs. 48.62 per cent). While the percentage of total unsaturated fatty acids in Native Chicken egg (47.35 vs. 51.38 per cent) was significantly lower (P≤0.01) compared with that of White Leghorn egg. The ratio between saturated and unsaturated fatty acids was significantly higher (1.11) in Native Chicken eggs compared with that of White Leghorn eggs (0.95).
6. The content of Linoleic acid (Omega-6 fatty acid) in egg yolk was 8.50 per cent in Native Chicken and 11.53 per cent in White Leghorn egg and it was significantly lower in the former group (P≤0.01). The presence of Omega-3 fatty acids in Native Chicken egg is numerically higher (3.50 vs. 2.56 per cent). Thereby, the ratio between omega-6: Omega-3 was significantly lower in Native Chicken (2.89) compared with that of White Leghorn egg (6.01) (P≤0.01).
7. In Native Chicken and White Leghorn egg albumen, the content of iron (2.10 vs 4.76 ppm) was more than that of Zinc (1.59 vs.0.66 ppm). Significantly lower quantity of Iron and significantly higher content of Zinc was noticed in Native Chicken egg (P<0.05).
8. Copper and Magnesium in yolk were significantly lower in Native Chicken eggs (P<0.05). The Copper content was 1.18 and 1.49 ppm and the Magnesium content was 0.0088 and 0.0125 mg per cent in Native Chicken and White Leghorn eggs, respectively.
9. The Age at First Egg in Native Chicken was found to be 185.62 days and that in White Leghorn was 141.25 days. The egg production up to 40 weeks of age on hen housed, hen day and survivor basis was 40.23 (28.70 per cent), 41.86 (29.90 per cent) and 41.91 eggs in Native Chicken and 121.57 (86.83 per cent), 123.60 (88.28 per cent) and 125.35 in White Leghorn respectively. The livability up to the end of 40 weeks was 88.33 per cent for Native Chicken and 96.67 per cent for White Leghorn.

10. The survey revealed that in addition to scavenging, the birds were handfed and the main feed item provided by the farmers include rice and wheat (85 per cent) and majority of households (61.11 per cent) provided about 20 to 30 g feed. The overall mean feed intake per bird per day was found to be 113 g in White Leghorn and the overall Feed Conversion Ratio obtained was 1.53.

Based on the above findings, it was concluded that the egg weight, shell weight and the albumen weight were significantly higher in White Leghorn, but the yolk weight was comparable. The yolk per cent and shell per cent were lower and albumen per cent was higher in White Leghorn. Therefore, the increased egg weight was due to the higher albumen weight. The albumen width was higher in Native Chicken and the albumen height was higher in White Leghorn. Thus, a superior Albumen Index and Haugh Unit Score were noticed in White Leghorn. Even though the yolk width was comparable, the yolk height and index was higher in White Leghorn. Better yolk color index was noticed in Native Chicken.

Copper and Magnesium in egg yolk and Iron in egg albumen were significantly higher in White Leghorn egg. In Native Chicken egg, significantly higher content of Zinc in albumen can be considered as a positive attribute. Even though the percentages of all the individual saturated fatty acids were comparable, the total saturated fatty acid per cent was significantly higher. The significantly lower per cent of total unsaturated fatty acid was due to the lower per cent of omega-6 fatty acid in Native Chicken, even though the omega-3 fatty acid per cent was higher in Native Chicken. Thus a higher saturated:unsaturated fatty acid ratio and a lower omega-6:omega-3 ratio were obtained.

Late sexual maturity and poor egg production are inherent in Native Chicken; more studies are warranted to establish the quality profile of Native Chicken eggs.

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ABSTRACT

A study was conducted to evaluate the egg quality in 100 eggs each of Native chicken (NC) and White Leghorn (WL) during 21 to 40 weeks of age which included the external and internal quality parameters, fatty acids, yolk cholesterol and mineral estimation in yolk and albumen. Also, the egg production, livability and feed intake in NC reared in backyard system and WL layers reared in cages were studied.

Among the external quality traits, the egg weight (39.35 vs. 49.54 g), egg length (50.36 vs. 54.02 mm) and breadth (37.55 vs. 40.74 mm) were lower in NC whereas, the shape index was comparable. Except the albumen width (83.73 vs. 76.54 mm), all the albumen traits were inferior in NC compared to WL with Albumen height (4.32 vs. 6.41 mm), index (0.05 vs. 0.09 mm), weight (21.92 vs. 31.36 g), per cent (55.65 vs. 63.45) and Haugh Unit Score (71.47 vs. 81.33). Significantly lower values yolk height (13.94 vs. 15.87 mm) and index (0.35 vs. 0.42) and higher values for yolk per cent (33.62 vs. 27.26) and yolk color index (8.11 vs. 5.31) were noticed in NC. The yolk width, weight and cholesterol content were comparable between the breeds. Significantly lower shell weight (4.21 vs. 4.61 g), higher shell per cent (10.73 vs. 9.30) noticed in NC.

In the egg yolk, the mean values of saturated fatty acids; Palmitic , Stearic, Arachidic and Behenic acids were comparable between NC and WL eggs, although these acids when put together, a significantly higher (52.65 vs. 48.62 per cent) in the former group was noticed. Significantly lower quantity of Linoleic acid (8.50 vs. 11.53 per cent) the omega-6 category as well as the Omega-6: omega-3 ratio (2.89 vs. 6.01) was advantageous even though total unsaturated fatty acid was significantly lower in NC eggs (47.35 vs. 51.38 per cent). On the other hand, the ratio between saturated and unsaturated acids was significantly higher in NC egg (1.11 vs. 0.95). The monounsaturated fatty acids, Oleic acid (31.24 vs. 31.52 per cent) and Palmitoleic acid (4.11 vs. 5.77 per cent) and these two acids put together (35.35 vs. 37.29 per cent) were non-significant. The total poly unsaturated fatty acids, including Omega-6 and Omega-3 were comparable

both in NC and WL eggs. Of the total fatty acids, the mean value of and Omega-3 fatty acids; linolenic acid, EPA and DHA were comparable separately (0.83, 1.61 and 1.06 vs. 0.61, 0.88 and 1.07 per cent). The total of Omega-3 acids was numerically higher in NC egg (3.49 vs. 2.55 per cent).

