ISSN 1682-8356
ansinet.org/ijps

INTERNATIONAL JOURNAL OF POULTRY SCIENCE

ANSInet
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan
Mob: +92 300 3008585, Fax: +92 41 8815544
E-mail: editorijps@gmail.com

OPEN ACCESS International Journal of Poultry Science

ISSN: 1682-8356
DOI: 10.3923/ijps.2017.105.111

Research Article
Comparison of Fatness and Meat Quality of Kampung Chickens, Arabic Chickens and Laying Type Cockerels at Different Slaughtering Ages

M.H. Tamzil

Laboratory of Poultry Production, Faculty of Animal Science, University of Mataram, Jalan Majapahit No. 62, Mataram, Lombok, Code Post 83125, Nusa Tenggara Barat, Indonesia

Abstract

Background and Objective: Fat levels affect meat quality. This study aimed to determine the level of abdominal fat deposits, fat carcass and meat quality of Kampong, Arabic and laying type cockerels. **Methodology:** The study used a completely randomized design with a 3×7 factorial arrangement. The first factor was the type of chicken and consisted of 3 levels (laying type cockerels, Kampong chickens and Arabic chickens). The second factor was slaughter ages and consisted of 7 levels (chickens 4, 5, 6, 7, 8, 9 and 10 weeks old). A total of 63 day-old chicks (DOCs) of laying type cockerels, 63 DOCs of unsexed Arabic chickens and 63 DOCs of unsexed Kampong chickens were divided into 9 groups, each group consisted of 7 DOCs. Parameters included the weight of abdominal fat, the fat of the meat, water holding capacity, pH, cooking loss and meat tenderness. Data obtained were analyzed using analysis of variance and LS-MEAN advance tests. **Results:** Results of the study showed that the type of chicken affected levels of abdominal fat ($p<0.01$), the fat level of meat ($p<0.05$), water holding capacity and cooking loss ($p<0.05$), but did not affect the pH value and the meat tenderness ($p>0.05$). Slaughter age increased the level of abdominal fat ($p<0.01$), the fat level of meat ($p<0.05$), water holding capacity, cooking loss ($p<0.01$) and meat tenderness ($p<0.05$). However, there was no interaction between types of chicken and slaughter age across all observed variables ($p>0.05$). **Conclusion:** Meat quality of Kampong and Arabic chickens were lower than that of laying type cockerels. Meat quality decreased with slaughtering age.

Key words: Kampong chicken, Arabic chicken, laying type cockerels, slaughter age, fatness, meat quality

Received: December 14, 2016 Accepted: January 26, 2017 Published: February 15, 2017

Citation: M.H. Tamzil, 2017. Comparison of fatness and meat quality of Kampung chickens, Arabic chickens and laying type cockerels at different slaughtering ages. Int. J. Poult. Sci., 16: 105-111.

Corresponding Author: M.H. Tamzil, Laboratory of Poultry Production, Faculty of Animal Science, University of Mataram, Jalan Majapahit No. 62, Mataram, Lombok, Code Post 83125, Nusa Tenggara Barat, Indonesia

Competing Interest: The author has declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Laying type cockerels and Arabic chickens are two types of chicken-producing poultry meat alternatives which are widely used as a Kampong chicken meat substitute in traditional dishes due to the limited availability of Kampong chicken meat. Kampong chicken is Indonesia's native chicken which is derived from the red jungle fowl that was domesticated and developed in Indonesia[1,2], while Arabic chicken is a new local chicken, namely chicken Braekel (*Gallus turnicus*), which at a later stage is known as Arabic chicken[2-4]. Kampong chickens have low egg production and slow growth rates[3,5,6], presenting difficulties in efforts to increase its population. Egg production of Arabic chicken reaches 300 eggs per year[2,4] with a growth rate that is relatively the same as that of Kampong chicken, although lower than that of laying type cockerels[6-8]. Arabic chickens' body endurance is also relatively similar to that of Kampong chickens in high temperature maintenance, making them suitable to live in humid tropical areas such as Indonesia[7,9,10]. Laying type cockerels are hatchery by product; however, study show that the chicken has potential to be developed as an alternative for poultry meat producers[8]. Laying type cockerels have better growth rates than those of Kampong and Arabic chickens[8]; however, laying type cockerels are vulnerable to heat stress[7,9-11].

