



Received: 11 April 2016
Accepted: 25 May 2016
Published: 17 June 2016

*Corresponding author: Sohail Hassan Khan, Directorate of Poultry Research Institute, Murree Road, Shamsabad, Rawalpindi, Pakistan
E-mail: sohailhassan64@gmail.com

Reviewing editor:
Pedro González-Redondo, University of Seville, Spain

Additional information is available at the end of the article

ANIMAL HUSBANDRY & VETERINARY SCIENCE | RESEARCH ARTICLE

A comparative study on quality, proximate composition and cholesterol content of eggs and meat in Fayoumi and commercial White Leghorn chickens

Salma Abdul Rehman¹, Shamim Akhter¹, Sohail Hassan Khan^{2*} and Muhammad Ashraf Anjum²

Abstract: The present study was conducted at Poultry Research Institute, Rawalpindi (Pakistan) with the objective of evaluating egg quality, proximate composition and cholesterol content of eggs and meat in Fayoumi (FAY) and commercial (Nick chick) White Leghorn (WLH) breeds of chickens. For this purpose, 64 adult (40 weeks-old) laying hens, 32 each of FAY and WLH breeds were maintained on littered floor in two separate pens under optimal management conditions. The birds were fed *ad libitum* a balanced layers ration. They had free access to clean and fresh drinking water and were kept under 16 h daily lighting schedule. Egg quality parameters, proximate composition and cholesterol content of eggs were studied for 6 weeks by randomly collecting 3 eggs daily from each breed. Thigh and breast meat samples were obtained from randomly selecting two birds from each breed by slaughtering them at the termination of experiment for determination of proximate composition and cholesterol content. The results show significantly higher egg weight, albumen weight and moisture content in WLH eggs in comparison to FAY eggs, whereas significantly higher yolk, ether extract content and yolk: albumen

ABOUT THE AUTHORS

Salma Abdul Rehman has done MSc in Zoology.

Shamim Akhter is an Associate professor at Department of Zoology, Pir Mehr Ali Shah Arid Agriculture University, Rawalpindi, Pakistan. She completed her PhD in Zoology from the same university. She has published more than 100 papers in national and international journals. Her area of interest is reproductive physiology.

Sohail Hassan Khan is working as Assistant Nutrition Chemist at Poultry Research Institute, Rawalpindi, Pakistan. He got PhD in Animal Nutrition from the University of Agriculture Faisalabad, Pakistan. He has published more than 80 papers in national and international journals. He is a reviewer of many international journals. He works in the area of feed science.

Muhammad Ashraf Anjum is a research scholar in the Poultry Research Institute, Rawalpindi, Pakistan. He got MSc (Hons) Animal Nutrition degree from the University of Agriculture Faisalabad, Pakistan. His area of interest is poultry feeds.

PUBLIC INTEREST STATEMENT

Importance of native birds for rural economy is immense in different countries. Consumers prefer village produced eggs and poultry meat and are willing to pay higher price for these products. The eggs and poultry meat produced from rural chickens still have higher consumer preference than those from commercial chicken. Though these birds are being used for rural backyard poultry production, their genetic potential has not been fully exploited. The results of this study are helpful to all stake holders to consume eggs and meat of rural chickens.

ratio were observed in *FAY*. Non-significant differences in shell weight, shell thickness, crude protein, ash and cholesterol contents were recorded between breeds. Breed differences in ether extract content both in breast and thigh meat and in cholesterol content in thigh portion were significant ($p < 0.05$).