The mineral profile of eggs indicated that WL eggs are superior ($P<0.05$) in respect of Iron in albumen (2.10 vs. 4.76 ppm), Copper in yolk (1.18 vs. 1.49 ppm) and Magnesium in yolk (0.0088 vs. 0.0125 mg per cent). This indicated the necessity of inclusion of trace mineral mixture in the diet of native chickens. NC egg albumen is a rich source of Zinc (1.59 vs. 0.66 ppm).

Late sexual maturity indicated by age at first egg of 185.62 days in NC vs. 141.25 days in WL and poor egg production indicated by 40.23 vs. 121.57 eggs (28.70 vs. 86.83 per cent) on HH basis and 41.86 vs. 123.60 eggs (29.90 vs. 88.28 per cent) on HD basis up to 40 weeks of age suggest modifications in feeding patterns of Native chicken. The livability was (88.33 vs. 96.67 per cent) in WL and NC hens with survivor egg numbers 41.91 and 125.35 eggs per hen.

The feed intake per bird per day was 113 g in WL whereas the native chicken was being reared by providing only about 20 to 30 g of supplemental feed per bird per day.

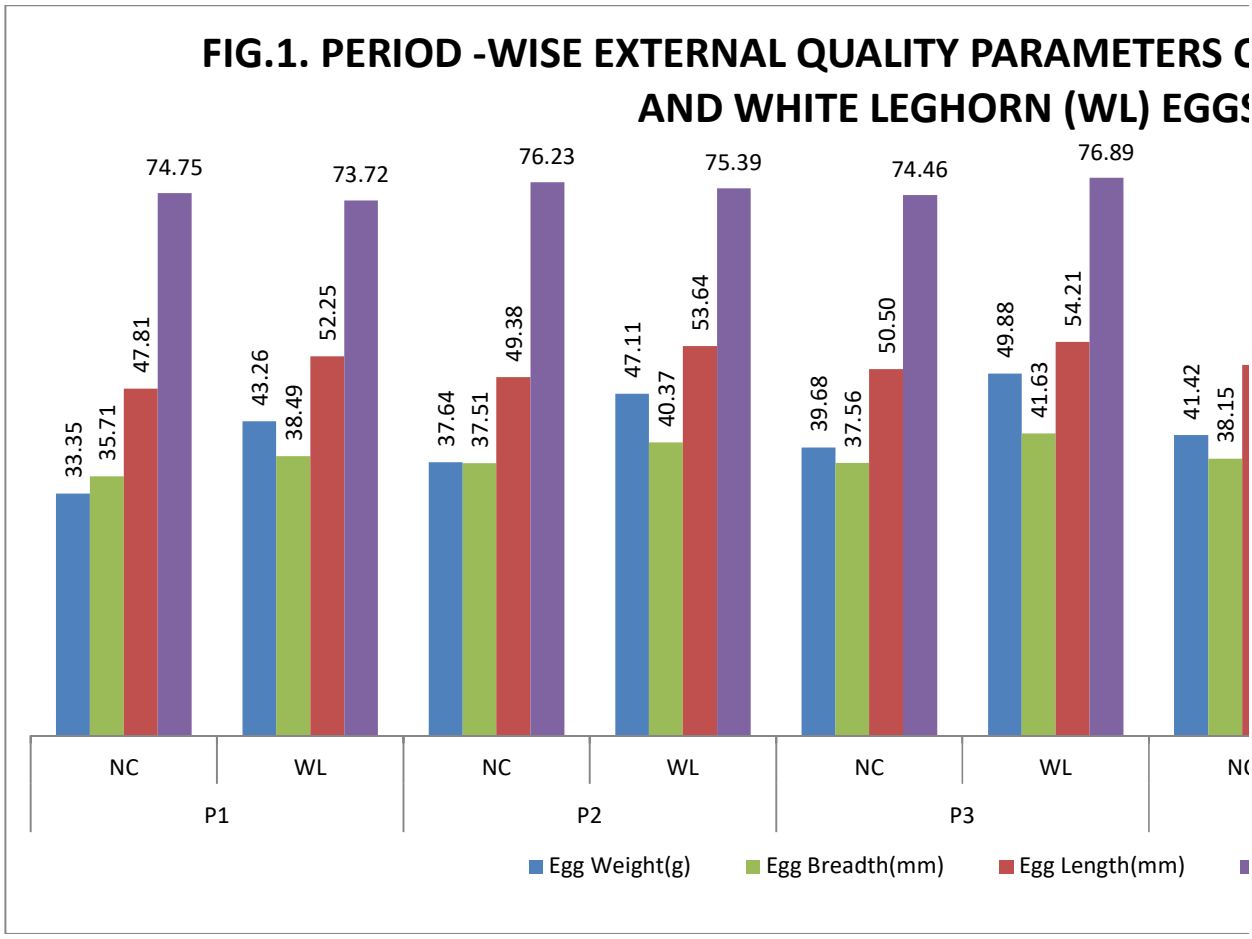
FIG.1. PERIOD -WISE EXTERNAL QUALITY PARAMETERS C
AND WHITE LEGHORN (WL) EGGS
74.75
73.72
76.23
75.39
74.46
76.89
33.35
35.71
47.81
43.26
38.49
52.25
37.64
37.51
49.38
47.11
40.37
53.64
39.68
37.56
50.50
49.88
41.63
54.21
41.42
38.15
NC
WL
NC
WL
NC
WL
NC
P1
P2
P3
Egg Weight(g)
Egg Breadth(mm)
Egg Length(mm)

