

Comparison of Proximate, Amino acid, Fatty acid Composition and Sensory Evaluation of Meat from Domestic Guinea Fowl, Local and Exotic Chicken Breeds

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ABSTRACT

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Domestic guinea fowl (*Numida meleagris*) is a poultry bird raised in different parts of the world for its quality meat, eggs, and socio-cultural purposes. Even though the bird exists in Ethiopia, there is no study conducted on its meat quality in comparison with chickens. Therefore, this study was conducted to compare the meat quality parameters for proximate composition, amino acid profile, fatty acid content, and sensory evaluation of breast and thigh meat of guinea fowl (GF), Horro (HR) and Tilili (TL) local chicken, and Potchefstroom Koekoek (PK) exotic chicken genotypes. Seventy-five-day old chicks from each genotype were divided into three replications and fed commercial starter and grower rations up to week 20. At the end of week 20, three male birds from each pen were randomly selected for meat quality tests and samples were taken from breast and thigh cuts. GF's breast and thigh meat has a higher crude protein content of 24.92 and 20.64 g/100 g, respectively, compared to the chicken genotypes (breast = 21.67-22.70; thigh = 19.82-19.98 g/100 g). Horro chicken breast meat contains significantly ($P < 0.05$) higher lysine and arginine essential amino acids (EAA) than the other genotypes. Similarly, the thigh muscle of HR and TL contained higher levels of histidine, lysine, threonine, arginine and total EAA than the other genotypes. The dominant fatty acids of the breast and thigh meat for all genotypes were palmitic, stearic, oleic, linoleic and arachidonic acids; with a higher content of unsaturated versus saturated fatty acids (SFA). The SFA content of the breast meat was similar between genotypes, while the value for the thigh meat was higher for GF than for the chicken genotypes. The n-3 polyunsaturated fatty acid (PUFA) content in breast and thigh meat and total PUFA for thigh meat of GF was

greater than in chicken genotypes, indicating that meat from GF is healthier for consumption and has better juiciness. However, in terms of tenderness, flavour, and overall acceptance, meat from local chicken genotypes was better than GF and PK. Generally, the poultry genotypes studied have nutritional attributes for the healthy consumption of animal-sourced foods and can play a role in averting protein malnutrition in Ethiopia.

1. INTRODUCTION

According to the Central Statistics Agency of Ethiopia (CSA 2021), the poultry population of the country was estimated to be 57 million, of which 78.9% are indigenous birds, 12.0% are hybrids, and 9.1% are pure exotic breeds, and hence, Ethiopia is one of the largest countries in the world where village poultry plays a dominant role in total poultry production and marketing. Poultry plays an important role in the diet and the economy of the Ethiopian people. Poultry, especially in the small-scale scavenging village context, can make considerable contributions to poverty alleviation and to the supply of high-quality protein. Eggs and poultry meat are more readily available than many other animal products, and the small unit size does not require them to be stored or preserved. It is widely recognized that village poultry plays important nutritional, economic and sociocultural roles in developing countries such as Ethiopia where the sector makes up the largest portion of the national poultry meat and egg production (Aklilu and Berhanu 2020).

Nutritionally, poultry meat is rich in protein and minerals and contains a small amount of fat with a large portion of unsaturated fatty acids and low cholesterol (Barroeta 2007). Consequently, compared to red meat, the main advantage of white chicken meat is its low caloric value and a low portion of saturated fat, so consumption of chicken meat is recommended for people who want to reduce their fat intake, as well as for people suffering from heart and coronary diseases (Gordana 2017). The relevance of poultry meat for humans has been evaluated by FAO which, in a recent

document, states that ‘the human population benefits greatly from poultry meat and eggs, which provide food containing high-quality protein and a low level of fat with a desirable fatty acid profile’ (Marangoni et al 2015). In rural communities of many developing nations, chicken meat is supplied from chicken strains that are adapted to the extensive rearing system. These indigenous chicken strains are known for their tough, lean, and flavorful meat (Sebola et al 2018). Similarly, meat from guinea fowl is white like chicken meat and is regarded as very lean, tender and flavorful (Yildirim et al 2020). Due to all of these characteristics, nowadays guinea fowl meat is popular with health-conscious consumers and has a higher price than chicken meat in restaurants (Musundire et al 2017).

The quality of meat is measured in terms of the main chemical components such as proteins, fats, carbohydrates, vitamins, macro and trace minerals, cholesterol, the profile of fatty acids, and other biologically active compounds (Pearson and Gillet 1996). Research results indicated that poultry meat quality characteristics are affected by various factors such as genetics, the rearing system, sex of birds, slaughter age of birds and the bird's diet (López-Pedrouso et al 2019). Ovesen et al (2003) noted that poultry meat contains 20-22% protein of high biological value. The average protein content for guinea fowl breast meat (23%) is above the average value of 19% for a typical mammalian muscle (CAB International 1987). This shows that guinea fowls can be a good alternative as a protein source to traditional chickens. In Ethiopia, the term poultry is almost

synonymous with chicken. Rearing and meat consumption of other poultry species such as guinea fowl, geese, turkeys, quail and ducks were not common in the country. Guinea fowl production has proven to be commercially viable and they are raised in large numbers in Europe and the United States of America, where they have been successfully commercialized (Moreki and Radikara 2013). Currently, domestic guinea fowl rearing was reported to exist in the lowland areas of the Amhara National Regional State of Ethiopia. They are reared under a free-ranging system for home consumption and income generation.

According to Yildirim et al (2020) guinea fowl meat contains 72.41% moisture, 25.86% protein, 0.68% fat and 1.05% ash. The values reported for chicken were 73.07% moisture, 20.05% protein, 4.58% fat and 1.29% ash (Pambuwa and Tanganyika 2017). However, there is no work done on chicken and guinea fowl meat quality in Ethiopia. Information on approximate composition, amino acid and fatty acid profiles, and sensory evaluation for Horro and Tilili indigenous chicken ecotypes and domestic guinea fowls compared to Potchefstroom Koekoek exotic dual breed in Ethiopia was not worked and documented. Although domestic guinea fowl exists in Ethiopia, research has never been carried out on this unique poultry species locally for meat quality parameters. Generating and availing information on meat quality characteristics of guineafowl in comparison with chicken genotypes reared under the indoor system in the country is timely and indispensable. Therefore, this study was conducted to generate basic data on the approximate composition of meat, amino acid, fatty acid profiles, and meat-eating quality of Horro and Tilili indigenous chicken, domestic guinea fowls, and exotic Potchefstroom Koekoek breeds of chicken kept under the indoor production system.

2. MATERIALS AND METHODS

2.1. Description of the Study Area

The experiment was carried out at the Andassa Livestock Research Center (ALRC) of the Amhara Regional Agricultural Research Institute (ARARI), Ethiopia. The center is located at 11° 29' N latitude and 37° 29' East longitude with an elevation of 1730 meters above sea level. It receives an average annual rainfall of 1150 mm with a temperature ranging from 6.5 to 30°C.

