Kafkas Univ Vet Fak Derg
x (x): xxx-xxx, 2018
DOI: 10.9775/kvfd.2018.19523

Kafkas Universitesi Veteriner Fakultesi Dergisi
Journal Home-Page: http://vetdergi.kafkas.edu.tr
Online Submission: http://submit.vetdergikafkas.org

Research Article

Article in Press

Effect of Different Dietary Lysine Regimens on Meat Quality Attributes in Varieties of Indigenous Aseel Chicken

Tahira BATOOL [1] Salman FAROOQ [1] Nabila ROOHI [1] Athar MAHMUD [2]
Muhammad USMAN [2] Abdul GHAYAS [2] Sohail AHMAD [2]

[1] Department of Zoology, University of the Punjab, Lahore, 54000, PAKISTAN
[2] Department of Poultry Production, Faculty of Animal Production and Technology, University of Veterinary and Animal Sciences, Lahore, 54000, PAKISTAN

Article Code: KVFD-2018-19523 Received: 10.02.2018 Accepted: 01.06.2018 Published Online: 03.06.2018

How to Cite This Article

Batool T, Farooq S, Roohi N, Mahmud A, Usman M, Ghayas A, Ahmad S: Effect of different dietary lysine regimens on meat quality attributes in varieties of indigenous Aseel chicken. *Kafkas Univ Vet Fak Derg,* 2018 *(Article in Press).* DOI: 10.9775/kvfd.2018.19523

Abstract

This study was planned to evaluate the effect of different dietary lysine regimens on sensory attributes and meat quality in Lakha, Mianwali, Mushki and Peshawari varieties of indigenous Aseel. A total of 240 day-old chicks, 60 per each variety were casually selected and sub-divided equally into A, B and C groups. Three lysine regimens namely L1, L2 and L3 were offered to these birds, L1 comprising of 1.3% lysine was served from 0-6th week to birds of group A, and L2 constituting1.4 and 1.2% lysine, where 1.4% lysine from 0-3rd week and 1.2% lysine from 4-6th week was offered to group B. L3 having 1.5, 1.3 and 1.1% lysine was offered as 1.5 from 0-2nd, 1.3 from 3-4th and 1.1% lysine from 5-6th week, respectively to group C. For evaluation of organoleptic and meat quality traits, 72 birds counting 18 per each variety were randomly selected and slaughtered. The breast and thigh meat pieces were separated and their pH was determined at various intervals. The cooked meat color, taste, flavor, tenderness and juiciness were checked to calculate overall acceptability of panelists on nine hedonic scale points between extreme liking and disliking. The findings of this study revealed L3 lysine regimen to be the best for nourishing the birds having good quality meat with respect to color, taste, flavor tenderness, juiciness and overall acceptability towards its consumers.

Keywords: *Aseel varieties, Lysine regimens, Meat quality, Meat pH, Sensory attributes*

Yerel Aseel Tavuklarında Farklı Miktarlarda Diyetsel Lizin Uygulamalarının Et Kalite Özelliklerine Etkisi

Öz

Bu çalışma Lakha, Mianwali, Mushki ve Peshawari yerel Aseel tavuklarında farklı miktarlarda diyetsel lizin uygulamalarının duyusal özellikler ve et kalitesi üzerine etkisini araştırmak amacıyla gerçekleştirildi. Toplam 240 adet bir günlük civciv her deneysel uygulamada 60 adet olacak şekilde seçildi ve A, B ve C olmak üzere gruplara ayrıldı. Üç farlı lizin rejimi oluşturuldu; L1: Grup A'daki civcivlere 0-6. haftalar arasında %1.3 lizin verildi, L2: Grup B'deki civcivlere 0-3. haftalar arasında %1.4 ve 4-6. haftalar arasında %1.2 lizin verildi, L3: Grup C'deki civcivlere 0-2. haftalar arasında %1.5, 3-4. haftalar arasında %1.3 ve 5-6. haftalar arasında %1.1 lizin verildi. Organoleptik ve et kalite özelliklerini değerlendirmek amacıyla her bir varyantta 18 adet olacak şekilde 72 civciv rastgele seçildi ve kesime sevk edildi. Göğüs ve but etlerinin pH değerleri farklı aralıklarla ölçüldü. Pişmiş et rengi, tadı, lezzeti, pişkinliği ve suyu 9 hedonik skala puanlaması kullanılarak panelistlerin sevme ve sevmemeleri değerlendirildi. Çalışma sonuçları L3 lizin uygulamasının et rengi, tadı, lezzeti, pişkinliği, suyu ve genel olarak tüketicilerin memnuniyeti bakımından en iyi uygulama olduğunu gösterdi.