Differences in chicken strain affect growth rate, the percentage of carcass weight, carcass percentage of primal cuts and levels of meat fat[8,12]. The growth rate of laying type cockerels is higher than the growth rate of Kampong and Arabic chickens but the growth rate of Kampong chicken is relatively the same as that of Arabic chicken[8]. The differences in growth rate across chicken types have implications for the differences in muscle tissue and fat growth which affects meat quality[12]. Some studies[13-16] have shown that strains with high growth rates and experienced spontaneous or idiopathic myopathy, which causes poultry to become more vulnerable to stress and can cause low-quality meat production, marked by pale, soft and exudative (PSE) meat[17]. A high growth rate also causes abnormal morphology, expansion of fiber diameters, improvement of glycolytic fibers proportions and lowers the proteolysis potential on muscles[17,18]. Another associated abnormality is the increase in rigor mortis and meat bleaching and reduction of water holding capacity[18]. Therefore, this study aimed to evaluate the fatness and meat quality of three chicken strains (Kampong chickens, Arabic chickens and laying type cockerels) slaughtered at different ages.

MATERIALS AND METHODS

Research location: Rearing and slaughtering were conducted at the Laboratory of Teaching Farm, Faculty of Animal Science, University of Mataram, located in Lingsar village, West Lombok regency (approximately 15 km from the University of Mataram campus). Analysis of fat level was carried out at the Laboratory of Nutrition and Feed Science, Faculty of Animal Science, University of Mataram, while the quality of meat analysis was conducted at the Laboratory of Animal Products Processing Technology of Faculty Animal Science, University of Mataram.

Experimental design: This study was carried out using the same method used by Tamzil *et al.*[8] with a completely randomized design with a 3×7 factorial arrangement. The first factor was the type of chicken and consisted of 3 levels (the laying type cockerels, Kampong chickens and Arabic chickens). The second factor was slaughter age and consisted of 7 levels (chickens 4, 5, 6, 7, 8, 9 and 10 weeks old). A total of 63 day-old chicks (DOCs) of laying type cockerels (strain ISA Brown), 63 DOCs of unsexed Arabic chickens and 63 DOCs of unsexed Kampong chickens were divided into 9 groups, so that each group consisted of 7 DOCs.

Chicken maintenance: The chickens were maintained using the same method as described by Tamzil *et al.*[8] in which 27 compartments of cages lined with wire (1×1×1 m, length×width×height) were used, so that each type of chicken used 9 cages. For identification, all the experimental chickens were wing-banded. Feed and drinking water were available *ad libitum*. The type of feed administered was a commercial feed produced by PT Sinar Indochem. Crude protein, crude fat and crude fiber contents of the ration used were 20.46, 6.75 and 2.13%, respectively. Calcium and phosphor contents of the ration were 0.75 and 0.63%, respectively. The quality of nutrition met standards for the growth of chickens[19]. Nutritional values of the commercial feed are presented in Table 1.

Table 1: Nutrient composition of experimental feed

Nutrient	Percentage
Crude protein	20.46
Crude fat	6.75
Crude fiber	2.13
Water	11.19
Ash	6.51
Calcium	0.75
Phosphor	0.63

Laboratory Analytic Faculty of Mathematics and Science, Mataram University

Chicken slaughter: To evaluate meat quality, slaughtering was started at 4 weeks. Every week, one chicken from each cage was slaughtered (9 chickens for each type of chicken). The slaughtering process was carried out using a manual system, by cutting the digestive and breathing tracks in the neck using a sharp knife. To make the cleaning process of the feathers easier, the slaughtered chickens were put into hot water (±80°C). After the feathers were removed, the legs and necks were cut followed by the disposal of the offal. All fat found in the chicken stomach (abdominal fat) was removed and weighed using a scale from Ohaus brand with a 100 g capacity and 0.01 g sensitivity. Samples of breast meat were then taken to measure fat content and meat quality.

