

Effect of intensive and semi –intensive systems of management on egg and meat quality of layer chickens

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Abstract

The study was carried out to determine the effect of management systems on the egg and meat quality of layers. A total of 150 (21 weeks old) dominant black pullets were used and randomly divided into two groups of 75 birds per treatment (free range and deep litter production systems). Each treatment was sub-divided into three replicates of 25 birds each. The birds were fed with commercial layers mash continuously for 10 weeks with those on the semi-intensive system having access to green forages for consumption. At the end of 10th week, two birds were randomly selected from each replicate, slaughtered, scaled, and de –feathered for sensory evaluation, determination of cooking weight loss and meat composition. Data obtained were subjected to statistical analysis using T-test. The yolk colour was significantly (P<0.05) by the rearing system. The results indicated no significant (P>0.05) differences in nutritive value of egg from both management systems. Carbohydrate value of thigh muscle was significantly (P<0.05) affected by the management system. There was significant (P<0.05) difference in the juiciness and overall acceptance of the breast meat of the birds. There was no significant (P> 0.05) difference on the cooking weight loss between the meat samples from the two management systems. It was concluded that semi - intensive production system improve yolk colour, thus semi- intensive is recommended for farmer because eggs produced from birds with this management system have an improved yolk colour while layers raised intensively on deep litter management system have a tender breast muscle.

Keywords: Semi intensive, free range, egg quality, meat quality

Introduction

Animal welfare is increasingly viewed as a factor affecting the quality of animal products while being an important tool of marketing strategy (Połtowicz and Doktor, 2011). It has been observed that egg safety or quality or the both could be affected when hens are move from conventional cages to either an enriched cage or a non-cage system (Holt, 2011). Quality may be affected through changes in the integrity of the shell, yolk, or albumen along with changes in function, composition, or nutrition. Season, hen breed, flock age, and flock disease-vaccination status also interact to affect egg safety and quality and must be taken into account (Holt et al., 2011). Alternative poultry meat production has been long popular in Europe and the French Label Rouge programme, which requires outdoor access, has gained the widest recognition (Fanatico et al. 2005). According to Castellini et al. (2002) and Jahan et al. (2004) more natural rearing conditions and increased activity of the birds contribute to the lower lipid content in

broiler meat, and pasture intake encourages a greater degree of consumer acceptability of the meat (Ponte et al. 2008).

Modern day commercial poultry production involves confinement (Ogundipe, 2002), whilst rural poultry production involves free range (Orajaka, 2005). Typically four management systems have been recognized: the free range or unimproved backyard, the improved backyard, the semi-intensive and the intensive systems (Branckaert and Gueye, 2000; Gueye 2004). In Nigeria, the demand for chicken with respect to both eggs and meat by consumers was categorized as a high preference group (Essien et al., 2008). In most African urban areas, free range local chicken eggs and meat are more expensive than the intensively reared poultry because the former are considered as tastier, free of antibiotics, hormones and other harmful chemicals (Nonga et al., 2010). The choice of system is largely determined by availability of resources and inputs; such as housing, cages, feed, drugs, time attention and vaccination. Due to the converse relationship between the two systems (confinement and free-range) such as mode of feeding, energy conservation, nesting, perching, roosting, proximity to feacal or ammonia gas, proximity to water supply and the difference in environmental condition exposure, studies should then be carried out on the egg and meat quality of the birds raised under these two production systems.

Materials and Methods

Experimental Design

A total number of one hundred and fifty (150) dominant black strain layers were used for the experiment. The experimental birds were randomly distributed into two treatments; semi intensive and intensive systems of 75 birds per production system. Each treatment was sub-divided into three replicate of 25 birds per replicate. Cereal base feed was supplied to the birds in both production systems. The second group subjected to the semi intensive system was allowed to graze around and practice all other behavioural activities, they were supplied with housing and nest facilities where they perch and roost. The experiment lasted for ten weeks.