Anahtar sözcükler: *Aseel varyantları, Lizin rejimi, Et kalitesi, Et pH'sı, Duyusal nitelikler*

INTRODUCTION

The poultry meat is valued for its high quality protein source, less fat content, high digestibility and superior organoleptic traits. These nutritional characteristics makes the poultry meat, especially of the chicken more appreciable by consumers [1]. At market level, the breast part of chicken is considered to be the best among the whole carcass due to its muscle fiber conformation and development and even a mild change in its yield could have a substantial

İletişim (Correspondence)
+92 313 4288381
sohail.ahmad@uvas.edu.pk

economic impact [2]. That's why it is very essential to keep the chicken industry up to the running culinary standards by maintenance and improvement in the chemical composition and technical properties of carcass especially the breast muscle through performance evaluation [3]. As chicken carcass or meat quality of pectoral muscles is highly dependent on its biophysical, biochemical and histological properties which intern are influenced by age, sex, inheritance, nutrition and environmental factors [2]. In some studies, a positive correlation among biochemical, histological characteristics and meat quality of breast muscles has been found [4], while a negative impact of bird's age on meat quality has been revealed, especially when breast muscle fiber increases in size with the increase in age [5,6]. However, higher pH values with dark colored meat of pectoral muscle fibers along with increased in size and diameter among fast-growing chicken have also been reported [7]. The fast-growing commercial chicken meat have larger muscle fiber diameter which reduces its tenderness but the slow growing native breeds of chicken have shorter muscle fiber diameter and hence is comparatively more tender and soft [8]. Lot of variations have been found in meat quality of slow and fast-growing chicken with respect to breed and breeding system [9]. A slow-growing chicken (indigenous breeds) being reared under free range in natural environment and slaughtered at mature age might provide a meat with higher quality traits up to the consumer's taste and sensory quality expectations as compared to fast-growing (like broilers, leghorns as well as products of their crosses) chicken [10]. There is an emerging trend for the conservation and development of native chicken breeds as they are being important with respect to historical, traditional as well as socio-economical perspective [11]. The free-ranged and outdoor organic chicken models have significantly more sensory scores of panelists for juiciness of their breast meat as well as overall acceptability. Moreover, their breast and thigh meat have higher percentages of cooking and shear loss values with low fat content [12]. Another study has also revealed that free-ranged chicken had significantly higher breast meat percentages, CP (crude protein) content, values of shear force, chewiness with significantly less fat part, hardiness and factorability as compared to commercial fenced chicken [13,14]. Indigenous Aseel with better growth, carcass, blood biochemical profile, immunity, egg production and persistency have been found when lysine was supplemented as per growth requirements of birds [15]. With the hope that improved growth and carcass of Aseel will ultimately led to better quality, the current experiment was designed to evaluate the comparative sensory traits and meat quality among varieties of indigenous Aseel chicken been reared under three different dietary lysine regimens.

MATERIAL and METHODS

Place of Experiment and Animal Care

The present experiment was conducted at Indigenous Chicken Genetic Resource Center (ICGRC), University of Veterinary and Animal Sciences (UVAS), Lahore, Pakistan, by keeping in view the standard instructions for the care and welfare of the experimental birds. All the procedures used in this study were in accordance with the guidelines and code of practice of University of Veterinary and Animal Sciences, Lahore, Pakistan. Before conducted this study, ethical approval was granted.

Experimental Animals and Design

This experiment was started by securing 240 day-old Aseel chicks (34±2 g) counting 60 per each of the four varieties including Lakha, Mianwali, Mushki and Peshawari. These randomly selected birds were divided into three sub-groups A, B and C, each with 20 birds of each variety. These bird were positioned in equally spaced blocks following standard conditions under Randomized Complete Block Design (RCBD) with a factorial arrangement of 3 (lysine regimens/treatments) × 4 (varieties) × 20 (replicates) with one bird in each replicate.

Experimental Feed and Feeding Program

Three lysine regimens namely L1, L2 and L3 were offered to these Aseel birds, wherein L1 comprising 1.3% lysine was served from 0-6th week (in one phase) to birds of group A, and L2 constituting 1.4% and 1.2% lysine, where 1.4% lysine from 0-3rd week and 1.2% lysine from 4-6th week (in two phases) was offered to group B. Whereas, L3 having 1.5%, 1.3% and 1.1% lysine was offered as 1.5 from 0-2nd, 1.3 from 3-4th and 1.1% lysine from 5-6th week (in three phases), respectively to group C. *Table 1* and *Table 2* represent the ingredients and nutrients composition of experimental feed. After six weeks of rearing under three lysine regimens, all these birds were equally offered the normal broiler grower feed prepared as per standards of National Research Council [16].

Meat Quality and Sensory Evaluation Parameters

After eighteenth week of growth, 72 birds per each variety and 6 birds per treatment group were indiscriminately selected, exposed to fast for 12 h and slaughtered rendering to the Halal Muslim manner. Afterwards, the slaughtered birds were de-feathered and their breasts and thighs pieces were separated from the main body to evaluate the meat quality and organoleptic traits as per method adopted by Adedeji *et al.*[17]. The pH of each breast and thigh sample at various intervals was determined by direct probe and thrusting the digital pH meter into breast and thigh muscle. The meat samples were enfolded in impervious polythene wrappers which could be destroyed by cooking. The breast and thigh meat samples after 20 min of cooking in boiling water bath without using any spices were presented to a panel of ten experts for evaluation of color, taste, flavor, tenderness, juiciness and overall acceptability. The assessment was based on nine-point hedonic scale constituting maximum (9) for extremely like and the minimum (1) for poorest score of dislike.