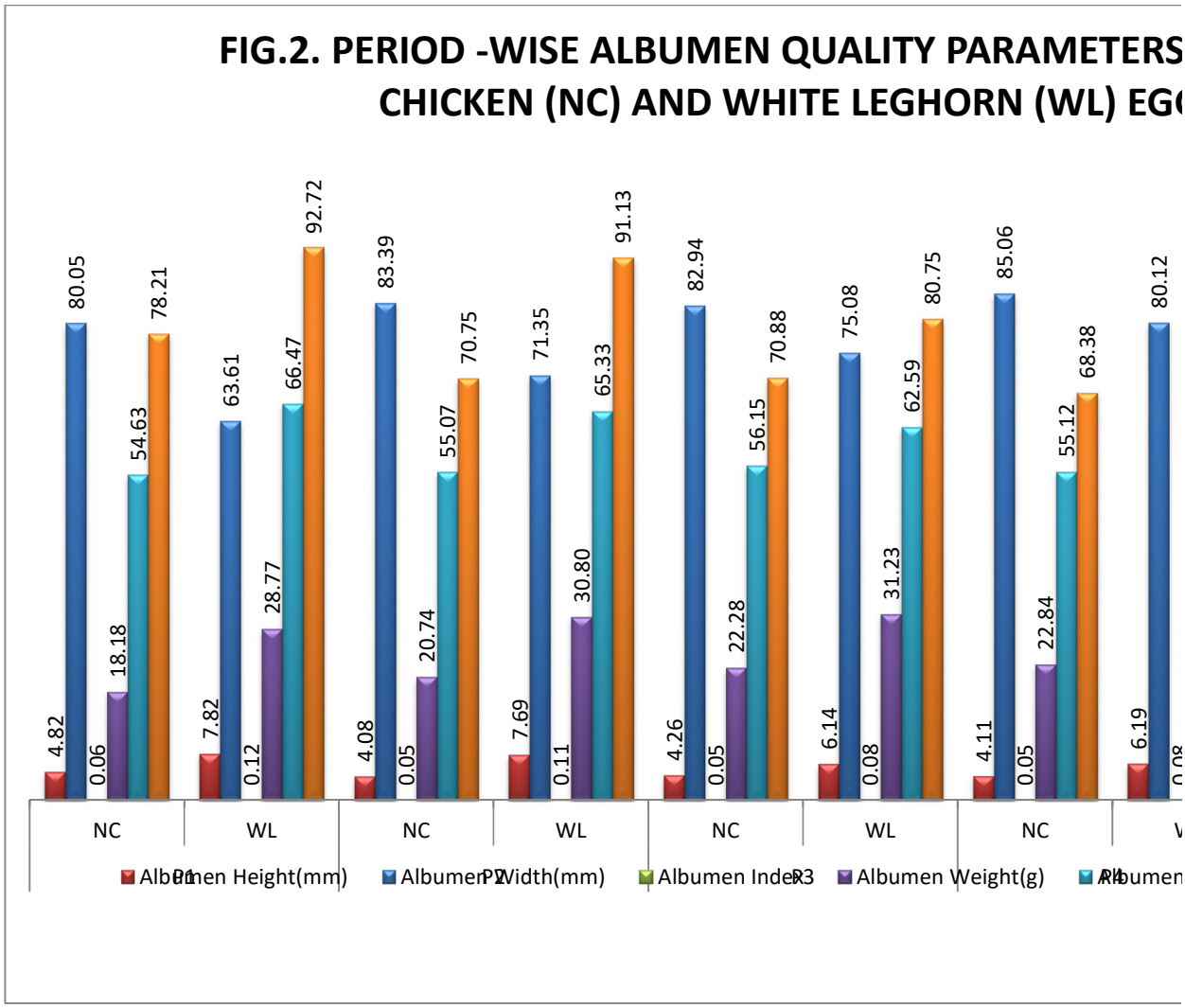
FIG.2. PERIOD -WISE ALBUMEN QUALITY PARAMETERS
CHICKEN (NC) AND WHITE LEGHORN (WL) EG
4.82
80.05
0.06
18.18
54.63
78.21
7.82
63.61
0.12
28.77
66.47
92.72
4.08
83.39
0.05
20.74
55.07
70.75
7.69
71.35
0.11
30.80
65.33
91.13
4.26
82.94
0.05
22.28
56.15
70.88
6.14
75.08
0.08
31.23
62.59
80.75
4.11
85.06
0.05
22.84
55.12
68.38
6.19
80.12
NC
WL
NC
WL
NC
WL
NC
Albumen Height(mm)
Albumen Width(mm)
Albumen Index
Albumen Weight(g)