2.2. Management of Experimental Animals and Experimental Design

On hatch day, a total of 300 unsexed birds, that is, 225 chicks, 75 from each of Horro (HR; local chicken ecotypes), Tilili (TL; local chicken ecotypes) and Potchefstroom Koekoek (PK; exotic dual chickens), and 75 keets of guinea fowl (GF) were randomly taken. Treatments were the four poultry genotypes in a completely randomized design (CRD). Each treatment was repeated three times, comprising 25 chicks or keets per replicate. Three pens (3.5 m x 3.5 m) were prepared for guinea fowl and covered with 0.5 x 0.5 cm wire mesh to prevent birds from flying out, and nine pens (2.5 m x 2.5 m) were made and used for chicken genotypes. The experimental pens, watering and feeding troughs were thoroughly cleaned, disinfected, and sprayed against external parasites before the commencement of the experiment. The floor of each pen was bedded with disinfected grass hay and was replaced when deemed appropriate. The chicks and keets were brooded by using 1500-Watt Infra-red electric heaters with gradual height adjustments as a source of heat. All chicks and keets were vaccinated against Newcastle, Gumburo (Infectious Bursal Disease IBD) and Fowl Typhoid diseases using the appropriate vaccine according to the manufacturer's recommendation. All birds were fed the commercial starter ration from up to week 8 and the grower

ration week 9 to week 20. At the end of week 20, three male birds from each replication were randomly selected for carcass evaluation. The birds were starved for 12 hours, weighed and exsanguinated by severing the neck. The meat from the breast and thigh (100 g each) was taken and chilled at 4°C for 24 h. The samples were then kept in a deep freezer at -20 °C until used for analysis of the approximate amino acid and fatty acid profile and sensory evaluation.

Proximate, Amino Acid, and Fatty Acid Analysis

The minced breast (*Pictoralis major*) and thigh muscle (*Biceps femoris*) meat samples were evaluated for moisture, CP, crude fat and ash contents using standard procedures (AOAC, 1998). The meat samples were evaluated for seventeen amino acids, i.e., nine essential and eight nonessential amino acids. The amino acid profiles of breast and thigh meat samples were determined based on the Chinese Standard (GB/T 5009.124 2003) determination of amino acids in foods. The amino acids were determined in triplicate using the amino acid analyzer (L-8900, HITACHI, Tokyo, Japan). The sum of essential amino acids (EAA) and non-essential amino acids (NEAA), as well as the EAA/NEAA ratio, were calculated. For fatty acid profile analysis, lipid extraction from breast and thigh muscles was performed according to the method of Folch et al (1957). Fatty acids (FA) were quantified as methyl esters (FAME) using a gas chromatograph (GC Trace 2000, Thermo Quest EC Instruments) with a flame ionization detector (260 °C) and a fused-silica capillary column (Zebron ZB-88, Phenomenex, Torrance, CA, USA) with a foil thickness of 100 m x 0.25 mm x 0.20 µm foil thickness. Helium was used as the carrier gas. The temperature in the oven was set at 100 °C for 5 min, then increased at 4 °C/min up to 240 °C and maintained for 30 min at 240 °C. The peaks for each fatty acid were identified by

comparison of retention times with those of FAME authentic standards run under the same operating conditions. Saturated fatty acids (SFA), monounsaturated fatty acids (MUFA) and poly-unsaturated fatty acids (PUFA) were calculated from their respective components and the ratio of n-6 to n-3 FA (n-6/n-3) and the ratio of PUFA to SFA (PUFA/SFA) were determined.

Sensory Evaluation

The meat samples from each cut were thawed at room temperature, minced, and cut into 2.5 cm cubes. The breast meat was cooked for 15 min on a pan with vegetable oil but without salt. The thigh meat was cooked in a similar way, but 2 minutes more than the breast. After cooking, the pieces were cooled to room temperature. Samples were evaluated using a nine-point hedonic scale test procedure of the American Meat Science Association (AMSA 2015). Sensory properties were determined by panels of 12 semi-trained people (10 female and 2 male) from the food science research unit of ARARI. The samples labelled with random 3-digit numbers were presented in white plastic plates, and panelists were instructed to rinse their mouth with bottled water between samples. The evaluators scored each sample for flavor (like to dislike), tenderness (tender to tough), juiciness (juicy to dry), and overall acceptability (like to dislike). For flavour and overall acceptability (9 = like extremely, 8 = like very much, 7 = like moderately, 6 = like slightly, 5 = neither like or dislike, 4 = dislike slightly, 3 = dislike moderately, 2 = dislike very much and 1 = dislike extremely. For tenderness: 9 = extremely tender, 8 = very much tender, 7 = moderately tender, 6 = slightly tender, 5 = neither tender nor tough, 4 = slightly tough, 3 = moderately tough, 2 = very much tough, 1 = extremely tough. For juiciness: 9 = extremely juicy, 8 = very much juicy, 7 = moderately juicy, 6 = slightly juicy, 5 = neither juicy nor dry, 4 = slightly dry, 3 = moderately dry, 2 =

very much dry, 1 = extremely dry. Scores from 6 to 9 are considered acceptable (AMSA 2015). The evaluation was completed in one day. The whole sensory analysis was repeated three times.

Statistical Analysis

Data were analyzed using the general linear model procedure of Statistical Analysis Systems Software (SAS 2009). Differences between treatment means were separated using the Tukey-Kuramer test. The model used for data analysis was $Y_{ij} = \mu + G_i + e_{ij}$, where: Y_{ij} = represents the j observation in the i^{th} breed level; μ = overall mean; G_i = genotype effect; and e_{ij} = random error. The effect was considered

significant at $P < 0.05$.

3. RESULTS

Meat Chemical Composition

There were no statistical differences ($P > 0.05$) in the moisture and ash content of the breast and thigh muscles between the poultry genotypes (Table 1). The CP content of GF breast and thigh meat was higher ($P < 0.05$) as compared to chicken genotypes. The crude fat content of the breast muscle was similar ($P > 0.05$) between poultry genotypes, whereas the thigh muscle fat content differed among poultry genotypes ($P < 0.001$) and was of the order of PK = HR > TL > GF.