Table 1. *Chemical composition of experimental diets*

Ingredients	Dietary Lysine Levels (%)				
	1.1	1.2	1.3	1.4	1.5
Corn	59.08	59.08	59.08	59.08	59.08
Sunflower Meal (24%)	18.90	18.90	18.90	18.90	18.90
Soya bean Meal (44%)	7.04	7.04	7.04	7.04	7.04
Rapeseed Meal (36%)	3.00	3.00	3.00	3.00	3.00
Fish Meal (52%)	3.00	3.00	3.00	3.00	3.00
Poultry by-product Meal (50%)	3.00	3.00	3.00	3.00	3.00
Molasses	3.00	3.00	3.00	3.00	3.00
Limestone	1.14	1.14	1.14	1.14	1.14
Lysine Sulphate	0.75	0.80	0.90	1.00	1.10
Mono Calcium Phosphate	0.45	0.45	0.45	0.45	0.45
Vitamin-Mineral Premix*	0.20	0.20	0.20	0.20	0.20
Sodium Chloride	0.18	0.18	0.18	0.18	0.18
Alimet (Novus)	0.17	0.17	0.17	0.17	0.17
Betaine HCl	0.05	0.05	0.05	0.05	0.05
Threonine	0.04	0.04	0.04	0.04	0.04

** Vit-Min premix supplied per 1 kg of diet: Vit. A 12.000 IU; Vit. D_3 2.200 ICU; Vit. E 10 mg; Vit. K_3 2 mg; Vit. B_1 1 mg; Vit. B_2 4 mg; Vit. B_6 1.5 mg; Vit. B_{12} 10 µg; nicotinic acid 20 mg; folic acid 1 mg; pantothenic acid 10 mg; biotin 50 µg; choline chloride 500 mg; copper 10 iron 30 mg; manganese 55 mg; zinc 50 mg; iodine 1 mg; selenium 0.1 mg*

Table 2. *Calculated nutritional composition of experimental diets*

Nutrients (%)	Dietary Lysine Level %				
	1.1	1.2	1.3	1.4	1.5
Metabolize Energy (k calories/kg)	2746.99	2753.69	2760.39	2767.09	2773.79
Dry Matter	87.17	87.36	87.56	87.76	87.96
Crude Protein	17.06	17.18	17.29	17.40	17.51
Crude Fiber	6.93	6.93	6.93	6.93	6.93
Ash	4.09	4.09	4.09	4.09	4.09
Either Extract	3.59	3.59	3.59	3.59	3.59
Calcium	0.84	0.84	0.84	0.84	0.84
Chloride	0.22	0.22	0.22	0.22	0.22
Sodium	0.16	0.16	0.16	0.16	0.16
Total phosphorus	0.68	0.68	0.68	0.68	0.68
Potassium	0.71	0.71	0.71	0.71	0.71
Digestible phosphorus	0.36	0.36	0.36	0.36	0.36
Linoleic Acid	1.42	1.42	1.42	1.42	1.42
Lysine	1.1	1.2	1.3	1.4	1.5
Methionine	0.45	0.45	0.45	0.45	0.45
Methionine+Cystine	0.78	0.78	0.78	0.78	0.78
Digestible Arginine	0.98	0.98	0.98	0.98	0.98
Digestible Tryptophan	0.14	0.14	0.14	0.14	0.14
Digestible Threonine	0.57	0.57	0.57	0.57	0.57
Digestible Lysine	0.99	1.09	1.20	1.31	1.41
Digestible methionine	0.42	0.42	0.42	0.42	0.42
Digestible Methionine+Cysteine	0.67	0.67	0.67	0.67	0.67
Threonine	0.67	0.67	0.67	0.67	0.67
Tryptophan	0.19	0.19	0.19	0.19	0.19
Arginine	1.10	1.10	1.10	1.10	1.10
Cysteine	0.32	0.32	0.32	0.32	0.32
Digestible Cysteine	0.26	0.26	0.26	0.26	0.26
Valine	0.82	0.82	0.82	0.82	0.82
Digestible Valine	0.71	0.71	0.71	0.71	0.71
Histidine	0.43	0.43	0.43	0.43	0.43
Digestible Histidine	0.37	0.37	0.37	0.37	0.37
Phenylalanine	0.78	0.78	0.78	0.78	0.78
Digestible Phenylalanine	0.67	0.67	0.67	0.67	0.67
Leucine	1.44	1.44	1.44	1.44	1.44
Digestible Leucine	1.21	1.21	1.21	1.21	1.21
Isoleucine	0.66	0.66	0.66	0.66	0.66
Digestible Isoleucine	0.58	0.58	0.58	0.58	0.58

Statistical Analysis

Prior to analysis, degree of uniformity and homogeneity of variance was tested and verified for the normality, collected data were analyzed by two-way Analysis of Variance (ANOVA) and General Linear Model of SAS [18] software and the outcomes (results) were indicated as least square means and their standard errors. Duncan's Multiple Range test [19] was used to compare the treatment means and they were considered to be significant at $P \leq 0.05$.