Egg quality

Four eggs were collected per replicate from the different systems of management on the 1st, 3rd, 5th, 7th, and 9th week in lay, tagged and analyzed for both internal and external qualities. Egg weight, eggshell thickness, albumen height and yolk colour was considered for determination of egg quality. Fresh eggs were collected and weighed using electronic digital balance. Egg shell thickness was measured using micro meter screw gauge. Albumen height was measured by spherometer. The eggs were broken on a petrish dish and the height of the albumen was measured by the distance between the petrish dish and the tip of the equipment placed on top of the thick egg white of the broken egg. Yolk colour was determined using yolk colour fan.

Cooking weight loss

At the end of 10^{th} week, two birds were randomly selected from each replicate, slaughtered, scaled, and de –feathered. Meat samples from breast and thigh of slaughtered birds in each replicate were put in a separate air tight polythene bag and then weighed before being cooked for 15 minutes at 70˚C. Final weight was taken when the sample was allowed to cool to room temperature for thirty minutes.

Cooking weight loss= Initial weight before cooking – final weight after cooking

% cooking weight loss
$$= \frac{\text{Initial weight} - \text{final weight} \times 100}{\text{Initial weight}}$$

Sensory evaluation

The parameters observed were colour, flavour, juiciness, tenderness, overall flavour and overall acceptability. Sensory evaluation was done by invited 10 trained panelists that were isolated from each other, they were asked to rinse their mouth with ordinary water between samples to avoid any carry over effect. A nine-point hedonic scoring scale was used to score the meat sample for sensory parameters. 1= dislike extremely, 2= dislike very much, 3=dislike moderately, 4=dislike slightly, 5=intermediate, 6=like slightly,7=like moderately, 8= like very much and 9=like extremely.

Meat pH Determination

The pH of the meat samples from the breast and thigh muscles was determined using a portable pH meter. The pH meter was calibrated using certified buffer. The pH electrode was used to touch the surface of the meat samples from the thigh and breast, and the pH meter readings were noted for each samples and recorded to the nearest 0.01 unit.

Chemical Analysis

Sample of eggs from each of the replicate and meat samples from the breast and thigh of the birds in both production systems were taken to the laboratory and analyzed for proximate composition according to the AOAC (2000) methods. The gross energy of the samples was also determined using a bomb calorimeter.

Statistical analysis

Data collected were subjected to one way analysis of variance using the SAS (1999) package and the significant means were separated using Duncan Multiple Range Test (DMRT) of the same software.

Results

Table 1 showed the effect of production system on the egg quality. The production systems significantly ($P<0.05$) affected only the yolk colour while other internal and external qualities were not significantly ($P>0.05$) affected. It was observed that birds on semi-intensive recorded a higher value of 1.96 of yolk colour (golden yellow) while deep-litter had a value of 0.99 (yellow colour).

Table 2 showed the effect of production system on the nutritional composition of the egg produced by both production systems at the eighth week of experiment. It was observed that there was no significant ($P>0.05$) difference among the eggs' nutrient composition of both semi intensive and intensive system of management.

Meat Quality (Nutrient Composition and pH)

The nutrient composition of the meat samples of pullets from deep litter and semi-intensive production systems is shown in Table 3. It was only carbohydrate value of thigh muscle that was significantly ($P<0.05$) influenced among the parameters measured. The birds in the semi-intensive system had more carbohydrate stored in the thigh compared to that of deep litter. Numerically higher crude protein content (20.60%) was recorded in the semi-intensive system. The breast fat ranged from 6.93% in the deep litter to 7.39% in the semi-intensive system. The moisture content of breast meat sample of the bird was higher in the deep litter (71.09%) compared to that of semi-intensive system (70.38%). Also, the values of carbohydrate were numerically higher in the breast meat sample of the deep litter bird than that of the semi-intensive system. The pH ranged from