Study parameter measurements

Measurement of abdominal fat weight: Sampling of abdominal fat was performed in conjunction with offal disposal. The weight of abdominal fat obtained was divided by body weight and multiplied by 100.

Measurement of crude fat of meat: Crude fat levels were analyzed using the AOAC method[20]. Meat used as samples include breast meat taken from each sample. A total of 0.5 g of meat sample was diluted with 2.5 mL of acetone and vortexed for 1 min. After that, the samples were boiled in a water bath for 3-7 min at 40°C. Next, the samples were centrifuged for 10 min at a speed of 300 rpm.

Meat quality

Water holding capacity: Measurement of water holding capacity was conducted using the same method used by Soeparno[21]. Meat samples with 0.3 g weight were placed on the top of Whatman 41 filter paper and then compressed between two glass plates with load weighing 35 kg for 5 min. The result of meat sample compression was drawn on transparent plastic. The wet area outside pressed meat samples was measured with millimeter block paper (cm^2). The level of water holding capacity was calculated with the following equation:

$$\text{mg } H_2O = \frac{\text{Wet area (cm}^2) - 8.0}{0.0948}$$

$$\text{Water holding capacity} = \text{Total water level (\%)} - \frac{\text{mg } H_2O \times 100\%}{300 \text{ mg}}$$

Cooking loss: Data related to cooking loss was obtained using Soeparno's method[21]. Meat samples were first weighted (X) and then placed in plastic bags before they were cooked. The plastic bags were tied tightly to prevent water from the bags when the samples were cooked. The samples were cooked for 1 h at 80°C, then, the samples were taken out of the plastic bags and separated from the broth. After that, the samples were wiped using tissue paper without pressure. Lastly, the samples were weighted (Y). Cooking loss was determined using the following equation:

$$\text{Cooking loss} = \frac{X - Y}{x} \times 100\%$$

Tenderness: Data related to meat tenderness was obtained using Soeparno's method[21]. Meat samples measuring 1×1×1 cm were placed at the bottom of the penetrometer. The pointer of the penetrometer was set so that the meat surface met the tip of the pointer and the pointer was in the zero position. Loads weighing 50 g (a) were released when the timer was pressed; the timer was on for 10 sec. The depth of the pointer was observed on the penetrometer scale (b). Tenderness of meat was expressed by b/a/t (mm sec^{-1}).

Statistical analysis: The effects of the type of chickens and slaughtering age on all observed variables were analyzed using variance analysis and LS-MEAN tests. All data were tabulated and counted with GLM procedures using SAS software[22].

RESULTS AND DISCUSSION

The effects of slaughtering age on the number of samples that deposited abdominal fat are presented in Table 2, whereas the effect of the chicken type and slaughtering age on the weight of the abdominal fat and the crude fat of meat are presented in Table 3.

Table 2 shows that the three types of chicken used in this study have a similar pattern of abdominal fat deposits. Kampong and Arabic chickens deposited abdominal fat a

Table 2: Percentage of experimental chickens showing abdominal fat deposition

Age (weeks)	Laying type cockerels (n = 9)	Kampong chicken (n = 9)	Arabic chicken (n = 9)
4	-	-	-
5	-	33.33	22.22
6	11.11	33.33	55.56
7	33.33	11.11	22.22
8	55.56	88.89	77.78
9	77.78	77.78	88.89
10	100.00	100.00	100.00

n: No. of samples

Table 3: Effects of chicken types on abdominal fat and meat fat when slaughtered at different ages

	Variables	
Treatment	Abdominal fat (%)	Meat fat (g/100 g)
Chicken Type (CT)		
Laying type cockerels	1.368[a]	0.672[a]
Kampong chicken	1.021[b]	0.486[b]
Arabic chicken	1.014[b]	0.477[b]
Slaughtering Age (SA)		
4 weeks	-	0.423[a]
5 weeks	0.483[a]	0.439[a]
6 weeks	0.637[a]	0.451[a]
7 weeks	0.925[a]	0.463[a]
8 weeks	1.157[b]	0.597[b]
9 weeks	1.186[b]	0.657[b]
10 weeks	1.235[b]	0.686[b]
p-value		
Chicken Type (CT)	<0.0001	0.002
Slaughtering Age (SA)	0.01	0.032
CT×SA	0.268	0.580