RESULTS

Significant ($P \leq 0.05$) variations were found in different organoleptic properties of thigh meat in Aseel birds reared on different lysine regimens and both L3 (1.5-1.3-1.1%) as well as L2 (1.4-1.2%) were found to be the better for nourishing the birds with moderately liked color, taste, juiciness and overall acceptability of panelists towards organoleptic properties of cooked meat. While, flavor and tenderness of meat was better in L3 followed by L2 and L1 lysine regimens. Non-significant variations were found among different varieties of Aseel for organoleptic properties of thigh meat *(Table 3)*. Likewise, significant variations were also shown by rating the breast meat organoleptic properties including very much liking color, taste, flavor and tenderness among lysine regimens, wherein, L3 found to be better followed by L2 and L1 feeding regimens. While juiciness and overall acceptability of breast meat was better in both L3 and L2 (non-significant among themselves) lysine regimens than L1 as was expressed by panelists during sensory evaluation. Non-significant variations were found among different varieties of Aseel for organoleptic properties of

Table 3. *Various parameters involving sensory evaluation of thigh meat in varieties of indigenous Aseel at 18th week of age*

Variables		Color	Taste	Flavor	Tenderness	Juiciness	Overall Acceptability
Lysine levels (%)/Regimens (LR)							
1.3 (L1)		7.21±0.13^{b}	6.50±0.26^{b}	5.96±0.18^{c}	5.79±0.16^{c}	5.79±0.13^{b}	6.75±0.12^{b}
1.4-1.2 (L2)		7.79±0.13^{a}	7.25±0.15^{a}	7.21±0.13^{b}	7.08±0.15^{b}	6.83±0.17^{a}	7.58±0.15^{a}
1.5-1.3-1.1 (L3)		8.08±0.18^{a}	7.63±0.19^{a}	7.88±0.16^{a}	7.54±0.13^{a}	7.17±0.18^{a}	7.75±0.11^{a}
Aseel Varieties (AV)							
Lakha		7.83±0.17	7.00±0.26	7.00±0.29	6.72±0.25	6.50±0.22	7.39±0.18
Mianwali		7.61±0.22	7.22±0.30	6.78±0.24	6.89±0.24	6.61±0.22	7.44±0.18
Mushki		7.61±0.23	7.22±0.22	7.11±0.28	6.67±0.24	6.61±0.28	7.28±0.18
Peshawari		7.72±0.16	7.06±0.26	7.17±0.25	6.94±0.25	6.67±0.21	7.33±0.18
Lysine levels (%)/Regimens × Aseel Varieties (LR × AV)							
1.3 (L1)	Lakha	7.50±0.22	6.33±0.49	5.67±0.33^{c}	5.67±0.33^{c}	5.67±0.21^{d}	6.83±0.17^{bc}
	Mianwali	7.00±0.26	6.50±0.76	5.83±0.31^{c}	6.00±0.37^{bc}	5.83±0.31^{cd}	6.67±0.21^{c}
	Mushki	7.00±0.37	6.50±0.43	6.00±0.37^{c}	5.67±0.33^{c}	5.67±0.21^{d}	6.67±0.33^{c}
	Peshawari	7.33±0.21	6.67±0.42	6.33±0.42^{bc}	5.83±0.31^{c}	6.00±0.37^{bcd}	6.83±0.31^{bc}
1.4-1.2 (L2)	Lakha	7.83±0.31	7.00±0.37	7.33±0.21^{ab}	6.83±0.31^{ab}	6.83±0.31^{abc}	7.67±0.42^{ab}
	Mianwali	7.67±0.21	7.33±0.33	7.00±0.26^{ab}	7.00±0.37^{a}	6.83±0.31^{abc}	7.67±0.21^{ab}
	Mushki	7.83±0.31	7.33±0.21	7.33±0.33^{ab}	7.00±0.26^{a}	6.83±0.48^{abc}	7.50±0.22^{abc}
	Peshawari	7.83±0.31	7.33±0.33	7.17±0.31^{ab}	7.50±0.22^{a}	6.83±0.31^{abc}	7.50±0.34^{abc}
1.5-1.3-1.1 (L3)	Lakha	8.17±0.31	7.67±0.33	8.00±0.37^{a}	7.67±0.21^{a}	7.00±0.37^{ab}	7.67±0.21^{ab}
	Mianwali	8.17±0.48	7.83±0.17	7.50±0.34^{a}	7.67±0.21^{a}	7.17±0.31^{a}	8.00±0.26^{a}
	Mushki	8.00±0.45	7.83±0.31	8.00±0.37^{a}	7.33±0.33^{a}	7.33±0.49^{a}	7.67±0.21^{ab}
	Peshawari	8.00±0.26	7.17±0.60	8.00±0.26^{a}	7.50±0.34^{a}	7.17±0.31^{a}	7.67±0.21^{ab}
Source of Variation		***P*-value**					
LR		0.0009	0.0016	<.0001	<.0001	<.0001	<.0001
AV		0.7991	0.8847	0.4827	0.6391	0.9443	0.8865
LR×AV		0.9683	0.9382	<.0001	<.0001	0.0013	0.0026

Values have been mentioned as Mean ± SE and various superscripted alphabets show significant (P≤0.05) differences among them (order of significance is as: a>b>c…….); Rating scale score points= 9; Dislike (extremely=1, very much=2, moderately=3, slightly=4); Neither dislike nor like=5; Like (slightly=6, moderately=7, very much= 8, extremely=9)

breast meat *(Table 4)*. As far as interactions among lysine regimens and Aseel varieties are concerned, inconsistent results of organoleptic properties of both thigh and breast meat were observed between moderately and very much liked. Non-significant variations were found among pH of both thigh and breast meat at various intervals (0, 20 and 120 min) after slaughtering in lysine regimens, Aseel varieties and their interaction (P>0.05) *(Table 5)*.