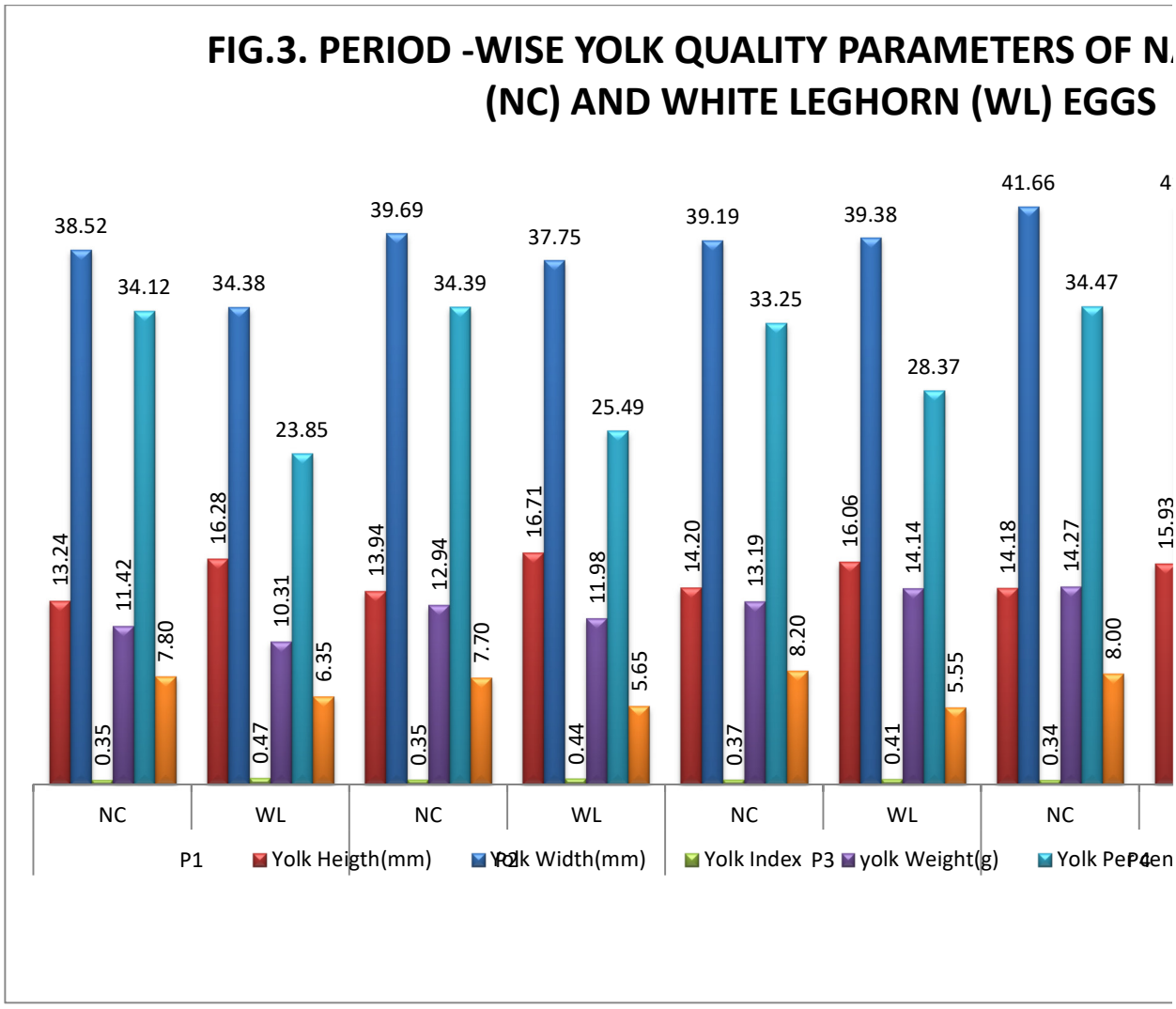
FIG.3. PERIOD -WISE YOLK QUALITY PARAMETERS OF N
(NC) AND WHITE LEGHORN (WL) EGGS
38.52
13.24
0.35
11.42
34.12
7.80
34.38
16.28
0.47
10.31
23.85
6.35
39.69
13.94
0.35
12.94
34.39
7.70
37.75
16.71
0.44
11.98
25.49
5.65
39.19
14.20
0.37
13.19
33.25
8.20
39.38
16.06
0.41
14.14
28.37
5.55
41.66
14.18
0.34
14.27
34.47
8.00
15.93
NC
WL
NC
WL
NC
WL
NC
P1
Yolk Heigth(mm)
Yolk Width(mm)
Yolk Index
P3
yolk Weight(g)
Yolk Pe
P4

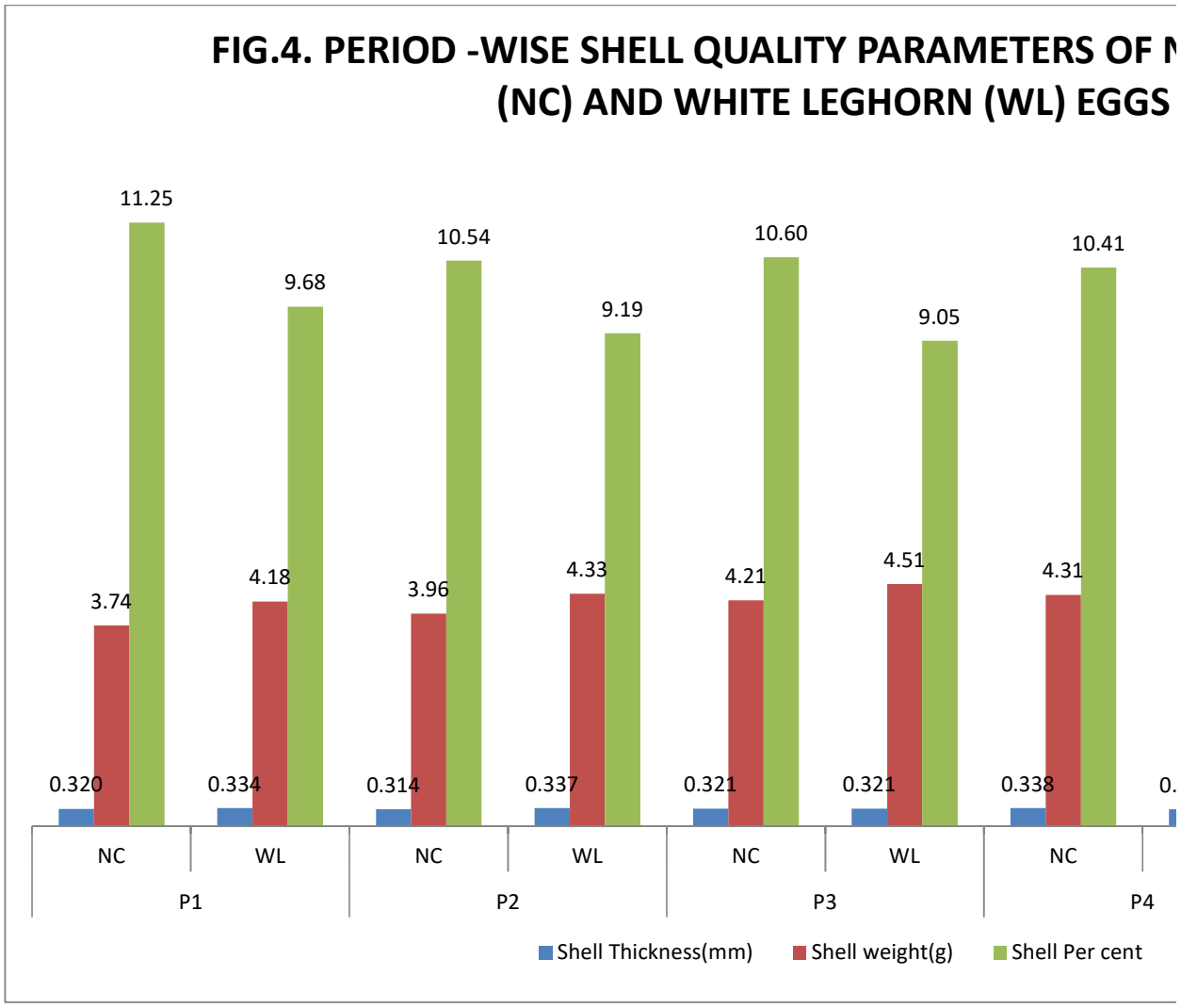
FIG.4. PERIOD -WISE SHELL QUALITY PARAMETERS OF N
(NC) AND WHITE LEGHORN (WL) EGGS
11.25
9.68
10.54
9.19
10.60
9.05
10.41
3.74
4.18
3.96
4.33
4.21
4.51
4.31
0.320
0.334
0.314
0.337
0.321
0.321
0.338
NC
WL
NC
WL
NC
WL
NC
P1
P2
P3
P4
Shell Thickness(mm)
Shell weight(g)
Shell Per cent