Subjects: Bioscience; Environment & Agriculture; Food Science & Technology

Keywords: egg quality; meat quality; composition of eggs; composition of meat

1. Introduction

In Pakistan, poultry production sector has been playing a vital role in bridging the gap between supply and requirement of animal protein foods for its ever increasing human population. This sector is one of the vibrant segments of agriculture segments of the country (Anonymous, 2012). The current investment in poultry sector is over 200 billion rupees (19,103,499 US\$) and this sector has shown spectacular growth rate of 15–20 percent annually which reflects its inherent potential. The total poultry population in the country during, 2011–12 has been about 721 million (641.33 million commercial and 79.67 million rural poultry) producing 13,114 million eggs and about 0.831 million metric ton poultry meat (Anonymous, 2012). The contribution of rural poultry in total eggs and poultry meat production of the country has been about 29.23 and 12.76 percent, respectively.

The frequent consumption of red meat has been associated with increased risks of “coronary heart diseases (CHD)” and colon and other cancers (Larsson & Nicola, 2014). On the contrary, consumption of white meat is not associated with a high risk of CHD and it also reduces the chances of colorectal cancer (Tantamango, Synnove, & Joan, 2011). Poultry meat is nutritious, economical and easy to prepare and serve. It is low in calories, a good source of essential fatty acids and essential amino acids (Bell & Weaver, 2002). The characteristics of avian eggs are highly variable depending on genotype and age of the hen (Kocevski, Nikolova, & Kuzelov, 2011). The yolk: albumen ratio differs in a breed or a strain within a breed (Ali & Anjum, 2013). The yolk is the most concentrated source of nutrients in the egg containing about 50 percent water and a high fat content. The albumen is mainly protein and water with small amount of carbohydrate. Egg shell is a bio-ceramic composite consisting of a mineral part, provided with an organic matrix, resulting in a structure which has excellent mechanical properties (Rodriguez-Navarro, Kalin, Nys, & Garcia-Ruiz, 2002).

White Leghorn (WLH) chickens are well known for table egg production (Bell & Weaver, 2002). *Desi* and *Fayoumi* (*FAY*) chickens are kept in Pakistan under rural scavenging conditions for egg and meat production (Sahota & Bhatti, 2001). *Desi* is a native, non-descript chicken possessing poor productive potential, broodiness and low egg size, however, it possesses better resistance to diseases and better adaptability to the rigorous local environmental conditions (Bhatti, Qureshi, Sahota, & Ashraf, 1990).

Fayoumi breed was imported in Pakistan on account of its better growth rate and egg production than the native *Desi*, however, its meat yield is low and egg size is smaller than exotic WLH chickens (Sahota & Bhatti, 2001). The meat and eggs from intensively maintained hybrid flocks are considered to have weak flavor and meat is of soft texture. Therefore consumers prefer village produced eggs and poultry meat and are willing ready to pay higher price Sonaiya & Swan (2004). The eggs and poultry meat produced from rural chickens (*FAY* and *Desi*) still have higher consumer preference than those from commercial hybrid chicken. However, very little information is available on the egg quality, proximate composition and cholesterol content of eggs and meat produced by *FAY* and WLH breeds. Keeping this in view the present study was therefore undertaken with the aim of investigating the quality, proximate composition and cholesterol content of eggs and meat of *FAY* and Commercial WLH breeds in Pakistan.

2. Materials and methods

The present study was conducted at the Breeding and Incubation Section, Poultry Research Institute, Rawalpindi (Pakistan). For this purpose, 64 adult (40 weeks-old) laying hens, 32 each of FAY and commercial (Nick Chick) WLH breeds were randomly picked up from the two flocks being maintained at this Institute. The experimental birds of both the breeds were kept in two separate pens each measuring 3.05 m (length × width × height). They were maintained on littered floor in an open sided house under optimal management conditions.

All the experimental birds were fed *ad libitum* a balanced layers mash prepared at feed mixing plant of Nutrition Section of this Institute according to National Research Council (NRC) (1994). The composition of the experimental ration is given in Table 1.