Table 4: Effects of chicken type and slaughtering age on meat quality

	Variables			
Treatment	Water holding capacity	pH	Cooking loss	Tenderness
Chicken Type (CT)				
Laying type cockerels	19.44[a]	5.68	17.93	4.68[a]
Kampong chicken	18.28[b]	5.43	17.73	4.17[b]
Arabic chicken	18.36[b]	5.52	17.69	4.26[b]
Slaughtering Age (SA)				
4 weeks	22.21[a]	5.65	18.98[a]	5.05[a]
5 weeks	20.78[a]	5.72	18.73[a]	4.87[a]
6 weeks	19.66[a]	5.80	18.31[a]	4.75[a]
7 weeks	18.97[a]	5.78	17.93[a]	4.67[a]
8 weeks	18.68[b]	5.93	17.45[b]	4.38[b]
9 weeks	17.46[b]	5.94	17.21[b]	4.39[b]
10 weeks	17.33[b]	5.98	16.90[b]	4.32[b]
SEM	1.443	0.194	0.648	0.278
p-value				
Chicken type	0.025	0.0563	0.0823	0.0371
Slaughtering age	<0.0001	0.0576	<0.0001	0.0421
CT×SA	0.8782	0.2478	0.2394	0.9762

week faster (week 5) compared to laying type cockerels (week 6). At 6 weeks and older, the three types of chickens studied show the same pattern of abdominal fat deposition.

Table 3 shows that each type of chicken has different abdominal fat deposits and meat fat ($p<0.01$). Slaughtering age increases abdominal fat weight ($p<0.01$) and the level of meat fat ($p<0.05$). However, there was no interaction between the types of chicken and slaughtering age on the weight of abdominal fat and the level of meat fat ($p>0.05$).

The different patterns of abdominal fat deposition and the level of fat deposit in each type of the chicken is an indication that each chicken species has different energy retention patterns for fat establishment and development. The growth of laying type cockerels is higher than that of Kampong and Arabic chickens, while Kampong and Arabic chicken share the same growth rate[7,8].

The different levels of abdominal fat deposits and meat fat between laying type cockerels and Kampong and Arabic chickens are indications that the three types of chickens are different. Kampong chicken is the indigenous chicken domesticated and developed in Indonesia[2,4,8]. Arabic chicken is an introduced local chicken that originated from Braekel kriel silver and Braekel kriel gold chickens (*Gallus turnicus*)[2,4,8]. Broiler chicken is a type of chicken bred in cold climate countries that are strictly selected for the production of consumed eggs. Commercial laying type cockerels in Indonesia are maintained as meat producers to substitute for Kampong chicken meat which is widely used in many traditional dishes in Indonesia[23]. Previous studies showed that feed consumption of laying type cockerels, Kampong and Arabic chicken is the same[8]. However, given the fact that the three types of chickens have different metabolism rates, fat deposit levels (meat fat and abdominal fat) are different as well[13]. The phenomenon of different levels of fat as the effect of different chicken types also occurs in broiler chickens[24], where among three types of broiler chickens studied (strains Ross 308, Hubbard Flex and Hubbard F15), it was found that strains Hubbard Flex produces the highest abdominal fat, followed by the Ross 308 strain and Hubbard F15 strain, respectively.

The effects of age on fat level (abdominal fat and meat fat) on the three types of chicken studied show the same phenomenon. Up to the age of 7 weeks, there was no significant effect but, after 8 weeks, abdominal fat deposits and meat fat were increased because energy usage from the feed before the age of 8 weeks is used mainly for the growth of vital organs (such as nerve tissues, bone and muscles) and the remaining energy is used for the growth of fat and body organs that grow the slowest[24,25]. The use of energy for fat synthesis increases with age[26-28]. The phenomenon of increased levels of fat (abdominal fat and meat fat) with slaughtering age was also reported by Baeza *et al.*[29] who found that abdominal fat levels and meat fat of strains Ross 308 chicken aged up to 56 days increased with age.