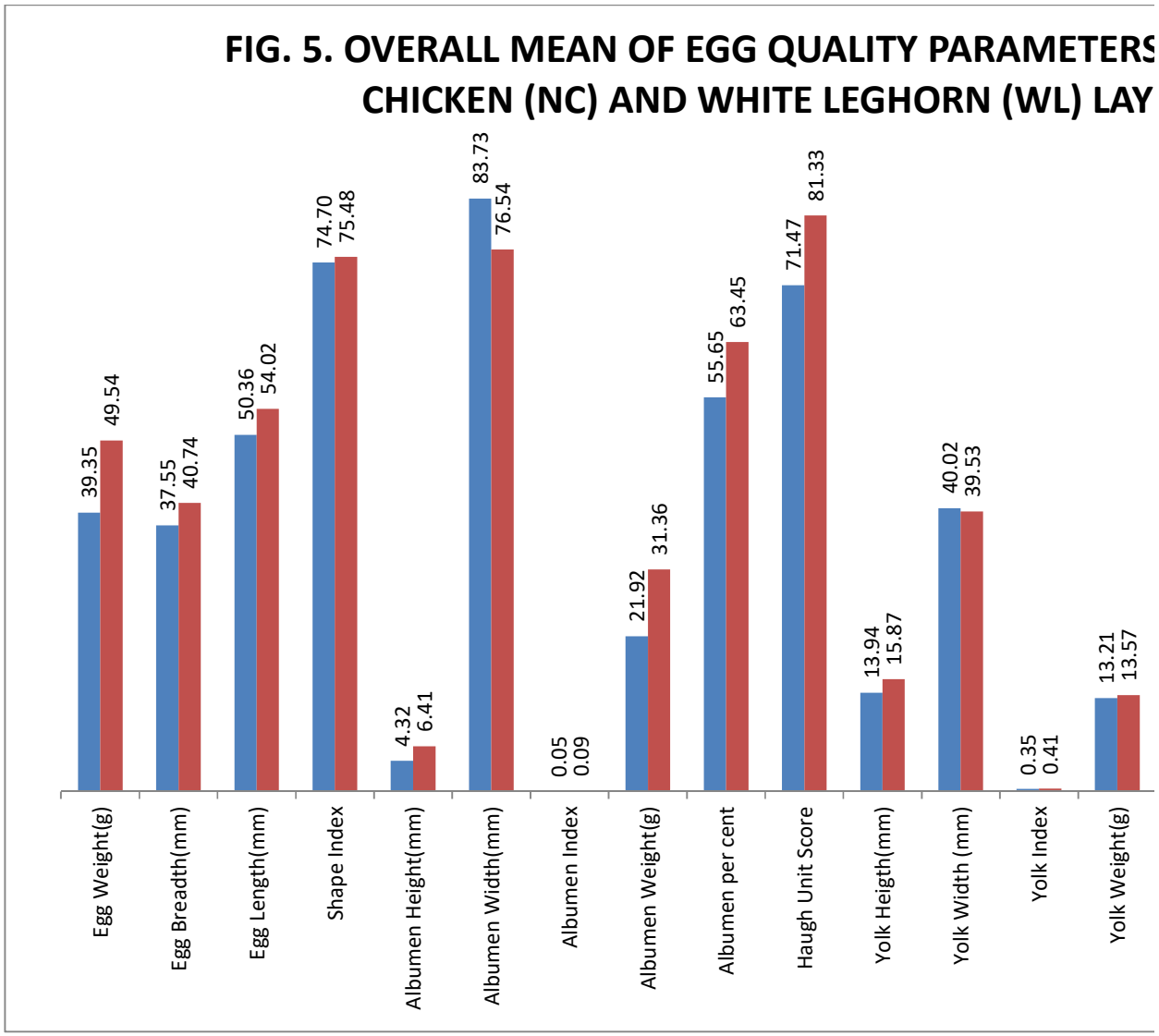
FIG. 5. OVERALL MEAN OF EGG QUALITY PARAMETERS
CHICKEN (NC) AND WHITE LEGHORN (WL) LAY
39.35
49.54
37.55
40.74
50.36
54.02
74.70
75.48
4.32
6.41
83.73
76.54
0.05
0.09
21.92
31.36
55.65
63.45
71.47
81.33
13.94
15.87
40.02
39.53
0.35
0.41
13.21
13.57
Egg Weight(g)
Egg Breadth(mm)
Egg Length(mm)
Shape Index
Albumen Height(mm)
Albumen Width(mm)
Albumen Index
Albumen Weight(g)
Albumen per cent
Haugh Unit Score
Yolk Heigth(mm)
Yolk Width (mm)
Yolk Index
Yolk Weight(g)