The birds had free access to fresh and clean drinking water and were provided 16 h light daily (natural day light supplemented with artificial light during night). A weekly sample of three eggs from each breed was collected for a period of 6 weeks for recording data on the egg quality parameters such as average egg weight, shell weight, yolk and albumen weight and shell thickness. The yolk: albumen ratio was worked out. The proximate composition of eggs and meat was determined using AOAC (2011). The cholesterol content of eggs and meat was determined through ELISA reader using the direct saponification method described by Fletouris, Botsoglou, Psomas, and Mantis (1998). The data thus obtained were statistically analyzed using t-test (Steel & Torrie, 1980). For data analysis of proximate composition and cholesterol contents, when differences between treatments were significant, means were separated using Duncan's multiple range tests at the 0.05 level of significance (Steel & Torrie, 1980). The analyses were conducted using SPSS 16.0 software (SPSS Inc., 2007).

Table 1. Ingredients composition of layer's ration

Ingredients	(%)
Maize	27.00
Rice broken	27.00
Wheat	05.00
Rice polishing	08.00
Cotton seed meal	03.50
Corn gluten meal	02.50
Rape seed meal	05.00
Guar meal	01.00
Soybean meal	05.00
Fish meal	05.00
Wheat bran	07.50
Molasses	02.00
Vitamin mineral premix	00.50
Dicalcium phosphate	01.00
Proximate composition	
Crude protein	16.00
Crude fiber	04.00
Crude Fat	03.00
Metabolizable energy (kcal/kg)	2750.00

3. Results and discussion

3.1. Egg quality

In this study, the egg weight in WLH chicken was observed to be significantly ($p < 0.01$) higher than in Fay (Table 2). These results indicating 44.52 ± 3.80 g egg weight in Fay are in close agreement with the earlier findings of Bhatti and Sahota (1996), who reported egg weight in Fay as 47.67 g. The egg weight in WLH (62.21 ± 3.29 g) recorded in this study is in close conformity of earlier findings of Padhi, Rai, Senani, and Saha (1998), who observed almost the similar egg weight (62.86 ± 1.80 g) in WLH. Breed and strain variation in egg weight has been reported (Ahmad, 2013; Singh, Cheng, & Silversiders, 2009). This variation could be attributed to genetics (Silversiders, Korver, & Budgill, 2006).

The results of the present study show numerically higher egg shell weight and greater shell thickness in WLH hens in comparison to Fay, however, the differences were observed to be non-significant. The results further indicated significantly ($p = 0.04$) higher albumen weight and significantly ($p = 0.04$) lower yolk weight and yolk: albumen ratio in WLH hens as compared to that of Fay. Breed and strain variation in egg quality has been reported (Ahmad, 2013; Silversiders et al., 2006) to be due to genetic variation (Silversiders et al., 2006). The proportion of yolk and albumen component of egg is largely dependent on strain of the hen (Ahn, Kim, & Shu, 1997). Within the strain, variation in egg weight has been associated with variations in albumen weight (Scott & Silversiders, 2000).

3.2. Proximate composition of eggs

In the present study, WLH eggs contained numerically higher crude protein than of Fay eggs, however, the difference was found to be non-significant (Table 2). The results further showed that contrary to crude protein, ether extract was significantly ($p = 0.03$) higher in Fay eggs than in WLH eggs. This could be attributed to higher yolk weight and higher yolk: albumen ratio in Fay eggs than in WLH. Yolk is reported to be a rich source of fat (Bell & Weaver, 2002). The numerically higher ash content was observed in Fay eggs in comparison to WLH eggs, however, difference was found to be non-significant.