Table 1: Proximate chemical composition (g/100 g) of the breast and thigh muscle cuts of Guinea fowl, Horro and Tilili local chickens and Potchefstroom Koekoek exotic chicken breeds kept under the indoor system

Parameters	Genotypes				SEM	P-values
	GF	HR	TL	PK		
Moisture						
Breast	72.76	73.48	73.33	72.89	0.25	0.216
Thigh	73.21	74.00	73.41	74.03	0.40	0.423
Crude protein						
Breast	24.92 ^a	22.70 ^b	22.63 ^b	21.67 ^b	0.40	0.002
Thigh	20.64 ^a	19.82 ^b	19.93 ^b	19.98 ^b	0.16	0.030
Crude fat						
Breast	1.73	1.72	1.56	1.69	0.12	0.770
Thigh	3.72 ^c	4.74 ^a	4.23 ^b	4.92 ^a	0.11	0.000
Ash						
Breast	1.06	1.46	1.51	1.65	0.16	0.131
Thigh	1.14	1.24	1.20	1.25	0.04	0.335

^{a,b} Means within a row with different superscripts differ ($P < 0.05$); GF = Guinea fowl; HR = Horro local chickens; TL = Tilili local chickens; PK = Potchefstroom Koekoek; SEM = Standard error of the mean

Amino Acid Profile

The breast muscle of HR has higher ($P < 0.05$) lysine content compared to the values for GF and other chicken genotypes (Table 2). The breast muscle lysine content of GF, TL and PK was not different ($P > 0.05$). The arginine content of breast

muscle, which is an amino acid classified as conditionally essential was higher ($P < 0.05$) for HR compared to TL and PK, while the value of GF was not different from the other genotypes. All of the other essential amino acids and total essential amino acid contents of breast muscle were

not significantly different among genotypes. The histidine, lysine, threonine, arginine and total essential amino acid contents of thigh muscle was greater for HR and TL than the values for GF and PK ($P < 0.05$), while values for other essential amino acids did not significantly differ among genotypes.

Among the nonessential amino acids, the alanine and glutamic acid contents of breast meat were higher for HR ($P < 0.05$) than other genotypes; while the values for GF, TL and PK did not significantly differ. The glycine content of the breast muscle was on the order of $HR = TL > PK > GF$. Total nonessential amino acid contents of breast muscle were the highest for HR,

intermediate for TL and lowest for GF, while the value for PK was similar to TL and GF. The alanine, glycine and total nonessential amino acid contents of thigh muscle was higher ($P < 0.05$) for HR and TL than GF, and the values for HR were also higher than PK. The serine content of the thigh muscle was higher for HR and TL than the values for PK and GF. The contents of other essential amino acids did not differ significantly among genotypes. The essential to non-essential amino acid ratio of breast muscle tended to be higher ($P = 0.085$) for GF but was not statistically different between genotypes for thigh muscle.

Table 2: Amino acid profile (g/100 g) of breast and thigh muscle cuts of guinea fowl, Horro and Tilili local chickens and Potchefstroom Koekoek exotic chicken breeds kept under the indoor system

Amino acids	Breast				SEM	P-values	Thigh				SEM	P-values
	GF	HR	TL	PK			GF	HR	TL	PK		
Essential Amino acids												
Histidine	2.16	2.40	2.30	2.30	0.06	0.183	1.73 ^b	1.96 ^a	1.93 ^a	1.80 ^b	0.04	0.011
Isoluesine	3.70	3.73	3.53	3.66	0.05	0.091	3.26	3.43	3.60	3.30	0.08	0.105
Luecine	5.90	5.83	5.53	5.70	0.12	0.246	5.10	5.43	5.60	5.23	0.11	0.070
Lysine	6.16 ^b	6.60 ^a	6.26 ^b	6.26 ^b	0.08	0.034	5.33 ^b	6.10 ^a	6.16 ^a	5.63 ^b	0.10	0.001
Methionine	1.70	1.70	1.66	1.66	0.06	0.961	1.53	1.63	1.66	1.56	0.03	0.077
Phenylalanine	3.40	3.43	3.33	3.40	0.07	0.813	2.86	3.16	3.00	2.96	0.08	0.182
Threonine	3.36	3.06	3.06	3.16	0.10	0.225	2.90 ^b	3.03 ^a	3.06 ^a	2.83 ^b	0.04	0.011
Valine	3.40	3.50	3.30	3.33	0.05	0.108	2.93	3.13	3.10	2.93	0.07	0.156
Arginine	4.63 ^{ab}	4.86 ^a	4.50 ^b	4.60 ^b	0.07	0.043	4.13 ^c	4.63 ^a	4.50 ^{ab}	4.30 ^{bc}	0.07	0.006
Total EAA	34.43	35.13	33.50	34.10	0.36	0.067	29.80 ^b	32.53 ^a	32.63 ^a	30.56 ^b	0.52	0.0108
Nonessential Amino acids												
Alanine	4.13 ^b	4.53 ^a	4.23 ^b	4.23 ^b	0.05	0.003	3.80 ^c	4.30 ^a	4.13 ^{ab}	3.96 ^{bc}	0.08	0.021
Aspartic acid	6.86	7.00	6.80	6.93	0.09	0.546	6.20	6.43	6.70	6.36	0.15	0.234
Cysteine	0.60	0.66	0.66	0.63	0.05	0.752	0.56	0.63	0.66	0.53	0.04	0.207
Glutamic acid	9.70 ^b	10.36 ^a	9.83 ^b	9.83 ^b	0.10	0.010	9.46	10.13	10.10	9.80	0.17	0.090
Glycine	2.90 ^c	3.43 ^a	3.36 ^a	3.20 ^b	0.04	0.000	2.96 ^c	3.60 ^a	3.36 ^{ab}	3.23 ^{bc}	0.09	0.007
Proline	2.03	2.06	2.26	1.90	0.09	0.112	1.93	2.20	2.00	2.06	0.11	0.468
Serine	2.60	2.60	2.63	2.63	0.03	0.847	2.36 ^b	2.70 ^a	2.63 ^a	2.40 ^b	0.04	0.002
Tyrosine	1.96	2.00	1.90	1.93	0.04	0.512	1.73	1.90	1.83	1.83	0.05	0.307
Total NEAA	30.80 ^c	32.66 ^a	31.70 ^b	31.30 ^{bc}	0.24	0.0039	29.03 ^c	31.90 ^a	31.43 ^{ab}	30.20 ^c	0.48	0.012
EAA/NEAA ratio	1.12	1.08	1.06	1.09	0.01	0.0850	1.03	1.02	1.04	1.01	0.01	0.7196

^{a,b,c}Means within a row and category with different superscripts differ ($P < 0.05$); GF = Guinea fowl; HR = Horro local chickens; TL = Tilili local chickens; PK = Potchefstroom Koekoek; EAA = Essential amino acid; NEAA = Nonessential amino acid; SEM = Standard error of the mean; AAs are expressed on a dry matter basis (g/100 g).

Fatty Acid Profiles

Tricosanoic acid (C23:0) was only present in PK breast meat, while the contents of the other saturated fatty acids (SFA) and the total saturated fatty acid content for breast meat were similar ($P > 0.05$) between genotypes (Table 3). The monounsaturated hexadecenoic acid (C16:1n-7) content of breast meat differed ($P < 0.05$) only between PK and HR and the value is higher for the former. The eicosenoic acid (C20:1n-9) content was undetected in the breast meat of HR, while the value did not significantly differ among the other three genotypes. Contents of the octadecaenoic or oleic acid (C18:1n-9c) and total monounsaturated fatty acids varied between genotypes in the order of $TL > PK = GF > HR$ ($P < 0.05$). The contents of linoleic, linoladic, alpha-linolenic and eicosadienoic polyunsaturated fatty acids (PUFA) of breast meat did not statistically differ among genotypes. The eicosatrienoic (C20:2n-3) content of breast meat was higher ($P < 0.05$) in GF than the values for HR and TL, while the value for PK was similar to GF and HR. The arachidonic acid (C20:4n-6) content was lower for PK than the value for other genotypes. Eicosapentaenoic acid (C20:5n-3) was present in breast meat of GF and HR, while it was not detected in TL and PK genotypes. The docosaheptaenoic acid content of breast meat and the sum of n-3 PUFA were lower ($P < 0.05$) for HR than the values for other genotypes, while the sum of n-3 and total PUFA did not differ ($P > 0.05$) between genotypes. The total fatty acids content is lower ($P < 0.05$) for

HR than the values for the other three genotypes, while the ratio of PUFA: SFA did not statistically differ among the genotypes.