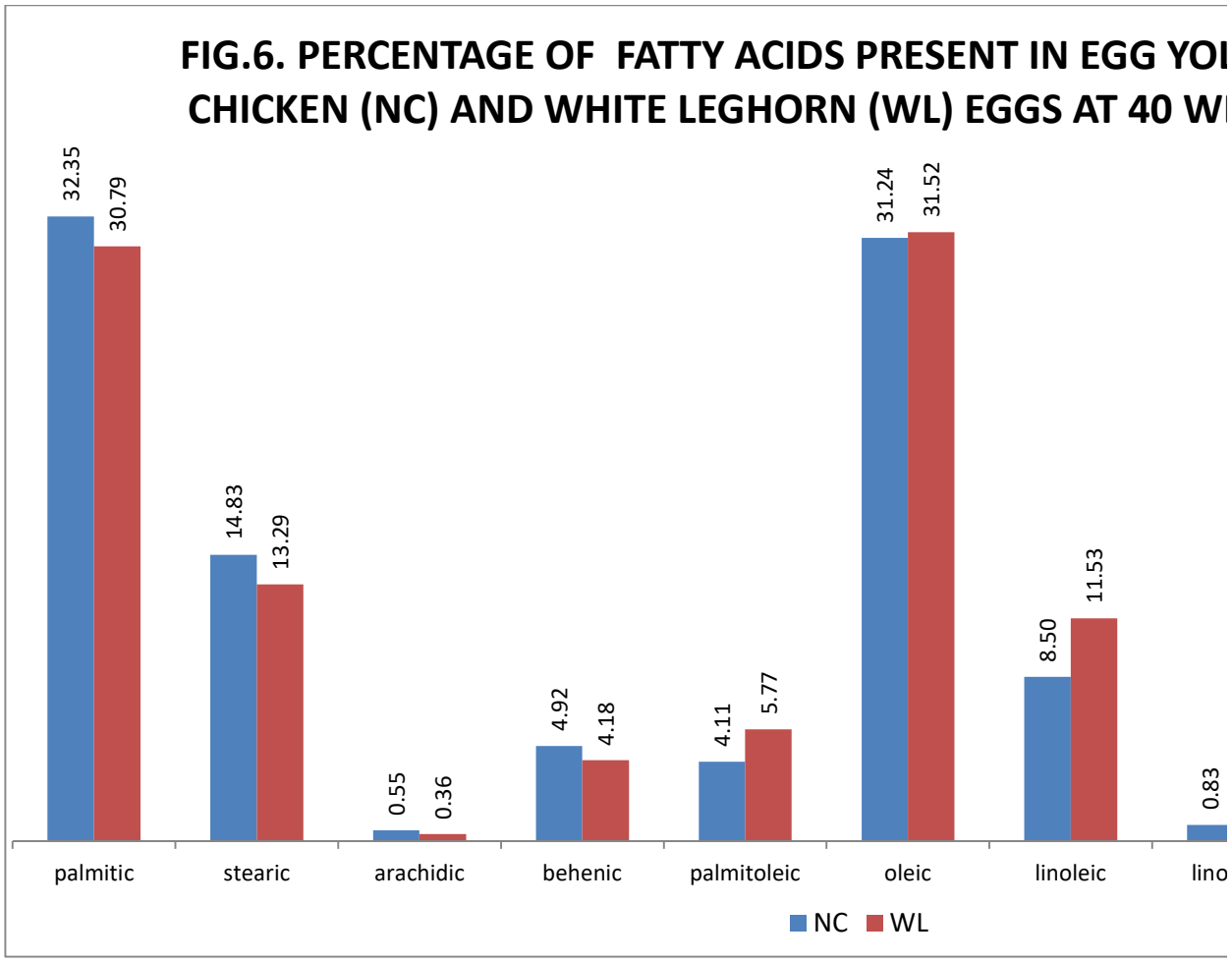
FIG.6. PERCENTAGE OF FATTY ACIDS PRESENT IN EGG YOI
CHICKEN (NC) AND WHITE LEGHORN (WL) EGGS AT 40 WI
32.35
30.79
14.83
13.29
0.55
0.36
4.92
4.18
4.11
5.77
31.24
31.52
8.50
11.53
0.83
palmitic
stearic
arachidic
behenic
palmitoleic
oleic
linoleic
lino
NC
WL