3.3. Cholesterol concentration in eggs

The results show a marginal tendency to show higher egg cholesterol concentration in WLH in comparison to Fay during first 2 weeks of the study; however, the trend was reversed during 3rd to 5th weeks of the experiment (Table 3). The statistical analysis revealed non-significant difference between weekly cholesterol concentrations of eggs in both the breeds. There has been a great concern about higher intake of dietary cholesterol leading to cardiovascular diseases in humans (Bell &

Table 2. Comparative egg quality characters and proximate composition of Fayoumi and White Leghorn eggs (Mean \pm SD)

Items	Breeds		p-value
	Fayoumi	White Leghorn	
Egg weight (g)	44.52 \pm 3.80	62.21 \pm 3.29	0.010
Shell weight (g)	6.31 \pm 0.99	8.51 \pm 0.63	0.060
Shell thickness (mm)	0.24 \pm 0.03	0.25 \pm 0.02	0.101
Albumen Wt (g)	22.06 \pm 2.54	38.85 \pm 3.38	0.040
Yolk Wt (g)	16.13 \pm 1.39	15.28 \pm 1.40	0.040
Yolk:albumen ratio	1:0.74 \pm 0.09	1:0.39 \pm 0.04	0.040
Moisture (%)	71.35 \pm 1.91	75.41 \pm 2.30	0.010
Crude protein (%)	10.94 \pm 2.54	11.75 \pm 3.56	0.080
Ether extract (%)	12.62 \pm 4.41	08.48 \pm 4.13	0.031
Ash (%)	4.20 \pm 0.34	3.92 \pm 0.37	0.100

Table 3. Weekly egg cholesterol concentration (mg/100 g) in Fayoumi and White Leghorn (Mean ± SD)

Weeks	Breeds		p-value
	Fayoumi	White Leghorn	
1st	90.42 ± 11.83	120.88 ± 36.50	0.092
2nd	78.93 ± 7.71	86.01 ± 30.99	0.101
3rd	99.42 ± 25.04	77.20 ± 13.16	0.060
4th	75.48 ± 2.32	66.86 ± 5.02	0.080
5th	197.70 ± 121.49	152.87 ± 73.48	0.110

Weaver, 2002). It is believed that in the presence of higher serum cholesterol levels, restricting dietary cholesterol may be beneficial for persons having diabetes, heart diseases and high blood pressure. Eggs having the higher concentration of cholesterol have been considered deleterious for these types of people (Bell & Weaver, 2002). However, no correlation could be found between egg consumption and stroke or CHD (Bell & Weaver, 2002). Later studies have indicated that egg consumption did not significantly increase serum cholesterol in healthy men and women (Bell & Weaver, 2002).

3.4. Proximate composition and cholesterol content of meat

In the present study, non-significant differences in crude protein and ash content both in breast and thigh meat in FAY and WLH were observed (Table 4). A similar non-significant difference in moisture content of breast and thigh meat in FAY and WLH breeds was recorded. The findings of this study showing non-significant difference in protein content of meat in FAY and WLH chickens are in agreement with those of Siddiqi, Gillani, Hug, and Habar (1994), who reported non-significant difference between protein content of WLH and other poultry breeds. The results further reveal significant ($p = 0.01$) difference in ether extract content between FAY and WLH breeds. The similar breed difference in fat content of meat has been reported (Twining, Thomas, & Bossard, 1978). A significant ($p < 0.01$) higher cholesterol concentration was observed in thigh meat of WLH in comparison to FAY. On the contrary, non-significant difference was observed in cholesterol content of breast meat in FAY and WLH chickens. The cholesterol content in thigh meat was comparatively higher than in breast portion of both the breeds Table 4.

Table 4. Proximate composition (%) and cholesterol content (mg/100 g) in Fayoumi and White Leghorn meat (Mean + SD)

Items	Breeds				p-value
	Fayoumi		White Leghorn		
	Breast	Thigh	Breast	Thigh	
Moisture	73.90 ± 0.14	74.15 ± 4.03	73.70 ± 0.14	74.55 ± 2.33	0.090
Crude protein	20.87 ± 2.47	21.43 ± 2.68	20.31 ± 1.85	20.62 ± 0.00	0.101
Ether extract	6.30 ± 1.41 ^a	4.80 ± 0.70 ^b	1.45 ± 0.63 ^d	3.10 ± 1.13 ^c	0.010
Ash	1.11 ± 0.03	1.83 ± 0.26	1.04 ± 0.24	1.55 ± 0.82	0.150
Cholesterol	87.10 ± 1.86 ^d	137.10 ± 18.23 ^c	211.58 ± 56.30 ^b	345.00 ± 5.58 ^a	0.010

^{a-d}Means accompanied with a different superscript are significantly different ($p < 0.05$).