Table 1: Effect of deep litter and free rang production systems on egg quality

Parameter	Deep-litter	Free-range
External		
Egg weight (g)	59.29 ± 0.97	57.88 ± 0.86
Egg length (cm)	4.04 ± 0.03	4.00 ± 0.44
Egg breadth (cm)	2.78 ± 0.02	2.73 ± 0.28
Shell thickness (mm)	0.37 ± 0.00	0.34 ± 0.01
Egg shape index	0.69 ± 0.00	0.68 ± 0.01
Shell weight	5.64 ± 0.16	5.26 ± 0.16
Internal		
Albumen height (mm)	6.46±0.18	6.50±0.24
Yolk colour	4.99±0.017[b]	8.96±0.020[a]
Yolk weight (g)	14.76±0.27	14.40±0.45
Albumen weight(g)	38.89±0.76	38.21±0.73
Percent albumen weight	65.57±0.41	66.02±0.82
Haugh Unit	79.54±1.07	80.14±1.52

a, b means in the same row with different superscript differs significantly (P<0.05)

6.15 to 6.36 for the breast meat samples. There was a numerically difference in the crude protein content of the thigh meat samples of the two production systems used. A significantly higher (P>0.05) fat value of the thigh meat was recorded from the birds on the deep litter system. Also, the Energy level ranges between 110.79 MJ and 113.65 MJ for the thigh meat sample.

Table 4 shows the results of sensory

Table 2: Nutrient composition of the eggs from layers raised on deep litter and free range production systems

Parameter	Deep-litter	Free-range
Yolk		
Protein	15.38±0.32	16.05±0.35
Fat	22.29±0.16	22.78±0.29
Ash	1.75±0.04	1.73±0.01
Fibre	0.00±0.00	0.00±0.00
Moisture	60.23±0.11	61.30±0.72
Carbohydrate	0.33±0.04	0.34±0.07
Albumen		
Protein	10.48±0.03	10.25±0.01
Fat	0.06±0.00	0.05±0.00
ash	0.66±0.01	0.67±0.02
Fibre	0.00±0.00	0.00±0.00
Moisture	78.31±0.07	81.42±1.78
Carbohydrate	10.48±0.11	7.60±1.76
Mixture (albumen and yolk)		
Protein	12.73±0.52	12.63±0.10
Fat	9.93±0.08	9.88±0.52
Ash	0.98±0.38	0.98±0.54
Fibre	0.00±0.00	0.00±0.00
Moisture	75.26±0.37	72.02±0.13
Carbohydrate	1.10±0.05	4.49±0.06

analysis of the meat samples raised under two different production systems. There was a significant ($P < 0.05$) difference in the juiciness and overall acceptance of the breast meat of the birds. The breast muscle of birds from intensive was better preferred (more liked) than that of semi intensive (liked moderately). The other parameters in the breast muscle and all the parameters from thigh muscle were not influenced ($P<0.05$) by the production systems.

Table 5 shows the cooking weight loss of the meat samples of birds from both production systems. There was no significant difference ($P> 0.05$) between the meat samples used for the cooking weight loss but numerical difference existed. The percentage cooking weight loss ranged from 5.38% to 6.45% for the breast meat samples and from 4.06% to 4.08% for the thigh meat samples.

Discussion

The non-significance differences recorded in all the external egg parameters especially egg weight corroborates with findings of Guesdon and Faure (2004) who worked on conventional cages and various aviary systems. The yolk colour of birds in free range was more deeply coloured compared to those of the deep litter this is probably related to the fact that hens allocated to outdoor enclosures had the possibility of ingesting, in addition to feed, other raw materials which supply pigments, such as grass and insects. This could be attributed to the presence of carotene in the diet of the birds subjected to the free-range system of management as reported by Mother Earth News (2007) that free-range egg has 7 times more beta carotene compare to caged birds.

The composition of the muscle was not found affected by management systems, this is in accordance with Fanatico et al. (2005)

Table 3: The nutritional composition of the breast and thigh meat of layers raised on deep litter and free range production systems