The effects of chicken types and slaughtering age on meat quality are presented in Table 4. The data show that chicken type affects water holding capacity and cooking loss ($p<0.05$), but do not affect the pH value or the tenderness of meat ($p>0.05$). Slaughtering age affects water holding capacity, cooking loss ($p<0.01$) and meat tenderness ($p<0.05$), but do not affect pH value ($p>0.05$). No interactions between chicken types and slaughtering age on the water holding capacity, pH, cooking loss and meat tenderness were found ($p>0.05$).

The high water holding capacity of laying type cockerels could be due to the higher growth rate of laying type cockerels compared to Arabic and Kampong chickens[7,8]. The high growth rate is followed by a high occurrence of spontaneous or idiopathic myopathy[14-16], causing birds to be more susceptible to stress and consequently triggering abnormal meat quality, such as pale, soft and exudative (PSE) meat. High growth rates also cause abnormal morphology, expands fiber diameters and improves glycolytic fiber proportion, reducing proteolysis potential on muscles. After slaughtering, the high growth rate accelerates rigor mortis and meat bleaching and lowers water holding capacity[17,18].

Table 4 shows that increasing age, decreases water holding capacity at 8 weeks. The decrease in water holding capacity due to slaughtering age could be caused by meat fat. The fat level of meat in this study increased with age. Meat with high fat levels have higher water holding capacity and meat with low fat levels have lower water holding capacity. The relationship between the fat level of meat with water holding capacity is complex. It is estimated that meat fat serves as a loosening factor on meat microstructure which provides greater opportunity for meat protein to hold water[21].

The effects of the type of chicken and slaughtering age did not affect pH value because the measurement of pH value was carried out 2 h after slaughter. The pH values range within the isoelectric pH (5.0-5.1), which are 5.43-5.98. Within the isoelectric pH, the protein of the meat is not charged and has minimal solubility, several positive charges are released and there is a surplus of negative charges that cause rejection of myofilament and provides more space for water molecules[21].

Data on the effects of chicken type on meat tenderness show that laying type cockerels' meat is more tender than that of Kampong and Arabic chickens because the fat level of laying type cockerels is higher than that of Kampong and Arabic chickens. The level of meat fat determines tenderness of meat as well as flavor[30].

Cooking loss value of meat is affected by slaughtering age, cooking loss declines as age increases due to the increase of meat fat[31]. A study conducted using Pekin duck showed similar results, in which the value of cooking loss of the meat decreased with slaughtering age[32]; however, other studies reported different results. A study by Abdullah and Matarneh[33] found that cooking loss value increased with slaughtering age and Poltowicz and Doktor[28] reported that there was no change in the value of cooking shrinkage of broiler meat slaughtered at different ages.

CONCLUSION

This study concludes that the level of abdominal fat deposits and meat fat of Kampong and Arabic chicken are the lowest, while the highest value is found in laying type cockerels. Abdominal fat deposits and meat fat start increasing when the chickens are 8 weeks old; however, the value of water holding capacity, cooking loss and meat tenderness decreases with age. Kampong and Arabic chickens have a lower water holding capacity and tenderness compared to laying type cockerels.

SIGNIFICANCE STATEMENT

This study found that fat levels of laying type cockerels was higher than those of Kampong and Arabic chickens. Meat quality of laying type cockerels was higher than that of Kampong and Arabic chickens. Fat levels increased after 8 weeks of age and conversely, the level of water holding capacity, cooking loss and meat tenderness decreased. This study could be used to determine the slaughtering age of laying type cockerels, Kampong and Arabic chickens to obtain higher meat quality. These results may help researchers in managing rearing of laying type cockerels, Kampong and Arabic chickens to produce better quality of chicken meat.

ACKNOWLEDGEMENT

Thanks and appreciations to the Directorate General of Higher Education of Ministry of Research, Technology and Higher Education that funded this research through MP3EI 2015 scheme with contract No. 482/SPP-MP3EI/H18.12/PL/2014. Appreciation is also addressed to Professor Wasmen Manalu, Ph.D., Professor at the Faculty of Veterinary Medicine, Bogor Agricultural University, for his willingness to read and correct this manuscript.

