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Physicochemical Comparison between the Broiler and Layer Carcasses and their Meat

Saeed M.S. Abdou, Soad A.S. Ismail, Ali M. Ahmed, Heba M. Shaheen*

Department of Food Hygiene, Faculty of Veterinary Medicine, Suez Canal University, Egypt.

***Correspondence**
Corresponding author: Heba M. Shaheen
E-mail address: hebashaheen@ymail.com

Abstract

Layer chickens are an important species of poultry that has the ability to produce a large number of eggs destined for consumption. However, after the end of the period of egg production and the preparation of their carcasses for marketing, the physicochemical quality of their meat is subject to debate. Therefore, a total of 100 random layier chicken samples intended for slaughter are randomly collected from different farms at Ismailia city after the end of the egg production period. All samples were inspected to ensure their suitability for consumers through determination of its live weight, carcass weight, dressing weight and meat weight. Other search aim was to determine of the physiochemical quality of this examined layer meat samples by estimation of pH, drip loss, cooking loss, proximate chemical analysis in comparing to broiler samples as control and the Egyptian standard specification. The results revealed that, there was a significant increase ($P<0.05$) in the live weight and carcass weight of layer carcasses by 5.4% and 22.1% respectively more than broiler, while there was insignificant increase ($P>0.05$) in dressing weight of layer carcasses. There was a significant decrease ($P<0.05$) in pH, drip loss and cooking loss in layer hen meat in compared to broiler meat. Using of acid milk as marinating techniques could improve sensory and physical quality of layer meat and could prefer by consumers.

KEYWORDS
Physiochemical, Layer meat, Acid milk, Quality

INTRODUCTION

Chicken meat occupies a high rank in the food pyramid because it contains multiple nutrients that are beneficial to the body, such as high quality proteins, healthy fats, vitamins, and mineral salts (Aktas *et al*, 2020). The increase in the demand for chicken products such as meat and eggs led to a great development in this industry which encourage companies to develop the types of chicken they offer and improve their genetic characteristics, which provides greater weights and a shorter breeding period (Andersen *et al*., 2016).

Layer chickens are an important species of poultry that has the ability to produce a large number of eggs destined for consumption, they have the task of laying eggs, and this task ends after a year and a half (Petracci *et al*., 2012). In the developed countries laying hens are directed to industrial slaughterhouses immediately after exhausting their task of ovulation and are slaughtered under the supervision of the concerned authorities. It is sold to consumers or used in the manufacture of poultry products such as luncheon meats, hamburgers, and hot dogs (Alvarado and McKee, 2021). Consumer reluctance to buy laying chicken meat is due to its large size and meat toughness, so it is not easy to ripen except after long periods of cooking (Wongwiwat *et al*., 2010).

Regarding the difference between broiler and layer chicken, the meat-producing chicken breeds are chicken breeds raised for the production of meat, and they are characterized by a good yield of meat, they grow faster than the breeds of laying chickens and often have a high feed conversion rate.

Veterinary medicine plays an important role in the development of the poultry industry through its continuous role in the health control of food, poultry slaughterhouses, and outlets for selling chicken meat and eggs in addition to its role in chemical and physical analysis of this meat and the development of its characters in various ways such as improving its palatability, taste, and tenderness (Ergezer and Gokce 2011).

Therefore, this research was aimed to determine the physiochemical quality of layer meat samples by estimation of carcasses performance, pH, dip loss, cooking loss, and proximate chemical analysis in comparing to broiler samples as control and the Egyptian standard specification. Another aim was to improve the sensory characteristics of layer meat by using acid milk.

MATERIALS AND METHODS

Samples collection

A total of 100 random layer chicken samples from different

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farms at Ismailia city intended for slaughter after the end of the egg production period. The laying hens breed is called ISA white and brown. Another 100 random broiler samples were collected from different farms at Ismailia city and kept as a control group. All samples were sent to Food Hygiene Laboratory, Faculty of Veterinary Medicine, Suez Canal University for evaluation.