Lauric acid was not detected in the thigh muscle (Table 4). Except for myristic, heptadecanoic and tetracosanoic acids, other SFA and total SFA contents of thigh meat differ ($P < 0.05$) among genotypes, where the values were consistently higher for GF than for the other genotypes. The hexadecenoic, tetracosenoic and total monounsaturated fatty acid (MUFA) contents of thigh muscle were statistically similar ($P > 0.05$) among genotypes. The oleic or octadecanoic acid and eicosenoic fatty acids contents were greater ($P < 0.05$) for GF than HR and TL, while the value for PK did not differ from the other three genotypes. The docosenoic acid was significantly lower for TL than GF and PK, and the value for HR was similar to all of the other genotypes. Among the PUFA the contents of linoleic (C18:2n-6c), linolaidic (C18:2n-6t), gamma-linoleic (C18:3n-6), and eicosapentaenoic (C20:5n-3) fatty acids were higher ($P < 0.05$) in GF compared to chicken genotypes, but linoleic acid content of GF and PK did not differ statistically. There was no difference ($P > 0.05$) between genotypes in alpha-linolenic, eicosadienoic, eicosatrienoic, arachidonic, and docosaheptaenoic acid contents and PUFA: SFA ratio of thigh meat. Total PUFA content was in the order of $GF > PK > HR$, while the value for TL differed only from that of GF.

Table 3: Fatty acid composition (g/100 g) of breast muscle cuts of Guinea fowl, Horro and Tillili local chickens and Potchefstroom Koekoek exotic chicken breeds kept under the indoor system

Parameters	Genotype				SEM	P-Values
	GF	HR	TL	PK		
Saturated fatty acids (SFA)						
C12:0 (Lauric acid)	nd	nd	nd	nd	-	-
C14:0 (Myristic acid)	0.01	0.02	0.01	0.01	0.001	0.0519
C16:0 (Palmitic acid)	0.48	0.26	0.53	0.58	0.080	0.0952

C18:0 (Stearic acid)	0.43	0.25	0.38	0.34	0.04	0.0853
C20:0 (Arachidic acid)	0.01	0.00	0.01	0.01	0.003	0.0672
C22:0 (Docosanoic acid)	0.01	0.02	0.01	0.01	0.003	0.8592
C23:0 (Tricosanoic acid)	nd	nd	nd	0.02	0.002	0.0030
C24:0 (Tetracosanoic acid)	0.01	0.01	0.003	0.01	0.003	0.1631
ΣSFA	0.97	0.56	0.94	0.97	0.114	0.0865
Monounsaturated fatty acids (MUFA)						
C16:1n-7 (Cis-9-Hexadecenoic acid)	0.02 ^{ab}	0.003 ^b	0.023 ^{ab}	0.05 ^a	0.01	0.0316
C18:1n-9 (Cis-9-Octadecaenoic acid)	0.80 ^b	0.32 ^c	1.32 ^a	0.94 ^b	0.09	0.0004
C20:1n-9 (Cis-11-Eicosenoic acid)	0.02 ^a	nd ^b	0.02 ^a	0.02 ^a	0.004	0.0095
C22:1n-9 (13 Z-Docosenoic acid)	0.02	0.01	0.02	0.01	0.006	0.8630
C24:1n-9 (Cis-15-Tetracosenoic acid)	0.01	0.01	0.01	nd	0.004	0.1039
ΣMUFA	0.87^b	0.35^c	1.39^a	1.03^b	0.096	0.0004
Polyunsaturated fatty acids (PUFA)						
C18:2n-6, cis (Linoleic acid)	0.63	0.26	0.69	0.66	0.105	0.0660
C18:2n-6 trans (Linolaidic acid)	nd	nd	nd	nd	-	-
C18:3n-3 (Alpha lenolenic acid)	0.02	0.02	0.02	0.02	0.004	0.8477
C20:2n-3 (Eicosadienoic acid)	0.02	0.01	0.01	0.02	0.003	0.0553
C20:2n-6 (Eicosatrienoic acid)	0.013 ^a	0.003 ^{bc}	0.00 ^c	0.01 ^{ab}	0.002	0.0144
C20:4n-6 (Arachidonic acid)	0.280 ^a	0.260 ^a	0.260 ^a	0.200 ^b	0.011	0.0063
C20:5n-3 (Eicosapentaenoic)	0.013 ^a	0.010 ^a	nd	nd	0.002	0.0110
C22:6n-3 (Docosaehaenoic acid)	0.050 ^a	0.030 ^b	0.030 ^b	0.020 ^b	0.003	0.0014
ΣPUFA n-6	0.930	0.520	0.980	0.870	0.110	0.0736
ΣPUFA n-3	0.110^a	0.060^b	0.070^b	0.060^b	0.003	<0.0001
ΣPUFA	1.040	0.580	1.050	0.930	0.110	0.594
Total Fatty Acids (TFA)	2.870^a	1.490^b	3.380^a	2.930^a	0.270	0.005
n-6: n-3 ratio	8.74^{bc}	8.27^c	14.94^{ab}	15.42^a	1.91	0.0490
PUFA: SFA ratio	1.07	1.06	1.13	0.96	0.05	0.1846

^{a,b,c} Means within a row with different superscripts differ ($p < 0.05$); GF = Guinea fowl; HR = Horro local chicken; TL = Tilili local chickens; PK = Potchefstroom Koekoek; Σ = Summation; ΣSFA = Saturated fatty acids; ΣMUFA = Monounsaturated fatty acids; ΣPUFA = Polyunsaturated fatty acids; TFA = Total Fatty Acids; n-6 = omega 6 fatty acid; n-3 = omega 3 fatty acid; nd = not detected; SEM = Standard error of the mean.