DISCUSSION

As nutrition plays a vital role in muscle growth and meat quality characters of poultry birds, particularly, the muscle development and yield may largely be determined by protein intake which intern affects many molecular pathways with substantial consequences on post mortem metabolism of muscles and eventually the meat quality [20]. Moreover, the meat quality can be modulated and improved more efficiently by strategically supplying the protein and amino acid during early growth [21]. This study is in close lines with our study and its findings, wherein, lysine was supplemented in various dietary regimens and three phase feeding lysine regimen (L3) was found to be very effective with respect to organoleptic and meat quality characteristics. Meat quality is a combination of biochemistry, muscle morphology, muscle fiber configuration [22]. However, genetic factors (sex, breed and strain) may also have great contribution in specific quality traits of meat consistency storing and processing ability [23]. In our findings of organoleptic traits and meat quality characteristics with respect to Aseel varieties, a variable pattern was observed which might also be due to genetic impact. The birds susceptible to fattening possess less sensitivity towards dietary variations than those which are leaner [24]. As far as, the change in post mortem pH of breast and thigh meat is concerned, a large number of factors are involved with respect to birds, feed and feeding processes [25]. Pre-slaughter management has direct relationship with meat

Table 4. *Various parameters involving sensory evaluation of breast meat in varieties of indigenous Aseel at 18th week of age*

Variables		Color	Taste	Flavor	Tenderness	Juiciness	Overall Acceptability
Lysine levels (%)/Regimens (LR)							
1.3 (L1)		6.75±0.14^{c}	7.00±0.16^{c}	6.75±0.12^{c}	7.13±0.14^{c}	6.83±0.17^{b}	6.96±0.18^{b}
1.4-1.2 (L2)		7.46±0.10^{b}	7.67±0.17^{b}	7.67±0.14^{b}	7.79±0.13^{b}	7.88±0.20^{a}	7.63±0.15^{a}
1.5-1.3-1.1 (L3)		7.96±0.14^{a}	8.17±0.16^{a}	8.13±0.13^{a}	8.33±0.12^{a}	8.25±0.18^{a}	7.96±0.15^{a}
Aseel Varieties (AV)							
Lakha		7.44±0.18	7.33±0.20	7.56±0.20	7.50±0.19	7.61±0.26	7.56±0.18
Mianwali		7.44±0.18	7.67±0.23	7.50±0.23	7.72±0.23	7.72±0.25	7.56±0.20
Mushki		7.22±0.19	7.83±0.20	7.50±0.20	7.83±0.17	7.78±0.29	7.61±0.22
Peshawari		7.44±0.20	7.61±0.23	7.50±0.19	7.94±0.17	7.50±0.23	7.33±0.23
Lysine Levels (%)/Regimens × Aseel Varieties (LR × AV)							
1.3(L1)	Lakha	6.83±0.31^{bc}	6.83±0.31^{c}	7.00±0.26^{bcde}	7.00±0.37^{de}	6.67±0.21^{cd}	7.00±0.26^{bc}
	Mianwali	6.83±0.31^{bc}	7.00±0.45^{c}	6.50±0.22^{e}	6.83±0.31^{e}	7.17±0.48^{abcd}	7.17±0.40^{abc}
	Mushki	6.50±0.22^{c}	7.17±0.31^{bc}	6.67±0.21^{de}	7.33±0.21^{cde}	7.00±0.37^{abcd}	6.83±0.31^{c}
	Peshawari	6.83±0.31^{bc}	7.00±0.26^{c}	6.83±0.31^{cde}	7.33±0.21^{cde}	6.50±0.22^{d}	6.83±0.48^{c}
1.4-1.2 (L2)	Lakha	7.50±0.22^{ab}	7.50±0.43^{abc}	7.50±0.34^{bcde}	7.50±0.22^{bcde}	7.83±0.48^{abc}	7.67±0.21
	Mianwali	7.50±0.22^{ab}	7.67±0.21^{abc}	7.67±0.21^{abc}	7.83±0.31^{abcd}	8.00±0.45^{ab}	7.67±0.33^{abc}
	Mushki	7.33±0.21^{abc}	7.83±0.31^{abc}	7.83±0.31^{ab}	7.83±0.31^{abcd}	8.00±0.52^{ab}	7.83±0.31^{abc}
	Peshawari	7.50±0.22^{ab}	7.67±0.42^{abc}	7.67±0.33^{abc}	8.00±0.26^{abc}	7.67±0.21^{bcde}	7.33±0.33^{abc}
1.5-1.3-1.1 (L3)	Lakha	8.00±0.26^{a}	7.67±0.21^{abc}	8.17±0.31^{a}	8.00±0.26^{abc}	8.33±0.33^{a}	8.00±0.37^{ab}
	Mianwali	8.00±0.26^{a}	8.33±0.33^{a}	8.33±0.33^{a}	8.50±0.22^{a}	8.00±0.37^{ab}	7.83±0.31^{abc}
	Mushki	7.83±0.31^{a}	8.50±0.22^{a}	8.00±0.26^{a}	8.33±0.21^{ab}	8.33±0.49^{a}	8.17±0.31^{a}
	Peshawari	8.00±0.37^{a}	8.17±0.40^{ab}	8.00±0.21^{a}	8.50±0.22^{a}	8.33±0.33^{a}	7.83±0.31^{abc}
Source of Variation		***P*-value**					
LR		<.0001	<.0001	<.0001	<.0001	<.0001	0.0003
AV		0.6837	0.3263	0.9926	0.2095	0.8221	0.7454
LR × AV		0.0004	0.0073	<.0001	<.0001	0.0041	0.0519