Preparation of the samples

All chicken were slaughtered then packed, one by one, in plastic bags and refrigerated at 4°C for 24 hours to carry out the physicochemical evaluation.

Determination of carcass characteristics

All chicken samples were subjected to evaluation of live weight, carcasses weight, and dressing weight.

Physical quality of the chicken samples

pH of chicken samples was determined according to procedure of Abubakar *et al.* (2021). Drip loss determination for chicken samples was performed according to procedure of Mir *et al.* (2017). Cooking losses of chicken samples were done according to procedure of Abubakar *et al.* (2021).

Proximate chemical analysis of chicken samples

Determination of moisture and ash content (AOAC, 2006): Porcelain dish (approximately 7 cm in diameter) was dried at 105°C for 3-5 hours in hot-air oven for moisture content and in muffle furnace at 550-600°C for 6-8 hours for ash content . The weight of the dish was recorded after drying. The dish was transferred to desiccator for cooling and then weighed. Five grams of the sample were put in the dried dish and the weight of both is recorded (weight before drying). The dish and dried sample were placed in desiccator, cooled and weighed and the process of heating, cooling and weighting was repeated until two constant successive weights were obtained. The moisture and ash was calculated from the percentage loss in weight.

Protein and fat contents were determined through Kjeldahl's and Soxhelt's method (AOAC, 2006).

Marinating of layer meat with acid milk

A total of 50 samples, 10 broiler chicken and 40 layers, were randomly collected from the chicken shops. The collected samples were divided into 3 groups; the first one was control broiler (10 samples), the second one was control layer (10 samples) and the third group (30 samples) was layer meat which was marinated with acid milk for one hour then cooked in different type as fry, grille and cooked in oven as consumer prefer, then the flavor, tenderness and juiciness of all samples were evaluated.

Statistical analysis

Data analysis was performed by using SPSS statistical software program (SPSS, 2016). Any significant differences ($P<0.05$) between means were analyzed using a level of significance of alpha = 0.05.

RESULTS AND DISCUSSION

Meat eating qualities mainly related to consumer acceptance. Juiciness, tenderness, and flavor are the most important parameters that determine chicken meat quality. Cooking also affects the flavor due to the chemical reactions within the lean and lipid portions during cooking.

Performance of broiler and layer carcasses

The physical quality of chicken meat may be affected by many parameters such as chicken species, age and weight. The performance of layer hens and broiler chicken is given in Table 1, which is described as live weight, dressing weight and meat weight. The minimum, maximum and average live body weight of layer hen were 2040g, 2200g and 2130±27.7g respectively, while those of broiler chicken were 1980g, 2100g and 2020±21g respectively. On the other hand, the minimum, maximum and average dressing weight of layer hens were 1700g, 1720g and 1704±28.6g

Table 1. Performance values of broiler and layer carcasses (grams).

Samples	Live weight		Dressing weight		Meat weight	
	Broiler	Layer	Broiler	Layer	Broiler	Layer
Minimum	1980	2040	1650	1700	830	670
Maximum	2100	2200	1750	1720	900	690
Mean±S.E.	2020.0±21.0 [a]	2130.0±27.7[b]	1698.0±16.6[a]	1704.0±28.6[a]	868.0±12.4[a]	676.0±4.0[b]
Change%	5.40%		0.35%		22.10%	

Data are presented as Mean±S.E. (standard error).
Mean in the same row with different letter are significantly difference ($P<0.05$)
P value is 0.0131

Table 2. Mean values of physical quality parameters of broiler and layer carcasses.

Samples	pH		Drip loss		Cooking loss	
	Broiler	Layer	Broiler	Layer	Broiler	Layer
Minimum	5.98	6.2	7.6	7.1	25.4	21.1
Maximum	6	6.35	8.2	7.4	25.7	21.5
Mean±S.E.	5.99±0.004 [a]	6.28±0.027[b]	8.0±0.11[a]	7.3±0.05[b]	25.5±0.05[a]	21.3±0.07[b]
Change%	4.80%		8.75%		16.50%	

Data are presented as Mean±S.E. (standard error).
Mean in the same row with different letter are significantly difference ($P<0.0001$).

respectively while those of broiler chicken were 1650g, 1750g and 1698±16.6g respectively. The minimum, maximum and average meat weight of layer hens were 670g, 690g and 676±4g respectively while those of broiler chicken were 830g, 900g and 868±12.4g respectively.