Table 4: Fatty acid composition (g/100 g) of thigh muscle cuts of Guinea fowl, Horro and Tilili local chickens and Potchefstroom Koekoek exotic chicken breeds kept under the indoor system

Parameters	Genotype				SEM	P-Values
	GF	HR	TL	PK		
Saturated fatty acids (SFA)						
C6:0 (Caproic acid)	0.017	nd	nd	nd	0.002	0.002
C8:0 (Octanoic acid)	0.020	nd	nd	nd	0.00	0.0001
C10:0 (Decanoic acid)	0.030 ^a	0.003 ^b	0.007 ^b	nd ^c	0.004	0.0018
C12:0 (Lauric acid)	nd	nd	nd	nd	-	-
C14:0 (Myristic acid)	0.01	0.02	0.01	0.010	0.001	0.0519
C15:0 (Pentadecanoic acid)	0.01	nd	nd	nd	0.000	<0.0001
C16:0 (Palmitic acid)	1.360 ^a	0.617 ^b	0.587 ^b	1.103 ^{ab}	0.174	0.0348
C17:0 (Heptadecanoic acid)	0.017	0.003	0.003	0.017	0.005	0.1742
C18:0 (Stearic acid)	1.220 ^a	0.590 ^b	0.540 ^b	0.737 ^b	0.088	0.0022
C20:0 (Arachidic acid)	0.047 ^a	0.023 ^b	0.013 ^b	0.027 ^b	0.004	0.0043
C22:0 (Docosanoic acid)	0.033 ^a	0.020 ^b	0.010 ^b	0.020 ^b	0.002	<0.0001
C24:0 (Tetracosanoic acid)	0.020	0.010	0.010	0.010	0.003	0.0951
ΣSFA	2.807 ^a	1.280 ^b	1.177 ^b	1.940 ^b	0.263	0.0082
Monounsaturated fatty acids (MUFA)						
C16:1n-7 (Cis-9-Hexadecenoic acid)	0.053	0.083	0.050	0.063	0.034	0.8945
C18:1n-9 (Cis-9-Octadecaenoic acid)	2.170 ^a	1.197 ^b	1.353 ^b	1.953 ^{ab}	0.246	0.0465
C20:1n-9 (Cis-11-Eicosenoic acid)	0.087 ^a	0.027 ^b	0.020 ^b	0.053 ^{ab}	0.011	0.0090
C22:1n-9 (13 Z-Docosenoic acid)	0.033 ^a	0.017 ^{ab}	0.010 ^b	0.033 ^a	0.006	0.0459
C24:1n-9 (Cis-15-Tetracosenoic acid)	0.017	0.013	0.010	0.020	0.002	0.0770
ΣMUFA	2.460	1.337	1.443	2.123	0.275	0.0565
Polyunsaturated fatty acids (PUFA)						
C18:2n-6, cis (Linoleic acid)	2.047 ^a	1.043 ^c	1.253 ^{bc}	1.623 ^{ab}	0.169	0.0139
C18:2n-6 trans (Linolaidic acid)	0.023 ^a	nd	nd	0.007 ^b	0.002	0.0003
C18:3n-6 (Gamma linolenic acid)	0.013	nd	nd	nd	0.003	0.0010
C18:3n-3 (Alpha linolenic acid)	0.070	0.020	0.020	0.030	0.012	0.0788
C20:2n-3 (Eicosadienoic)	0.030	0.020	0.010	0.020	0.004	0.1504
C20:3n-6 (Eicosatrienoic acid)	0.010	0.003	0.007	0.007	0.003	0.4872
C20:4n-6 (Arachidonic acid)	0.343	0.267	0.337	0.270	0.045	0.4981
C20:5n-3 (Eicosapentaenoic)	0.020 ^a	nd	0.007 ^b	0.003 ^b	0.002	0.0016
C22:6n-3 (Docosahexaenoic acid)	0.037	0.037	0.037	0.033	0.004	0.9314
ΣPUFA n-6	2.437 ^a	1.313 ^c	1.597 ^{cb}	1.907 ^b	0.162	0.0064
ΣPUFA n-3	0.180 ^a	0.077 ^b	0.080 ^b	0.093 ^b	0.015	0.0035
ΣPUFA	2.590 ^a	1.390 ^c	1.677 ^{bc}	2.000 ^b	0.178	0.0074
Total Fatty Acids (TFA)	7.857 ^a	4.007 ^b	4.297 ^b	6.063 ^{ab}	0.679	0.0131
n-6: n-3 ratio	13.610	17.167	21.013	23.000	3.286	0.2625
PUFA: SFA ratio	0.923	1.100	1.770	1.033	0.307	0.2747

^{a,b,c} Means within a row with different superscripts differ ($p < 0.05$); GF = Guinea fowl; HR = Horro local chicken; TL = Tilili local chickens; PK = Potchefstroom Koekoek; Σ = Summation; ΣSFA = Sum of saturated fatty acids; ΣMUFA = Sum of monounsaturated fatty acids; ΣPUFA = Sum of polyunsaturated fatty acids; TFA = Total Fatty Acids; n-6 = omega 6 fatty acid; n-3 = omega 3 fatty acid; nd = not detected; SEM = Standard error of the mean

Meat-Eating Quality

The tenderness of the breast meat was lower ($P < 0.05$) for GF compared to the chicken genotypes, while the values for the chicken genotypes were statistically similar (Table 5). The flavour and juiciness of breast meat did not differ among the genotypes. Overall acceptance

of breast meat was lower ($P < 0.05$) for GF compared to local chicken genotypes, while the value for PK was similar with other genotypes. The tenderness and flavor of thigh muscle were lower ($P < 0.05$) for GF compared to the chicken genotypes, while values for the chicken genotypes were similar. The juiciness of the thigh

muscle was higher for GF and PK than for the local chicken genotypes; while overall

acceptance was greater for the local chickens compared to GF.

Table 5: Meat sensory attributes of Guineafowl, Horro and Tilili local chickens and Potchefstroom Koekoek exotic chicken breeds kept under the indoor system

Parameters	Genotypes				SEM	<i>P</i> values
	GF	HR	TL	PK		
Breast						
Tenderness	6.16 ^b	7.50 ^a	7.33 ^a	7.33 ^a	0.24	0.003
Flavour	5.66	6.00	6.50	5.83	0.36	0.416
Juiciness	6.00	6.16	6.33	6.33	0.25	0.749
Overall	6.50 ^b	7.50 ^a	7.66 ^a	7.00 ^{ab}	0.22	0.007
acceptance						
Thigh						
Tenderness	7.00 ^b	8.16 ^a	8.00 ^a	8.16 ^a	0.25	0.010
Flavour	7.33 ^b	8.50 ^a	8.33 ^a	8.16 ^a	0.20	0.003
Juiciness	7.83 ^a	6.33 ^b	6.83 ^b	8.00 ^a	0.24	0.000
Overall	7.33 ^b	8.33 ^a	8.50 ^a	7.16 ^b	0.27	0.003
acceptance						

^{a,b}Means within a row with different superscripts differ ($P < 0.05$); GF = Guineafowl; HR = Horro local chicken; TL = Tilili local chicken; PK = Potchefstroom Koekoek; SEM = Standard error of the mean.

4. DISCUSSION

Meat Proximate Composition

The moisture content of breast and thigh meat from all genotypes in the current study ranged from 72.7 to 74.0%, which falls within the range noted by Adeyanju et al (2013). The moisture content of GF breast and thigh muscle cut in this study was in agreement with the 73% value for guinea fowl broilers reported by Laudadio et al (2012). Pambuwa and Tanganyika (2017) reported a moisture content of 72.67% for the meat of 20 weeks age indigenous chicken reared under an intensive system in Malawi, which was comparable to the results of the current study.