Parameters	Deep litter system	Free range system
Breast		
Protein (%)	20.20±0.52	20.60±0.21
Fat (%)	6.93±0.11	7.39±0.21
Ash (%)	1.11±0.03	1.09±0.43
Fibre (%)	0.0019±0.0003	0.0015±0.0002
Moisture content (%)	71.09±0.43	70.38±0.18
Carbohydrate (%)	0.66±0.23	0.53±0.25
pH	6.36±0.07	6.15±0.05
Energy (MJ)	16.54±1.45	118.89±0.64
Thigh		
Protein (%)	19.46±0.26	20.28±0.26
Fat (%)	7.12±0.21	7.03±0.36
Ash (%)	1.06±0.01	1.06±0.02
Fibre (%)	0.0016±0.0003	0.0017±0.0002
Moisture content (%)	72.09±0.27	71.38±0.48
Carbohydrate (%)	0.27±0.03^{b}	0.28±0.19^{a}
pH	6.22±0.08	6.31±0.13
Energy (MJ)	110.79±1.17	113.65±1.72

a,b: means on the same row with different superscript are significantly ($P<0.05$) different.

who reported that outdoor (free-range) production system had limited impact on dry matter and fat content of meat of slow-growing broilers (P>0.05). According to Gordon and Charles (2002) temperature fluctuations could cause variation in meat quality. Heat may increase fat content (especially abdominal) of carcass, and in cold temperature, less fat and meat are deposited.

The high tender breast muscle in deep litter system obtained in this study corroborates with the findings of Castellini et al. (2002) who reported that production system affects the shear force in the breast muscle of the organic animals (P<0.05), presumably as a consequence of their greater locomotor activity. However, Dou et al. (2009) and Fanatico et al. (2005) demonstrated that production system had no effect on tenderness of meat in the slow-growing broilers. High muscle pH results in shorter shelf-life of meat, especially as related to microbial growth. In the present report meat pH in indoor systems was higher, although not significantly (P>0.05), than in free-range birds. It is in accordance with Fanatico et al. (2007) who reported the free range production system to result in lower pH of meat in slow-growing chicken (P<0.05). Exercise is likely to affect muscle metabolism as altered by the forage intake and stocking density (Farmer et al., 1997). Culioli et al. (1990) and Castellini et al. (2002) found the similar relation while Alvarado et al. (2005) reported free-range raising system to result in higher pH of meat.

Table 4: Sensory analysis of the breast and thigh meat samples of layers on deep litter and free range production systems

Parameter	Deep litter system	Free range system
Breast		
Colour	8.07±0.18	8.27±0.07
Juiciness	7.93±0.48	8.27±0.13
Flavour	8.13±0.17	8.20±0.12
Tenderness	7.67±0.14[a]	7.13±0.13[b]
Saltiness	5.07±0.44	5.00±0.53
Overall flavour	8.13±0.18	8.00±0.12
Overall acceptance	8.13±0.27[a]	8.07±0.07[b]
Thigh		
Colour	7.20±0.12	7.07±0.07
Juiciness	6.40±0.40	6.93±0.13
Flavour	7.07±0.55	7.60±0.12
Tenderness	5.40±0.99	6.07±0.24
Saltiness	5.20±0.12	5.73±0.18
Overall flavour	6.73±0.41	6.93±0.13
Overall acceptance	7.07±0.48	7.00±0.12

a,b: means on the same row with different superscript are significantly (P<0.05) different.

Table 5: Cooking weight loss of the breast and thigh meat samples of the layers on deep litter and free range production systems

Parameters	Deep litter system	Free range system
Breast		
Weight before Cooking (g)	51.26±4.32	47.72±6.13
Weight after Cooking (g)	48.00±4.31	45.20±5.97
Weight Cooking loss (g)	3.26±0.81	2.52±0.24
Weight Cooking loss (%)	6.45±1.76	5.37±0.57
Thigh		
Weight before Cooking (g)	38.75±1.01	44.04±4.14
Weight after Cooking (g)	37.19±1.21	42.23±3.88
Weight Cooking loss (g)	1.56±0.23	1.81±0.27
Weight Cooking loss (%)	4.05±0.71	4.08±0.28

Conclusion

In this study, it was concluded that the two production systems did not have significant differences on external qualities of eggs but free-range production system improved yolk colour. However, yolk colour does not influence nutritional composition of egg. The nutrient composition of meat samples was not significantly ($P>0.05$) different apart from the carbohydrate content of the thigh meat and tenderness of breast muscle which were significantly ($P<0.05$) influenced by production systems.

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