The percentage of change (%) in the body weight of layer hens compared with broiler chickens was given in Table 1, where the results showed that there was a significant increase in the live weight and carcass weight of layer hens by 5.4% and 22.1% respectively more than in broiler, while there was insignificant increase in dressing weight of layer hens by 0.35% more than in broiler. Slightly lower results was reported by Alvarado and McKee (2021) who reported that body weight for mature Venda scavenging chickens in South Africa was 1531g. and by Usturoi and Radu-Rusu (2006) who reported that slaughter weights was ranging from 1045 g to 1292 g for different indigenous male chicken mean while higher results for dressing weight were obtained by Kefyalew and Puolanne (2015) who reported a relatively higher dressing percentage of 71.1% for commercial broilers and by Dhingra *et al*. (2007) who reported 67% dressing percentage values for Rhode Island Red chickens reared under intensive management system.

Physical quality of broiler and layer carcasses

The physical quality of layer hen and broiler carcasses was shown in Table 2, which was determined by estimation of the pH value, drip loss and cooking loss. The minimum, maximum and average pH values of layer hen were 6.2, 6.35, 6.28±0.027 respectively, while those of broiler chicken were 5.98, 6, 5.99±0.004 respectively. It was found that there was a significant increase (P<0.05) in pH of layer hen meat more than broiler meat in which the percentage of change was 4.8%. Nearly similar results obtained by Hussain *et al*. (2016) who found that the pH of chicken meat is 6.5% and by Zhou *et al*. (2008) who confirmed that the pH of chicken meat carcass was 6.2%.

pH influences some quality items of chicken meat such as color and the capacity of the meat to maintain water (Anadon, 2002).

Drip loss is an ongoing process involving the transfer of water from myofibrils to the extracellular space affected by structural features at several levels of organization within muscle tissue (Bertram *et al*., 2002). Drip loss is very important for palatability, and thus the overall quality and acceptability of meat (Forrest *et al*., 2000). By estimation of drip loss in broiler and layer hen meat as shown in Table 2, it was found that the minimum, maximum and mean values of drip loss of laying hen were 7.1, 7.4, 7.3±0.05 respectively, while those of broiler chicken were 7.6, 8.2, 8±0.11 respectively. There is a significant decrease (P<0.05) in drip loss value in layer hens' meat compared with that in broiler meat, where the percentage of change was 8.75%.

The decrease in the drip and the increase in the water content of muscles have a good desirable effect on meat quality as improving tenderness, juiciness, firmness, and appearance, enhance a great quality of meat (Mir *et al*., 2017).

Cooking loss is the level of shrinkage of meat in the course of cooking. The estimated values of the cooking loss in layer hens and broiler chicken meat were given in Table 2, where the minimum, maximum and mean values of cooking loss of laying hen meat were 21.1, 21.5 and 21.3±0.07 respectively, while those of broiler chicken were 25.4, 25.7and 25.5±0.05 respectively. The obtained findings revealed a significant decrease (P<0.05) in cooking loss of layer hen meet compared with broiler meat in which the percentage of change was 16.7%. The obtained results came in agreement with the findings of Aaslyng *et al*., (2003) who found that the cooking loss of layer hen meat is lower than the cooking loss of broiler meat.