The protein content of chicken meat is variable ranging 16 - 24% (Owens et al 2010), and the values for breast and thigh muscle of the chicken genotypes used in this study is within this range. Pambuwa and Tanganyika (2017) noted 20.72% protein content of meat of indigenous

chickens reared under an intensive system in Malawi at the age of 20 weeks, a value close to the current result. The protein content of the breast meat for Ross 308, Cobb 500 and Cobb 800 was 21.9%, 22.4%, and 22.8%, respectively (Ristic 2005), which is comparable to the results of this study for chicken genotypes. The relatively greater protein content of 23.88, 24.25, and 23.4% were reported by Susanto et al (2019) from Indonesian native chicken breast meat, Guan et al (2013) from Chinese indigenous chicken and Packard (2014) for PK genotypes, respectively. The lower protein content of 17.6% for thigh muscle of PK genotype as compared to the current result was reported by Packard (2014), while Zotte et al (2020) noted higher protein content for Polverara Italian indigenous chickens. The protein content for GF breast muscle noted by Yildirim et al (2020) ranged from 25.31% to 25.86%, which was similar to

the result of the current study, indicating a higher protein value for GF than chicken genotypes.

For indigenous chickens reared under an intensive system in Malawi at the age of 20 weeks, the ash and fat contents of the breast meat were 4.92% and 1.25% (Pambuwa and Tanganyika 2017), and the fat was comparable, and ash was higher compared to the current result. For the PK genotype Packard (2014) noted that breast meat contains 2.51% fat and 1.10% ash, and thigh meat has 7.20% fat and 1.00% ash, with the fat content being relatively higher and the mineral content lower than the result recorded by the chicken genotypes studied. The relatively higher level of protein and lower level of fat in GF as compared to chicken genotypes is an indication of quality meat with good nutritional value from these bird species.

Amino Acid Profile of Breast and Thigh Meat

The difference observed between breast and thigh muscle in essential amino acid contents for all of the genotypes studied appeared to be greater than the non-essential amino acid contents, values being higher for breast than thigh muscle. This is apparently a consequence of differences in the protein content of the breast and thigh muscles, which contrast with results reported by Chae et al (2012), who observed higher amino acid contents in chicken thigh compared with breast muscle. It is widely known that high amino acid content, as well as essential amino acids, are found in high protein foods (Kim et al, 2009), which was more or less similar to the current findings from all genotypes. Differences in the types and percentages of essential amino acids (EAAs) in food could influence the value of protein consumed and proteins with a high content of EAAs are the most important components of poultry meat (Alfaig et al 2014). Protein quality is an important aspect of human food intake.

Furthermore, differences in the types and percentages of essential amino acids in food could influence the value of protein consumed (Alfaig et al 2014).

From a human nutritional point of view, meat from chicken and GF genotypes, with higher protein and essential amino acid contents can be considered as a higher nutritional value from the current study. The standard requirements of AA (g/100 g) per day from FAO/WHO/UNU (1985), for pre-school children, 2-5 years is leucine (6.6), threonine (3.4), valine (3.5), isoleucine (2.8), lysine (5.8), histidine (1.9) and total EAA (33.9). On the basis of this information, the histidine and isoleucine contents of the breast meat of all genotypes, the threonine of the GF and the valine of the HR breast, and the total EAA of all genotypes would almost provide enough of EAAs for preschool children. Additionally, from thigh meat, the isoleucine requirement would be satisfied from all genotypes and histidine from HR and TL chicken genotypes would be satisfactory for the requirements of AA according to the reference indicated as a standard requirement. Among the essential amino acids, lysine followed by arginine is the major amino acid found in a higher proportion in both breast and thigh meat for all of the genotypes. The lysine contents of the breast and thigh in the current study were higher than those obtained by Wattanachant et al (2004), Do and Chung (2017) and Zotte et al (2020) for different chicken genotypes. The HR of indigenous chicken has higher contents of lysine and arginine from both muscle cuts compared to the other genotypes. Arginine is considered a conditionally essential amino acid, which is not adequate to meet metabolic needs under certain conditions such as during early childhood (van Waardenburg et al 2007). Its higher proportion in both meat cuts makes it a promising source of arginine for children at an early age (Quaresma et al 2016) and preparation of child formula foods. Based

on the content of essential amino acids, HR local chicken followed by TL local chickens appeared to have better protein quality compared to the other genotypes, which was in agreement with Jung et al (2014) from Korean indigenous chicken breeds.

Among non-essential amino acids, aspartic acid and glutamic acid are the two major amino acids found in greater proportion in both muscle cuts of all genotypes studied. Both amino acids are strongly associated with umami taste and monosodium glutamate taste and are studied to create a full flavour in chicken products (Dashdorj et al 2015). Glutamic acid was found to have a detectable effect on the taste of chicken meat, and this may contribute to the differences in flavour between the meats of different genotypes (Wattanachant 2008). The glutamic acid in the breast meat was higher in local HR chickens followed by GF, TL, and PK. This result is in agreement with Wattanachant (2008), where the Thai indigenous chicken meat muscles contained slightly higher glutamic acid as compared to broiler muscles. It is also interesting to note that the ratio of EAA/NEAA is above one for both breast and thigh cuts of all genotypes, indicating that both muscles contain a relatively higher proportion of essential amino acid profiles than nonessential amino acids. These ratios from both cuts were superior to those reported for roosters (0.78; Franco et al 2012), indicating that both meat cuts were of superior quality from a human health perspective as reported by Chen et al (2016). Considering human requirements (g/100 g per day) of amino acids listed in the World Health Organization's report (WHO 2007), all genotypes considered in the current study can be a valuable source of the essential amino acids, although values favor HR.

Fatty Acid Profile of Breast and Thigh Meat

In the present study, total saturated fatty acids (SFA) of breast meat were lower than thigh meat, with values being similar among genotypes for breast meat but higher for GF for thigh meat. Not in agreement with the present study, Bernacki et al (2012) reported higher SFAs in guinea fowl breast meat as compared to chicken. Chiroque et al (2018) reported a greater total SFA (1.366 g/100 g) in breast meat cut of GF, which was higher than the current value. The saturated fat contained in GF and chicken breast and thigh meat of the current study were dominated by palmitic (C16:0) and stearic (C18:0) acids, as has been reported before (Kralik et al 2018; Sebola et al (2018). The lauric (C12:0) acid, which promotes hypercholesterolemia, was not detected in breast and thigh meat of all of the genotypes in this study, signifying a positive factor in the consumption of meat from these genotypes. The USA National Nutrient Database for Standard References (USDA, 2016) indicated the SFA content of chicken breast, pork, beef and lamb to be 1.01, 1.451, 2.661, and 2.380 g/100 g, respectively; and the current values for all of the genotypes were slightly less than this reference. The lower composition of the SFA might be considered positive for the healthy consumption of poultry meat, as reported by FAO (2013).