4. Conclusion

The findings of this study suggest that WLH had higher egg and albumen weight and lower ether extract content than in FAY chicken, however variation in proximate composition of meat could not be found between these two breeds except in ether extract and cholesterol content in thigh meat.

Funding

The authors receive no direct funding for this research.

Competing interests

The authors declare no competing interest.

Author details

Salma Abdul Rehman¹

E-mail: mabdulrehman2006@hotmail.com

Shamim Akhter¹

E-mail: sashraf1993@gmail.com

Sohail Hassan Khan²

E-mail: sohailhassan64@gmail.com

Muhammad Ashraf Anjum²

E-mail: drashrafanjum@gmail.com

¹ Department of Zoology, Pir Mehr Ali Shah Arid Agriculture University, Rawalpindi, Pakistan.

² Directorate of Poultry Research Institute, Murree Road, Shamsabad, Rawalpindi, Pakistan.

Citation information

Cite this article as: A comparative study on quality, proximate composition and cholesterol content of eggs and meat in Fayoumi and commercial White Leghorn chickens, Salma Abdul Rehman, Shamim Akhter, Sohail Hassan Khan & Muhammad Ashraf Anjum, *Cogent Food & Agriculture* (2016), 2: 1195539.

References

- Ahmad, Z. (2013). *Pre and post-moult productive and reproductive performance egg geometry, quality and meat composition of four varieties of Native Aseel chickens* (PhD Thesis). University of Veterinary and Animal Sciences, Lahore, Pakistan.
- Ahn, D. U., Kim, S. M., & Shu, H. (1997). Effect of egg size and strain and age of hens on the solid content of chicken eggs. *Poultry Science*, 76, 914–919.
- Ali, A., & Anjum, R. (2013). Evaluation of egg quality traits among different breeds/strains of chicken locally available in Pakistan. *Journal of Livestock Production*, 1, 16–23.
- Anonymous. (2012). *Economic survey of Pakistan*. Islamabad: Govt. of Pakistan, Economic Advisors Wing Finance Division.
- AOAC. (2011). *Official methods of analytical chemist* (18th ed.). Gaithersburg, MD: Association of Official Analytical Chemists.
- Bell, D. D., & Weaver, W. D. (2002). *Commercial chicken meat and egg production manual* (pp. 1119, 1124–1125). Norwell, MA: Kluwer Academic.
- Bhatti, B. M., & Sahota, A. W. (1996). A comparative study on growth and laying behavior of *Desi*, Fayoumi and Rhod Island Red breeds of chicken maintained under local environmental conditions of Rawalpindi (Pakistan). *Pakistan Veterinary Journal*, 16, 26–30.
- Bhatti, B. M., Qureshi, M. S., Sahota A. W., & Ashraf, M. (November, 28–29, 1990). Evolving of a chicken with potential of higher meat and egg yield for rural areas of Pakistan. Proceedings 3rd International Congress, Pakistan Veterinary Medical Association. Islamabad. (pp. 340–345).
- Fletouris, D. J., Botsoglou, N. A., Psomas, I. E., & Mantis, A. I. (1998). Rapid determination of cholesterol in milk and milk products by direct saponification and capillary gas chromatography. *Journal of Dairy Science*, 81, 2833–2840.
- Kocevski, D., Nikolova, N., & Kuzelov, A. (2011). The influence of strain and age on some egg quality parameters of commercial laying hens. *Biotechnology in Animal Husbandry*, 27, 1649–1658.
- Larsson, S. C., & Nicola, O. (2014). Red meat and processed meat consumption and all-cause mortality: A meta-analysis. *American Journal of Epidemiology*, 179, 282–289. doi: <http://dx.doi.org/10.1093/aje/kwt26.1>
- National Research Council (NRC). (1994). *Nutrients requirements of poultry* (9th revised ed.). Washington, DC: National Academy Press.