Proximate chemical analysis of broiler and layer meat

The chemical composition of broiler and layer hen meat were estimated as shown in Table 3, where the minimum, maximum and mean values of moisture content of layer hens' meat were 72.1%, 72.5% and 72.3%±0.07 respectively, while those of broiler chicken were 74.4%, 75.5% and 74.8%±0.19 respectively. In this study, there was a significant decrease (P<0.05) in moisture content in layer hen meat compared with that in broiler meat with a percentage of change was 3.3%. Nearly similar results obtained by Hussain *et al*. (2016) who found that moisture content of layer hen meat was 72.5% and Botka-Petrak *et al*. (2011) who confirmed that the moisture content of layer meat carcass was 72 %. Age of the layer hen had a decline effect on the moisture content

Table 3. Mean values of proximate chemical analysis of broiler and layer meat.

Samples	Protein%		Fat%		Moisture%		Ash%	
	Broiler	Layer	Broiler	Layer	Broiler	Layer	Broiler	Layer
Minimum	19.9	21.4	4.7	4.1	74.4	72.1	1.4	2.4
Maximum	20.9	22.1	5.38	4.39	75.5	72.5	1.9	2.6
Mean±S.E.	20.7±0.196^a	21.8±0.115^b	5.2±0.068^a	4.3±0.054^b	74.8±0.19^a	72.3±0.07^b	1.6±0.114^a	2.5±0.044^b
Change%	5.30%		17.30%		3.30%		56%	

Data are presented as Mean±S.E. (standard error).
Mean in the same row with different letter are significantly difference (P=0.0010).

Table 4. Effect of acid milk on sensory quality of broiler and layer meat

*Sensory Parameters	Control		Layer meat marinate with acid milk		
	Broiler	Layer	Grill	Fry	Oven pan
Flavor	3.0±0.30^a	2.0±0.10^a	5.0±0.42^b	5.0±0.54^b	5.0±0.23^b
Tenderness	4.0±0.24^a	2.0±0.34^b	4.0±0.11^a	5.0±0.35^a	4.0±0.50^a
Juiciness	4.0±0.26^a	1.0±0.05^b	3.0±0.60^c	5.0±0.72^a	4.0±0.12^a

*Sensory Scale range from 5 extreme acceptable to 1 extreme rejected.
Data are presented as Mean±S.E. (standard error).
Mean in the same row with different letter is significantly different (P=0.0010).

Table 5. Effect of acid milk on physical quality of broiler and layer meat.

Physical quality	Control		Marinate with acid milk for 1h
	Broiler	Layer	
Drip loss	8.0±1.042[a]	7.3±0.85[b]	6.0±0.9[c]
Cooking loss	15.5±2.48[a]	11.3±1.32[b]	9.0±0.1.01[c]

Data are presented as Mean±S.E. (standard error).
Mean in the same row with different letter is significantly different (P=0.0010).

of the meat products.

The minimum, maximum and mean values of protein content in layer hens' meat were 21.4%, 22.1%, 21.8%±0.115 respectively, while those of broiler chicken were 19.9%, 20.9%, 20.7%±0.196 respectively. It was found that there was a significant increase (P<0.05) in protein content of layer hen meat compared with broiler meat where the percentage of change was 5.3%. Nearly similar results was obtained by Botka-Petrak *et al*. (2011) who showed that the content of proteins were just 22% in layer hen meat samples of chicken meat, while in samples of broiler meat of breast were 20.5%, also the obtained results came in agreement with the findings of Crosland *et al*. (1995), who found that the nitrogen content of broiler meat were smaller than layer hen meat and with Hussain *et al*. (2016) who found that protein content of chicken meat was in the range of 20.32% to 22.36%.

For fat content in meat of broiler and layer hen, the estimated minimum, maximum and mean values of fat in layer hens' meat were 4.1%, 4.39% and 4.3%±0.054 respectively, while those of broiler chicken were 4.7%, 5.36% and 5.2%±0.068 respectively. The obtained results declared that there is a significant decrease in fat content in layer hens' meat compared with broiler meat where the change % was 17.3%. Nearly similar results obtained by Hussain *et al*. (2016) who found that fat content of chicken meat was 5% and Botka-Petrak *et al*. (2011) who recorded that fat was highest in broiler meat (5%), slightly lower in layer hen meat with small age (4.8%) and the lowest in meat samples of layer hen meat with old age (4.2%)

Producers need to increase fat content for suitability of the product and increase in toughness of meat product is affect by the decrease in fat content (Serdaroğlu *et al*., 2005).