Poultry meat is well known for its relatively low fat and high unsaturated fatty acid content compared to other meats (Barroeta 2007), which was similar to the result of the present study. From the MUFA contents of breast and thigh meat, oleic acid (C18:1n-9c) was predominantly available for all of the genotypes. A similar result for Nigerian Fulani local chicken ecotypes (Tougan et al 2018) and GF (Chiroque et al 2018) was reported. The total MUFA content of the breast and thigh meat in this study differed between genotypes. The observed differences in MUFA between the ecotypes studied can be attributable only to the genetic

differences since diets and the rearing system were similar (Tougan et al 2018). The USDA (2016) reference values for MUFAs of chicken breast meat is 1.24 g/100 g, which is higher than the value recorded for all genotypes studied, except TL chicken genotype.

In this study, linoleic (C18:2n-6) and arachidonic (C20:4n-6) acids were the abundantly found PUFAs from both from breast and thigh meat cuts. This was in line with the report of Jayasena et al (2013) from Korean native chickens for both meat cuts. Milicevic et al (2014) also reported linoleic acid to be the major PUFA in chicken meat. On the contrary, linoladic acid (C18:2n-6t), a trans fatty acid, was not detected for all genotypes, making the meat healthy and safe for consumption as trans fatty acids melt at higher temperature. The result supports the fact that chicken meat as opposed to beef and lamb does not contain trans fats, which contribute to coronary heart disease (FAO 2013). Total PUFA from breast meat of GF, TL and PK ranged 0.94 - 1.05 g/100 g, which was more than USDA standard references, while the value for HR (0.58 g/100 g) was slightly less than the standard reference of USDA (2016). The total PUFA content of thigh meat from GF was higher as compared to chicken genotypes. The finding was supported by De Smet (2012), in that meat with reduced levels of intramuscular fat is rich in polyunsaturated fatty acids, due to the increased proportion of membrane phospholipids that contain a large amount of polyunsaturated fatty acids. Meat containing high concentrations of PUFA is of considerable value because PUFA is considered a functional ingredient capable of reducing the incidence of coronary heart disease and other chronic diseases (Laudadio et al 2012).

Both cuts of meat contained higher n-3 PUFA fatty acids for GF than the chicken genotypes. Similar to this study, a total

PUFA n-3 fatty acid of 0.113 g/100 g was noted for GF breast meat by Chiroque et al (2018). The n-3 docosahexaenoic acid (DHA), which is typically found in marine fish (Chauton et al 2015) was detected in GF and chicken breast and thigh meat cuts, which was in line with the report of Chen et al (2016). The n-3 fatty acids are known to have potentially positive effects against cardiovascular disease, some autoimmune disorders, diabetes, and some types of cancer (Motsepe et al 2016). The European Commission Community Research (2000) specifies for humans a requirement of omega 3 fatty acids of 1 g/day, while the Food and Nutrition Board in the United States (2005) reports a requirement of 0.11-0.16 g/day. According to Kris-Etherton et al (2002), the American Heart Association recommended for people with coronary heart disease a daily intake of docosahexaenoic acid (DHA) plus eicosapentaenoic (EPA) of 0.9 g/day. The GF breast and thigh meat with 0.18 and 0.11 g/100 g content of omega 3 fatty acid indicate that this meat to be able to contribute to the daily need for the essential fatty acids in humans. In most Western countries, where fish consumption (a major source of omega³) is relatively low, poultry meat may therefore represent an important source of these fatty acids (Ian Givens and Gibbs 2008).

Due to the potential effect of fatty acid compositions on human health, PUFA/SFA and n-6/n-3 ratios are of great importance to evaluate the nutritional quality of meat (López-Pedrouso et al 2019). The PUFA n-6/n-3 ratios in this study were lower for GF and HR than for PK breast meat. A lower ratio of n-6/n-3 fatty acids are more desirable in reducing the risk of many diseases (Simopoulos 2002). The ratio observed in this study was significantly lower than that reported for broiler chicken meat (Molee et al 2012). Kucukyilmaz et al (2012) also reported the ratio of n-6/n-3 for breast meat of 36.8 and

50.9 for chicken, which is much higher than the current result. Typical western diets provide ratios of n-6/n-3 PUFA between 10:1 and 30:1 (Hibbeln et al 2006), which is more or less in line with the value of the current study. It can be said that the breast and thigh meat from all genotypes investigated can be used as dietetic and healthy poultry meat as indicated in FAO (2013). The PUFA/SFA ratio for breast meat was around 1 for all genotypes, which is comparable to previous reports of 1.30 for GF (Bernacki et al 2012) and 1.21 for PK (Sebola et al 2018). The PUFA/SFA ratio of 0.81 to 1.47 for GF was also reported (López-Pedrouso et al 2019), which is in agreement with current findings. The PUFA/SFA ratio was not affected by genotype and the result was within the recommended values for human nutrition of 0.4–1.0 (Jimenez-Colmenero et al 2012). The PUFA/SFA ratio from this study in particular and poultry meat in general, was much better compared to the values for beef which ranged from 0.06 to 0.08 (Turner et al 2015). In general, thigh meat from all of the investigated genotypes of the current study had a higher content of fat than breast meat, which was in line with the findings of Kralik et al (2018).

Meat-Eating Quality

Chicken breast and thigh meat scored better for tenderness and overall acceptance compared to GF meat in the present study. Tenderness depends on the amounts of intramuscular fat, connective tissue, the length of the sarcomere and the proteolytic potential of the muscle and by external factors such as the processing condition and cooking methods (Owens et al 2004). Tenderness may be influenced by the species, breed, age, sex and diet of fowls (Wattanachant 2008). Lean meats with low intramuscular fat content are generally somewhat dry and less tasty (De Smet, 2012), as in the case of breast meat than the thigh meat observed in this study,

since the intramuscular fat content of breast meat was less than that of the thigh meat. Panellists praised the juiciness of the thigh meat cut from GF and PK as compared to HR and TL genotypes. This result was in agreement with Damaziak et al (2019) who noted that the GF thigh muscle was more liked for its juiciness, which could be related to the high content of unsaturated fatty acids. Based on tenderness, flavor, and overall acceptance, meat from local chickens possess preferred qualities compared to meat from GF and PK. This was in line with the report that native chicken has a unique taste, firm texture, and rich flavor, which is cherished by most consumers in comparison with broiler meat (Jayasena et al 2013).

5. CONCLUSION

The meat of domestic guinea fowl has higher protein content compared to chicken genotypes. Moreover, the fat content of thigh meat is lower for GF than for chicken genotypes. The breast and thigh meat of HR followed by TL local chicken genotypes appeared to have better essential amino acid profiles as compared to GF and PK. The predominant fatty acids of breast and thigh meat for all genotypes were palmitic, stearic, oleic, linoleic, and arachidonic acids, with a higher content of unsaturated versus saturated fatty acids. The higher level of n-3 PUFA for breast and thigh meat and total PUFA for thigh meat of GF as compared to chicken genotypes may be another advantage of guinea fowl meat in terms of nutritional value and can be an indication for meat from GF to be healthy for consumption and is also associated with a higher juiciness from meat of these genotypes. However, in terms of tenderness, flavor, and overall acceptance, meat from local chicken genotypes was better compared to GF and PK. In conclusion, meat from domestic guinea fowl with a higher protein and PUFA content and better essential amino acid profiles from local chicken

genotypes can be considered dietetic and healthy poultry meat for consumption. Rearing domestic guinea fowl can also be an alternate poultry species for quality meat with higher protein and PUFA contents.