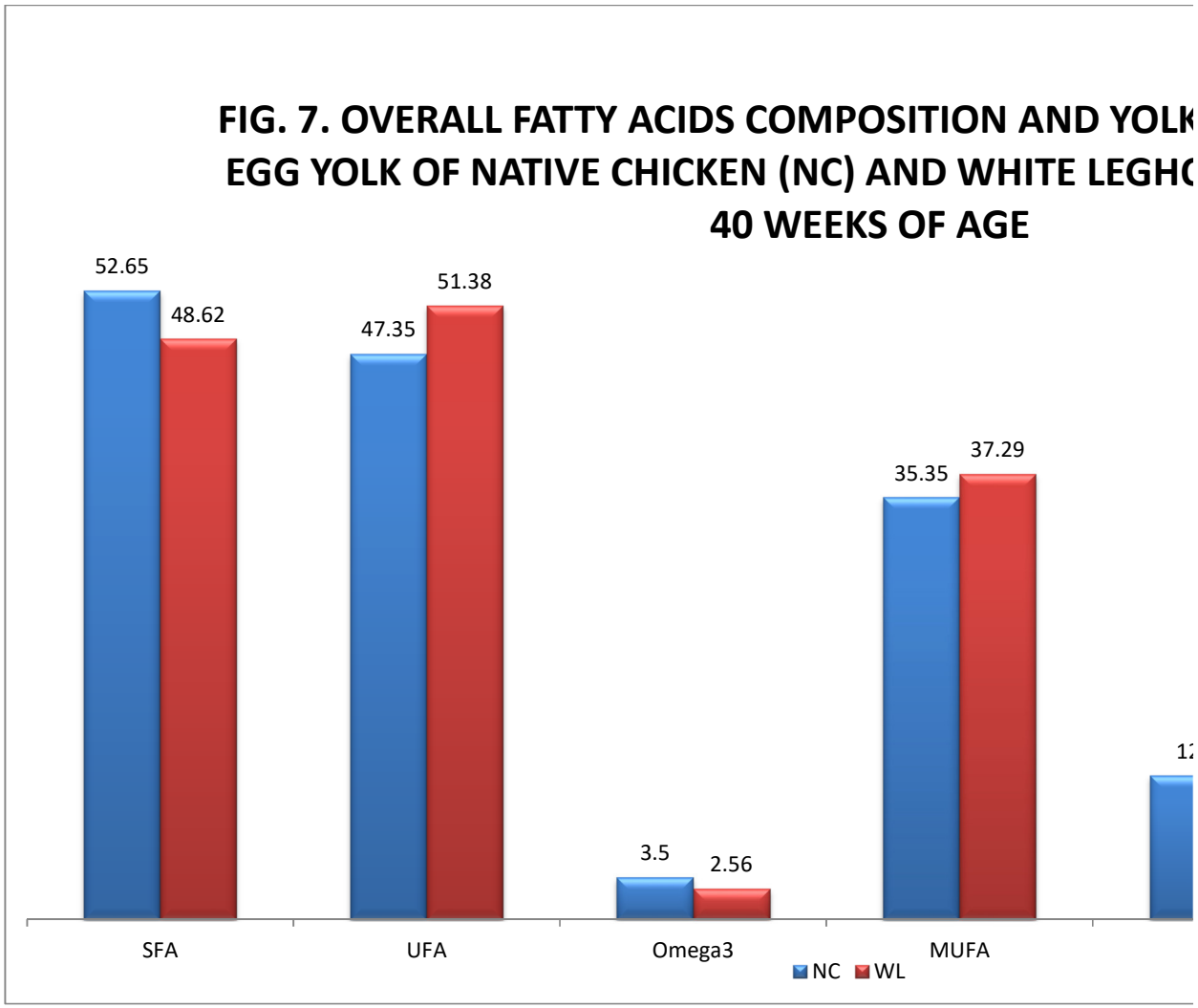
FIG. 7. OVERALL FATTY ACIDS COMPOSITION AND YOLK
EGG YOLK OF NATIVE CHICKEN (NC) AND WHITE LEGHO
40 WEEKS OF AGE
52.65
48.62
47.35
51.38
3.5
2.56
35.35
37.29
SFA
UFA
Omega3
MUFA
NC
WL

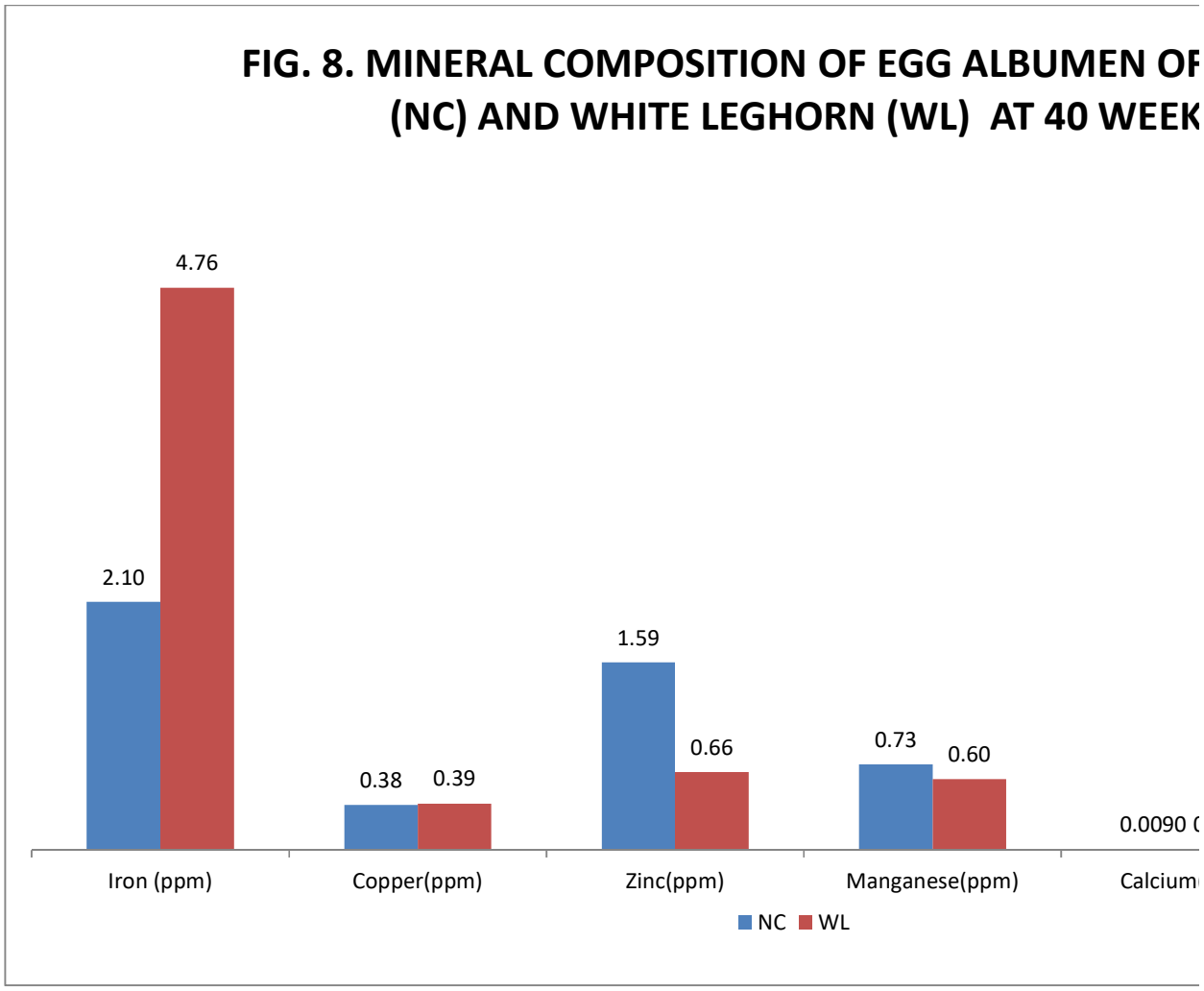
FIG. 8. MINERAL COMPOSITION OF EGG ALBUMEN OF
(NC) AND WHITE LEGHORN (WL) AT 40 WEEK
4.76
2.10
0.38
0.39
1.59
0.66
0.73
0.60
0.0090
Iron (ppm)
Copper(ppm)
Zinc(ppm)
Manganese(ppm)
Calcium
NC
WL