Values have been mentioned as Mean ± SE and various superscripted alphabets show significant (P≤0.05) differences among them (order of significance is as: a>b>c……..); Rating scale score points= 9; Dislike (extremely=1, very much=2, moderately=3, slightly=4); Neither dislike nor like=5; Like (slightly=6, moderately=7, very much= 8, extremely=9)

color and pH, which may directly affect the ability of myoglobin to bind water and meat quality attributes [26]. Contradictory study also reported non-significant variation regarding meat pH among the indigenous genotypes of India [27]. Moreover, other scientists observed that heavy birds did not struggle much and their pH decline was very slow [28]. Studies on indigenous chickens revealed higher pH value in higher weight birds as compared to lower ones [27]. The normal range of pH for broiler chickens were reported 5.80 to 6.29. Higher pH leads to dark, firm and dry (DFD) meat with poor storage quality due to accelerated microbial growth whereas low pH improves the shelf life of meat but pale coloration [28]. Meat pH has great effect on its color and water holding capacity, drip loss and tenderness which intern are dependent upon lysine supply and intake [21]. Breast muscle glycogen storage might also be greatly responsible for meat pH variations. High ultimate pH levels can be observed in breast meat when lysine intake is reduced along with decreased glycogen storage, while low pH when lysine supply is in excess and more energy storage in the form of muscle glycogen [29]. The present overall better acceptability of panelists towards breast meat in terms of color, taste, flavor, tenderness and juiciness as compared to thigh might be due to the presence of more inosine-5-monophosphate (IMP), generally the key nucleotide in muscles which imparts taste and flavor to cooked meat [30] and lysine content of breast (7% of breast meat), as the proper intake of protein in the form of lysine efficiently controls the molecular regulation of breast muscle growth and reinforce the modulation of meat quality characteristics [31] However, opposite to our study, some studies have also indicated that food programs and lysine supplementation had no impact on pork meat quality attributes i.e., pH, drip loss, water holding capacity and shear force [32].

The present study revealed that the change of nutritional strategy does effect the ultimate muscle growth, pH and

Table 5. *pH values of breast and thigh meat at different time intervals (minutes) after slaughtering among four varieties of indigenous Aseel at 18th week of age*

Variables Breast		0 min		20 min		120 min	
		Thigh	Breast	Thigh	Breast	Thigh	Breast
Lysine Levels (%)/Regimens (LR)							
1.3 (L1)		6.53±0.09	6.75±0.07	6.16±0.07	6.45±0.08	5.80±0.06	6.09±0.06
1.4-1.2 (L2)		6.59±0.08	6.73±0.08	6.27±0.07	6.29±0.06	5.76±0.05	6.02±0.05
1.5-1.3-1.1 (L3)		6.49±0.08	6.79±0.08	6.19±0.06	6.43±0.07	5.88±0.05	6.07±0.06
Aseel Varieties (AV)							
Lakha		6.46±0.11	6.65±0.08	6.14±0.05	6.27±0.02	5.74±0.07	6.06±0.07
Mianwali		6.50±0.07	6.82±0.09	6.28±0.08	6.44±0.01	5.88±0.04	6.01±0.08
Mushki		6.70±0.10	6.73±0.05	6.21±0.01	6.49±0.09	5.73±0.04	6.06±0.07
Peshawari		6.50±0.09	6.83±0.02	6.20±0.07	6.37±0.06	5.89±0.01	6.12±0.09
Lysine Levels (%)/Regimens × Aseel Varieties (LR × AV)							
1.3 (L1)	Lakha	6.29±0.12	6.55±0.13	6.11±0.12	6.15±0.11	5.65±0.11	6.03±0.11
	Mianwali	6.54±0.14	6.87±0.13	6.22±0.18	6.56±0.13	5.95±0.12	5.99±0.12
	Mushki	6.70±0.23	6.76±0.08	6.07±0.19	6.61±0.18	5.67±0.11	6.05±0.12
	Peshawari	6.62±0.20	6.84±0.14	6.23±0.11	6.49±0.15	5.95±0.13	6.29±0.12
1.4-1.2 (L2)	Lakha	6.48±0.01	6.54±0.13	6.22±0.23	6.26±0.12	5.67±0.11	6.06±0.11
	Mianwali	6.60±0.13	6.74±0.20	6.39±0.14	6.19±0.11	5.72±0.11	6.10±0.11
	Mushki	6.71±0.18	6.71±0.18	6.19±0.11	6.19±0.11	5.74±0.10	5.74±0.10
	Peshawari	6.57±0.12	6.91±0.13	6.31±0.12	6.30±0.12	5.91±0.11	5.91±0.12
1.5-1.3-1.1 (L3)	Lakha	6.62±0.24	6.86±0.13	6.10±0.12	6.41±0.14	5.92±0.12	6.10±0.12
	Mianwali	6.35±0.12	6.85±0.15	6.24±0.12	6.57±0.13	5.97±0.11	5.95±0.12
	Mushki	6.70±0.14	6.69±0.16	6.39±0.12	6.43±0.15	5.79±0.11	6.07±0.11
	Peshawari	6.31± 0.12	6.76±0.17	6.05±0.11	6.31±0.12	5.83±0.11	6.16±0.11
Source of Variation		***P*-value**					
LR		0.7127	0.8590	0.4895	0.2060	0.3472	0.7079
AV		0.2849	0.4133	0.6744	0.2244	0.1742	0.7167
LR × AV		0.5996	0.7199	0.6517	0.4048	0.4752	0.4388