REFERENCES

1. Sulandari, S., M.S.A. Zein and T. Sartika, 2008. Molecular characterization of Indonesian indigenous chickens based on mitochondrial DNA displacement (D)-loop sequences. HAYATI J. Biosci., 15: 145-154.

2. Sulandari, S., M.S.A. Zein, S. Paryanti, T. Sartika and M. Astuti *et al*., 2007. Sumberdaya Genetik Ayam Lokal Indonesia. In: Keanekaragaman Sumber Daya Hayati Ayam Lokal Indonesia: Manfaat dan Potensi Manfaat dan Potensi, Diwyanto, K. and S.N. Prijono (Eds.). Pusat Penelitian Biologi-LIPI, Bogor, Indonesia, ISBN: 978-979-799-183-8, pp: 45-104.
3. Abubakar, E. Suprijatna and Sutopo, 2014. Genotype distribution of local chicken crossbred in poultry breeding centre Temanggung-Central Java. Int. Refereed J. Eng. Sci., 3: 1-14.
4. Sartika, T. and S. Iskandar, 2007. Mengenal Plasma Nutfah Ayam Indonesia dan Pemanfaatannya. Balai Penelitian Ternak (Pusat Penelitian Pengembangan Ternak), Sukabumi, Indonesia, ISBN: 978-979-3057-41-5, Pages: 140.
5. Sidadolog, J.H.P., 2007. Pemanfaatan dan Kegunaan Ayam Lokal Indonesia. In: Keanekaragaman Sumber Daya Hayati Ayam Lokal Indonesia: Manfaat dan Potensi Manfaat dan Potensi, Diwyanto, K. and S.N. Prijono (Eds.). Pusat Penelitian Biologi-LIPI, Bogor, Indonesia, ISBN: 978-979-799-183-8, pp: 27-42.
6. Iskandar, S., 2007. Tata Laksana Pemeliharaan Ayam Lokal Dalam. In: Keanekaragaman Sumber Daya Hayati Ayam Lokal Indonesia: Manfaat dan Potensi Manfaat dan Potensi, Diwyanto, K. and S.N. Prijono (Eds.). Pusat Penelitian Biologi-LIPI, Bogor, Indonesia, ISBN: 978-979-799-183-8, pp: 133-155.
7. Tamzil, M.H., R.R. Noor, P.S. Hardjosworo, W. Manalu and C. Sumantri, 2013. Acute heat stress responses of three lines of chickens with different Heat Shock Protein (HSP)-70 genotypes. Int. J. Poult. Sci., 12: 264-272.
8. Tamzil, M.H., M. Ichsan, N.S. Jaya and M. Taqiuddin, 2015. Growth rate, carcass weight and percentage weight of carcass parts of laying type cockerels, Kampong chicken and Arabic chicken in different ages. Pak. J. Nutr., 14: 377-382.
9. Tamzil, M.H., R.R. Noor, P.S. Hardjosworo, W. Manalu and C. Sumantri, 2014. Hematological response of chickens with different heat shock protein 70 genotypes to acute heat stress. Int. J. Poult. Sci., 13: 14-20.
10. Tamzil, M.H., 2014. [Heat stress on poultry: Metabolism, effects and efforts to overcome]. Wartazoa, 24: 57-66, (In Indonesian).
11. Tamzil, M.H., R.R. Noor, P.S. Hardjosworo, W. Manalu and C. Sumantri, 2013. [Polymorphism of the heat shock protein 70 gene in Kampong, Arabic and commercial chickens]. Jurnal Veteriner, 14: 317-326, (In Indonesian).
12. Thutwa, K., S.J. Nsoso, P.M. Kgwatalala and J.C. Moreki, 2012. Comparative live weight, growth performance, feed intake, carcass traits and meat quality in two strains of Tswana chickens raised under intensive system in South East district of Botswana. Int. J. App. Poult. Res., 1: 21-26.
13. Chang, G.B., L.L. Lei, X.Y. Zhang, K.H. Wang, R. Chen, D.Q. Luan and G.H. Chen, 2010. Development rule of intramuscular fat content in chicken. J. Anim. Vet. Adv., 9: 297-298.
14. Duclos, M.J., C. Berri and E. Le Bihan-Duval, 2007. Muscle growth and meat quality. J. Appl. Poult. Res., 16: 107-112.