- Padhi, M. K., Rai, R. B., Senani, S., & Saha, S. K. (1998). Assessment of egg quality in different breeds of chicken. *Indian Journal of Poultry Science*, 33, 113–115.
- Rodriguez-Navarro, A., Kalin, O., Nys, Y., & Garcia-Ruiz, J. M. (2002). Influence of the microstructure on the shell strength of eggs laid by hens of different ages. *British Poultry Science*, 43, 395–403.
- Sahota, A. W., & Bhatti, B. M. (2001). A study on the growth and productive performance of *Desi* and Fayoumi breeds of chicken under controlled housing conditions. *Pakistan Journal of Science*, 53, 71–74.
- Scott, T. A., & Silversiders, F. G. (2000). The effect of storage and strain of hen on egg quality. *Poultry Science*, 79, 1725–1729.
- Siddiqi, Z., Gillani, A. H., Hug, A., & Habar, I. E. (1994). Study on the chemical composition of breast and thigh muscle tissues in different breeds of poultry. *Pakistan Journal of Agricultural Science*, 31, 322–328.
- Silversiders, F. G., Korver, D. R., & Budgill, K. L. (2006). Effect of strain of layer and age at photo-stimulation on egg quality and bone strength. *Poultry Science*, 85, 1136–1144.
- Singh, R., Cheng, K. M., & Silversiders, F. G. (2009). Production performance and egg quality of four strains of laying hens kept in conventional cages and floor pens. *Poultry Science*, 88, 256–264.
- Sonaiya, E. B., & Swan, S. E. J. (2004). *Small-scale poultry production—Technical guide* (chapter 1, introduction, pp. 1–5). Rome: Food and Agriculture Organization of the United Nations.
- SPSS Inc. (2007). *SPSS 16.0 Command syntax reference 2007*. Chicago, IL: SPSS.
- Steel, R. G. D., & Torrie, J. H. (1980). Principles and procedures of statistics *A biometrical approach*. New York, NY: McGraw Hill Book.
- Tantamango, Y. M., Synnove, F. K., & Joan, S. (2011). Association between dietary fiber and incident cases of colon polyps: The Adventist health study. *Gastrointestinal Cancer Research*, 4, 161–167.
- Twining, Jr., P. V., Thomas, O. P., & Bossard, E. H. (1978). Effect of diet and type of birds on the carcass composition of broilers at 28, 49 and 59 days of age. *Poultry Science*, 57, 492–497.



© 2016 The Author(s). This open access article is distributed under a Creative Commons Attribution (CC-BY) 4.0 license.

You are free to:

Share — copy and redistribute the material in any medium or format

Adapt — remix, transform, and build upon the material for any purpose, even commercially.

The licensor cannot revoke these freedoms as long as you follow the license terms.

Under the following terms:

Attribution — You must give appropriate credit, provide a link to the license, and indicate if changes were made.

You may do so in any reasonable manner, but not in any way that suggests the licensor endorses you or your use.

No additional restrictions

You may not apply legal terms or technological measures that legally restrict others from doing anything the license permits.



***Cogent Food & Agriculture* (ISSN: 2331-1932) is published by Cogent OA, part of Taylor & Francis Group.**

Publishing with Cogent OA ensures:

- Immediate, universal access to your article on publication
- High visibility and discoverability via the Cogent OA website as well as Taylor & Francis Online
- Download and citation statistics for your article
- Rapid online publication
- Input from, and dialog with, expert editors and editorial boards
- Retention of full copyright of your article
- Guaranteed legacy preservation of your article
- Discounts and waivers for authors in developing regions

Submit your manuscript to a Cogent OA journal at www.CogentOA.com