other physico-chemical traits of meat and L3 lysine regimen found to be better for producing the meat with superior sensory attributes. The present findings also disclosed the new ways of research to define the requirement of amino acid (s) and the metabolic reasons involved in breast and thigh muscle pH variations in relation to protein and carbohydrate metabolism among slow growing breeds like Aseel.

Acknowledgements

Prof. Dr. Muhammad Akram (Late), Ex-Dean, Faculty of Animal Production and Technology, UVAS, Lahore, is greatly acknowledged for his marvelous contribution during the planning of present research project and cooperation extended by UVAS administration to provide the research facilities at Indigenous Chicken Genetic Resource Centre, Department of Poultry Production, Ravi Campus, Pattoki.

Disclosure Statement

The content matter of this article is based on findings of original research work and there is no any personal conflict and interest on the part of any author.

REFERENCES

1. Mueller S, Kreuzer M, Siegrist M, Mannale K, Messikommer RE, Gangnat IDM: Carcass and meat quality of dual-purpose chickens (Lohmann Dual, Belgian Malines, Schweizerhuhn) in comparison to broiler and layer chicken types. *Poult Sci*, 2018. DOI: 10.3382/ps/pey172

2. Scheuermann GN, Bilgili SF, Tuzun S, Mulvaney DR: Comparison of chicken genotypes: Myofibre number in pectoralis muscle and myostatin ontogeny. *Poult Sci*, 83, 1404-1412, 2004. DOI: 10.1093/ps/83.8.1404

3. Mir NA, Rafiq A, Kumar F, Singh, Shkla V: Determinants of broiler chicken meat quality and factors affecting them: A review. *J Food Sci Tech.* 54 (10): 2997-3009, 2017. DOI: 10.1007/s13197-017-2789-z

4. Rehfeldt CH, Fiedler I, Stickland NC: Number and size of muscle fibres in relation to meat production. **In,** Pas MFW, Everts ME, Haagsman HP (Eds): Muscle Development of Livestock Animals: Physiology, Genetics, and Meat Quality. Cambridge (MA), CABI Publisher, 2004. DOI: 10.1079/9780851998114.0000

5. Chen XD, Ma QG, Tang MY, Ji C: Development of breast muscle and meat quality in Arbor Acres broilers, Jingxing 100 crossbred chickens and Beijing fatty chickens. *Meat Sci*, 77 (2): 220-227, 2007. DOI: 10.1016/j.meatsci.2007.03.008

6. Choi YM, Kim BC: Muscle fiber characteristics, myofibrillar protein isoforms, and meat quality. *Livest Sci*, 122 (2-3): 105-118, 2009. DOI: 10.1016/j.livsci.2008.08.015

7. Tumova E, Teimouri A: Chicken muscle fibres characteristics and meat quality: A review. *Scientia Agric Bohem*, 40 (4): 253-258, 2009.

8. Guan RF, Lyu F, Chen XQ, Ma JQ, Jiang H, Xiao CG: Meat quality traits of four Chinese indigenous chicken breeds and one commercial broiler stock. *J Zhejiang Univ Sci B*, 14 (10): 896-902, 2013. DOI: 10.1631/jzus.B1300163

9. Ayaşan T, Okan F: Effects of diets containing different levels of threonine and lysine aminoacids on fattening performance of broiler chicks. *Süleyman Demirel Üniv Ziraat Fak Derg*, 5 (1): 36-43, 2010.

10. Le Bihan-Duval E: Genetic variability within and between breeds of poultry technological meat quality. *Worlds Poult Sci J*, 60, 331-340, 2004. DOI: 10.1079/WPS200321

11. De Marchi M, Cassandro M, Lunardi E, Baldan G, Siegel PB: Carcass characteristics and qualitative meat traits of the Padovana breed of chicken. *Int J Poult Sci*, 4 (4): 233-238, 2005. DOI: 10.3923/ijps.2005.233.238

12. Castellini C, Mugnai C, Bosco AD: Effect of organic production system on broiler carcass and meat quality. *Meat Sci,* 60 (3): 219-225, 2002. DOI: 10.1016/S0309-1740(01)00124-3

13. Cheng FY, Huang CW, Wan TC, Liu YT, Lin LC, Lou Chyr CY: The effects of free-range farming, compared to a conventional production system, on carcass and meat qualities were studied using black-feathered Taiwan native chickens. *Asian-Australas J Anim Sci,* 21 (8): 1201-1206, 2008. DOI: 10.5713/ajas.2008.80080

14. Thutwa K, Nsoso SJ, Kgwatalala PM, Moreki JC: 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 Appl Poult Res*, 1 (1): 21-26, 2012.