The estimated minimum, maximum and mean values of ash content in layer hens' meat were 2.4%, 2.6% and 2.5%±0.044 respectively, while those of broiler chicken were 1.4%, 1.9% and 1.6%±0.114 respectively as shown in Table 3, where there was a significant increase (P<0.05) in ash content of layer compared with broiler meat with percentage of change was 56%. Nearly similar results were given by Hussain *et al*. (2016) who found that ash content of chicken meat was 2%.

The main variation in the chemical composition of the meat between layer hens and broiler chicken was due to differences in the feeding regime, age at which slaughtering takes place and breeds.

Sensory quality of broiler and layer meat treated with acid milk

On an approach for improving tenderness of spent-laying hen meat, acid milk was used as one of a marinating technique. Table 4 shows its effect on sensory quality of layer hen meat. Acid milk was found to have a great effect upon sensory parameters of laying hen meat compared with the unmarinated groups, where the highest effect was on the flavor of marinated hen meat (Grilled, fried and oven cooked) compared by the unmarinated ones. Its effect on meat tenderness and juiciness was higher in fried marinated portion followed by the oven and grilled cooked portion. Berge *et al*. (2001) confirmed that sodium bicarbonate, citric acid and lactic acid could improve tenderness of chicken meat, reduce its toughness and increase the consumer acceptance score towards the tenderness and its overall quality. Similar results were reported by Ergezer and Gokce (2011) and Yang *et al*. (2012).

Physical quality of broiler and layer meat treated with acid milk

The effect of acid milk on the physical quality of laying hen meat was also estimated as shown in Table 5, where there was a significant decrease in the drip and cooking losses of the treated meat (6 and 9 respectively) compared with the untreated broiler meat (8 and 15.5 respectively) and layer hen meat (7.3 and 11.3 respectively). This obtained results disagreed with results obtained by Yang *et al*. (2012) and Ergezer and Gokce (2011) who reported that lactic acid and sodium bicarbonate increased drip loss of poultry meat.

CONCLUSION

It can be argued that improvement of layer chicken meat quality is dependent on multiple factors. Using acid milk as marinating techniques could improve the sensory and physical quality of layer meat and is preferred by consumers.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

REFERENCES

Aaslyng, G., Anderson, J., Gillett, T., 2003. Extractable emulsifying capacity of hand and mechanically deboned mutton. Journal of Food Science 39, 1147-1149.

Abubakar, A., Fitri, C.A., Oesmara, H.K., Ardatami, S., 2021. Analysis of pH and cooking losses of chicken meat due to the use of different percentages of turmeric flour. Earth and Environmental Science 66, 012042.

Aktas, N., Aksu, M.I., Kaya, M., 2003. The effect of organic acid marination on tenderness, cooking loss and bound water content of beef. J. Muscle Foods 14, 181-194.

Alvarado, C., McKee, S., 2021. Marination to improve functional properties and safety of poultry meat. J. Appl. Poult. Res. 16, 113-120.

Anadon, H.L.S., 2002. Biological, nutritional, and processing factors affecting breast meat quality of broilers, Ph.D. Thesis, Virginia Polytechnic Institute and State University, Blacksburg, VA, 24061, USA, p. 181.

Andersen, M.B. S., Frydenvang, J., Henckel, P., Rinnan, Å., 2016. The potential of laser-induced breakdown spectroscopy for industrial at-line monitoring of calcium content in comminuted poultry meat. Food Control 64, 226-233.

AOAC, 2006. Official methods of analysis. 12th ed., Washington DC, USA: Association of Official Analytical Chemists.

Berge, P., Ertbjerg, P., Larsen, L.M., Astruc, T., Vignon, X., Møller, A.J., 2001. Tenderization of beef by lactic acid injected at different times post mortem. Meat Sci. 57, 347-357.