15. Petracci, M., M. Bianchi and C. Cavani, 2009. The European perspective on pale, soft, exudative conditions in poultry. Poult. Sci., 88: 1518-1523.
16. Strasburg, G.M. and W. Chiang, 2009. Pale, soft, exudative Turkey-The role of ryanodine receptor variation in meat quality. Poult. Sci., 88: 1497-1505.
17. Petracci, M. and C. Cavani, 2011. Muscle growth and poultry meat quality issues. Nutrients, 4: 1-12.
18. Barbut, S., A.A. Sosnicki, S.M. Lonergan, T. Knapp and D.C. Ciobanu *et al*., 2008. Progress in reducing the Pale, Soft and Exudative (PSE) problem in pork and poultry meat. Meat Sci., 79: 46-63.
19. NRC., 1994. Nutrient Requirements of Poultry. 9th Edn., National Academy Press, Washington, DC., USA., ISBN-13: 9780309048927, Pages: 155.
20. AOAC., 1990. Official Methods of Analysis. 15th Edn., Association of Official Analytical Chemists, Washington, DC., USA.
21. Soeparno, 2005. Ilmu dan Teknologi Daging. Gadjah Mada University Press, Yogyakarta, Indonesia.
22. SAS., 2004. SAS/STAT User's Guide: Version 9.1. Statistical Analysis System Institute Inc., Cary, NC., USA.
23. Ichsan, M., 2009. Peluang dan strategi pengembangan peternakan ayam Kampong untuk meningkatkan perekonomian masyarakat pedesaan. Orasi Ilmiah Guru Besar Tetap Ilmu Produksi Ternak, Fakultas Peternakan, Univesitas Mataram, Indonesia.
24. Kokoszynski, D., Z. Bernacki, H. Korytkowska, K. Krajewski and L. Skrobiszewska, 2013. Carcass composition and physicochemical and sensory properties of meat from broiler chickens of different origin. J. Cent. Eur. Agric., 14: 303-315.
25. Murawska, D., 2013. The effect of age on the growth rate of tissues and organs and the percentage content of edible and inedible components in Koluda White geese. Poult. Sci., 92: 1400-1407.
26. Andi, M.A., 2012. Effects of additional DL-methionine in broiler starter diet on blood lipids and abdominal fat. Afr. J. Biotechnol., 11: 7579-7581.
27. Fouad, A.M. and H.K. El-Senousey, 2014. Nutritional factors affecting abdominal fat deposition in poultry: A review. Asian-Aust. J. Anim. Sci., 27: 1057-1068.
28. Poltowicz, K. and J. Doktor, 2012. Effect of slaughter age on performance and meat quality of slow-growing broiler chickens. Ann. Anim. Sci., 12: 621-631.

29. Baeza, E., C. Arnould, M. Jlali, P. Chartrin and V. Gigaud *et al*., 2012. Influence of increasing slaughter age of chickens on meat quality, welfare and technical and economic results. J. Anim. Sci., 90: 2003-2013.
30. Tumova, E. and A. Teimouri, 2010. Fat deposition in the broiler chicken: A review. Scientia Agriculturae Bohemica, 41: 121-128.
31. Fanatico, A.C., P.B. Pillai, J.L. Emmert and C.M. Owens, 2007. Meat quality of slow- and fast-growing chicken genotypes fed low-nutrient or standard diets and raised indoors or with outdoor access. Poult. Sci., 86: 2245-2255.
32. Lacin, E., M.I. Aksu, M. Macit, A. Yildiz, M. Karaoglu, N. Esenbuga and M.A. Yoruk, 2008. Effects of different raising systems on colour and quality characteristics of Turkish pekin duck meats. S. Afr. J. Anim. Sci., 38: 217-223.
33. Abdullah, A.Y. and S.K. Matarneh, 2010. Broiler performance and the effects of carcass weight, broiler sex and postchill carcass aging duration on breast fillet quality characteristics. J. Appl. Poult. Res., 19: 46-58.