15. Batool T, Roohi A, Roohi N, Mahmud A: Impact of different dietary lysine regimens on blood biochemical profile and immune response in indigenous Aseel varieties. *Pak Vet J,* 37 (4): 393-398, 2017.

16. NRC: Nutrient requirements of poultry. 9th ed., Washington (DC): National Academy Press; 1994.

17. Adedeji OS, Amao SR, Oguntunde MM, Dada ID: Evaluation of general performance and carcass qualities of organically raised broiler chickens from day old to 12 weeks of age. *IJAIR*, 2 (4): 466-471, 2014.

18. SAS Institute Inc: SAS/STAT User's Guide: Statistics.Version 9.1. SAS Inst. Inc., Cary, NC; 2002-2003.

19. Duncan DB: Multiple range and multiple F-tests. *Biometrics*, 11 (1): 1-42, 1955. DOI: 10.2307/3001478

20. Berri C, Besnard J, Relandeau C: Increasing dietary lysine increases final pH and decreases drip loss of broiler breast meat. *Poult Sci*, 87 (3): 480-484, 2008. DOI: 10.3382/ps.2007-00226

21. Lessire M, Primot Y, Corrent E, Fraysse P, Tesseraud S, Berri C: Lysine supply in finishing broilers: Effect on performances and meat quality. **In,** Oltjen JW, Kebreab E, Lapierre H (Eds): Energy and Protein Metabolism and Nutrition in Sustainable Animal Production. 134, 209-210, Wageningen Academic Publishers, Wageningen 2013.

22. Saxena VK, Sachdev AK, Gopal R, Pramod AB: Roles of important candidate genes on broiler meat quality. *Worlds Poult Sci J*, 65 (1): 37-50, 2009. DOI: 10.1017/S0043933909000038

23. Le Bihan-Duval E, Debut M, Berri C, Sellier N, Sante-Lhoutellier V, Jego Y, Beaumont C: Chicken meat quality: Genetic variability and relationship with growth and muscle characteristics. *BMC Genet,* 9 (1): 53, 2008. DOI: 10.1186/1471-2156-9-53

24. Jlali M, Gigaud V, Métayer-Coustard S, Sellier N, Tesseraud S, Le Bihan-Duval E, Berri C: Modulation of glycogen and breast meat processing ability by nutrition in chickens: Effect of crude protein level in 2 chicken genotypes. *J Anim Sci*, 90 (2): 447-455, 2012. DOI: 10.2527/JAS.2011-4405

25. Zhao JP, Zhao GP, Jiang RR, Zheng MQ, Chen JL, Liu RR, Wen J: Effects of diet-induced differences in growth rate on metabolic, histological, and meat-quality properties of 2 muscles in male chickens of 2 distinct broiler breeds. *Poult Sci*, 91 (1): 237-247, 2012. DOI: 10.3382/PS.2011-01667

26. Dadgar S, Lee ES, Leer TLV, Crowe TG, Classen HL, Shand PJ: Effect of acute cold exposure, age, sex and lairage on broiler breast meat quality. *Poult Sci*, 90 (2): 444-457, 2011. DOI: 10.3382/ps.2010-00840

27. Rajkumar U, Muthukumar M, Haunshi S, Niranjan M, Raju MVLN, Rama Rao SV, Chatterjee RN: Comparative evaluation of carcass traits and meat quality in native Aseel chickens and commercial broilers. *Br Poult Sci*, 57 (3): 339-347, 2016. DOI: 10.1080/00071668.2016.1162282

28. Sarsenbek A, Wang T, Zhao JK, Jiang W: Comparison of carcass yields and meat quality between Baicheng-You chickens and Arbor Acres broilers. *Poult Sci,* 92 (10): 2776-2782, 2013. DOI: 10.3382/ps.2012-02841

29. Zhuang H, Savage EM: Comparisons of sensory descriptive flavor and texture profiles of cooked broiler breast fillets categorized by raw meat color lightness values. *Poult Sci,* 89 (5): 1049-1055, 2010. DOI: 10.3382/PS.2009-00422

30. Jayasena DD, Ahn DU, Nam KC, Jo C: Flavour chemistry of chicken meat: A review. *Asian-Austtralas J Anim Sci,* 26 (5): 732-742, 2013. DOI: 10.5713/ajas.2012.12619

31. Berri C: Poultry meat: Expectations for quality that diversify and specific defects to correct. *INRA Prod Anim*, 28 (2): 115-118, 2015.

32. Apple JK, Maxwell CV, Brown DC, Friesen KG, Musser RE, Johnson ZB, Armstrong TA: Effects of dietary lysine and energy density on performance and carcass characteristics of finishing pigs fed ractopamine. *J Anim Sci*, 82 (11): 3277-3287, 2004. DOI: 10.2527/2004.82113277x