Bertram, H.C., Purslow, P.P., Andersen, H.J., 2002. Relationship between Meat Structure, Water Mobility, and Distribution: A Low-Field Nuclear Magnetic Resonance Study. Journal of Agricultural and Food Chemistry 50, 4, 824-829

Botka-Petrak, K., Hraste, A., Lucić, H., Gottstein, Ž., Gomerčić, M. Đ., Chen,

Y., Qiao, Y., Xiao, Y., Chen, H., Zhao, L., Huang, M., Zhou, G., 2011. Differences in Physicochemical and Nutritional Properties of Breast and Thigh Meat from Crossbred Chickens, Commercial Broilers, and Spent Hens. Asian-Australasian Journal of Animal Sciences 29, 855.

Crosland, A.R., Patterson, R.L., Higman, R.C., Stewart, C.A., Hargin, K.D., 1995. Investigation of methods to detect mechanically recovered meat in meat products. Chemical composition. Meat Science 40, 289-302.

Dhingra, R., Sullivan, L.M., Fox, C.S., Wang, T.J., D'Agostino, R.B., Gaziano, J.M., Vasan, R.S., 2007. Relations of serum phosphorus and calcium levels to the incidence of cardiovascular disease in the community. Archives of Internal Medicine 167, 879885.

Ergezer, H., Gokce, R., 2011. Comparison of marinating with two different types of marinade on some quality and sensory characteristics of turkey breast meat. J. Anim. Vet. Adv.10, 60-67.

Forrest, J.C., Morgan, M.T., Borggaard, C., Rasmussen, A.J., Jespersen, B.L., Andersen, J.R., 2000. Development of technology for the early post mortem prediction of water holding capacity and drip loss in fresh pork. Meat Science 55, 115-122.

Hussain, P., Somoro, A. H., Hussain, A., Arshad, M.W., 2016. Evaluation of Quality and Safety Parameters of Poultry Meat Products Sold In Hyderabad Market, Pakistan. World Journal of Agricultural Research 4,3, 85-93.

Kefyalew, M., Puolanne, E., 2015. Theoretical aspects of water-holding in meat. Meat Science 86, 151-165.

Mir, N.A., Rafiq, A., Kumar, F., Singh, V., Shukla, V., 2017. Determinants of broiler chicken meat quality and factors affecting them: A review, J. Food Sci. Technol. 54, 2997–3009.

Petracci, M., Laghi, L., Rocculi, P., Rimini, S., Panarese, V., Cremonini, M.A., Cavani, C., 2012. The use of sodium bicarbonate for marination of broiler breast meat. Poult. Sci. 91, 526-534.

Serdaroğlu, M., Yildiz, G. T., Bağdatlioğlu, N., 2005. Effects of deboning methods on chemical composition and some properties of beef and turkey meat. Turkish Journal of Veterinary and Animal Sciences 29, 797-802.

SPSS, 2016. Statistical Packages of Social Sciences. Version 21 for windows. SPSS. Inc. USA.

Usturoi, M., Radu-Rusu, R.M., 2006. Alternative solutions to be used in laying hen's husbandry. Bulletin of University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca 62, 32-36.

Wongwiwat, P., Wattanachant, S., Siripongvutikorn, S., 2010. Effect of phosphate treatments on microbiological, physicochemical changes of spent hen muscle marinated with Tom Yum paste during chilled storage. J. Sci. Food Agric. 90, 1293-1299.

Yang, H.S., Moon, S.S., Jeong, J.Y., Choi, S.G., Joo, S.T., Park, G.B., 2012. Effect of sodium bicarbonate injection in pre-rigor porcine M. Longissimus lumborum on pork quality. Asian Australas J Anim Sci.19, 898-904.

Zhou, M., Lei, M., Rao, Y., 2008. Polymorphisms of vasoactive intestinal peptide receptor-1 gene and their genetic effects on broodiness in chickens, Poult. Sci. 87, 893-903.