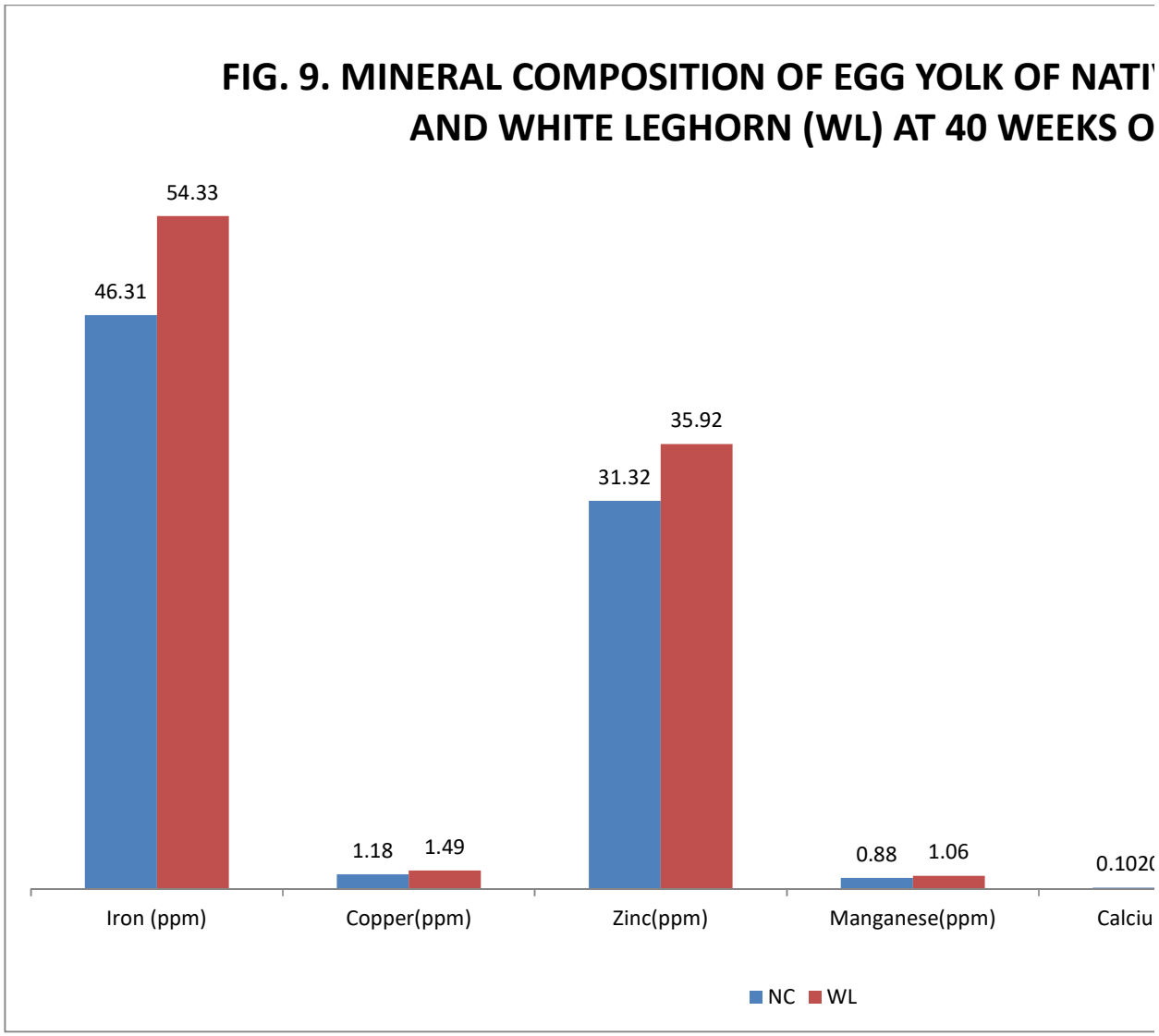
FIG. 9. MINERAL COMPOSITION OF EGG YOLK OF NATI
AND WHITE LEGHORN (WL) AT 40 WEEKS O
54.33
46.31
35.92
31.32
1.18
1.49
0.88
1.06
Iron (ppm)
Copper(ppm)
Zinc(ppm)
Manganese(ppm)
Calciu
NC
WL