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REFERENCES

- Adeyanju T M, Abiola S S, Sanwo K A, Shittu T A and Adeyanju S A (2013). Quality characteristics of meat from two strains of indigenous chicken cocks. *International Journal of Energy Research* 2(1).
- Aklilu Hailemichael, Berhanu Gebremedhin (2020). Marketing, consumption and their determinants in village poultry production in four states of Ethiopia. *Animal Production Science* 60, 2021-2030. <https://doi.org/10.1071/AN19085>.
- Alfaig E, Angelovičova M, Kral M, Bučko O (2014). Effect of probiotics and thyme essential oil on the essential amino acid content of the broiler chicken meat. *Acta Scientiarum Polonorum, Technologia Alimentaria* 13(4), 425-432.
- AMSA (American Meat Science Association) (2015). Research guidelines for Cookery, Sensory Evaluation, and Instrumental Tenderness Measurements of Meat, 2nd ed., Champaign, Illinois, USA, p: 104
- AOAC (Association of Official Analytical Chemist). (1998). *Official Methods of Analysis*, 16th Edition, Washington, DC.
- Barroeta A C (2007). Nutritive value of poultry meat: relationship between vitamin E and PUFA. *Worlds Poultry Science Journal* 63(2):277-284.
- Bernacki Z, Bawej M, Kokoszynski D (2012). Quality of meat from two guinea fowl (*Numida meleagris*) varieties. *Arch Geflugelk* 76: 203-207.
- CAB. International. (1987). *The Technical Centre for Agricultural and Rural Cooperation. Manual of poultry production in the tropics*. Cambrian News Limited, Aberystwyth, UK. pp 111–114.
- Central Statistical Agency- C S A (2021). *Federal Democratic Republic of Ethiopia, Central Statistical Agency, Agricultural Sample Survey, Livestock and Livestock Characteristics. Statistical Bulletin* 589, Addis Ababa
- Chae, H S, Choi, H C, Na, J C, Kim, M J, Kang, H K, Kim, D W, Kim, J H, Jo, S H, Kang, G H, and Seo, O S (2012). Effect of raising periods on amino acids and fatty acids properties of chicken meat. *Korean Journal of Poultry Science* 39: 77–85. doi:10.5536/kjps.2012.39.2.077.
- Chauton M S, Reitan K I, Norsker N H, Tveterås R, and Kleivdal H T (2015). A techno-economic analysis of industrial production of marine microalgae as a source of EPA and DHA rich raw material for aquafeed: Research challenges and possibilities. *Aquaculture* 436:95-103.

- Chen Y, Qiao Y, Xiao Y, Chen H, Zhao L, Huang M and Zhou G (2016). 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: 855-864.
- Chinese Standard GB/T 5009.124. (2003). National Standard of the people's republic of China, Determination of Amino Acids in Foods, www.ChineseStandard.net
- Chiroque G, Vásquez G, Vásquez E, Vásquez E, Más D, Betancur C, Ruiz C, Botello A and Martínez Y (2018). Growth performance, carcass traits and breast meat fatty acids profile of helmeted guinea fowls (*Numida meleagris*) fed increasing level of linseed (*Linum usitatissimum*) and pumpkin seed (*Cucurbita moschata*) meals. *Brazilian Journal of Poultry Science* 20 (4): 665-674. doi: 10.1590/1806-9061-2018-0760.
- Damaziak K, Stelmasiak A, Riedel J, Zdanowska-Sąsiadek Ż, Buław M and Gozdowski D (2019). Sensory evaluation of poultry meat: A comparative survey of results from normal sighted and blind people. *PLOS ONE* 14(1): 210722. doi: 10.1371/journal.pone.0210722.
- Dashdorj D, Amna T, and Hwang I (2015). Influence of specific taste-active components on meat flavor as affected by intrinsic and extrinsic factors: an overview. *Eur Food Res Technol* 241: 157–171.
- De Smet S (2012). Meat, poultry, and fish composition: strategies for optimizing human intake of essential nutrients. *Animal Frontiers* 2: 10-16.
- Do H W and Chung H (2017). A comparison of the essential amino acid content and the retention rate by chicken part according to different cooking methods. *Korean Journal for Food Science of Animal Resources* 37(5): 626-634. doi: 10.1017/S0043933907001468.
- European Commission of Community Research (2000). Project Report: Functional food science in Europe, Volume 1; Functional food science in Europe, Volume 2; Scientific concepts of Functional Foods in Europe, Volume 3. EUR-18591, Office for Official Publications of the European Communities, L-2985, Luxembourg.
- FAO (2013). The role of poultry in human nutrition: Poultry Development Review, David Farrell, School of Land, Crops and Food Sciences, The University of Queensland, St. Lucia 4072, Queensland, Australia.
- FAO/WHO/UNU (1985). Energy and protein requirements. Report of a Joint FAO/WHO/UNU Expert Consultation. Geneva, World Health Organization. WHO Technical Report Series, No.724.
- Folch J, Lees M and Sloane-Stanley G H (1957). A simple method for the isolation and purification of total lipids from animal tissues. *Journal of Biological Chemistry* 226: 497–509.
- Food and Nutrition Board (2005). Institute of Medicine. Dietary reference intakes for energy, carbohydrate, fiber, fat, fatty acids, cholesterol, protein, and amino acids (macronutrients). Washington, DC: National Academy Press.
- Franco D, Rois D, Vázquez J A, Purriños L, González R, Lorenzo J M (2012). Breed effect between Mos rooster (Galician indigenous breed) and Sasso T-44 line and finishing feed effect of commercial fodder or corn. *Poultry Science* 91: 487–498.
- Gordana K Z K, Manuela G, and Danica H (2017). Quality of chicken meat, animal husbandry and nutrition. Intech Open, doi: 10.5772/intechopen.72865.
- Guan R, Lyu F, Chen X, Ma J, Jiang H and Xiao C (2013). Meat quality traits of four Chinese indigenous

- chicken breeds and one commercial broiler stock. *Biomed & Biotechnol* 14(10): 896-902.
- Hibbeln J R, Nieminen L R, Blasbalg T L, Riggs J A and Lands W E (2006). Healthy intakes of n-3 and n-6 fatty acids: estimations considering worldwide diversity. *The American Journal of Clinical Nutrition* 83(6):1483S–93S.
- Ian Givens D and Gibbs R A (2008). Current intakes of EPA and DHA in European populations and the potential of animal-derived foods to increase them. *Proceedings of the Nutritional Society* 67: 27380.
- Jayasena D D, Jung S, Kim H J, Bae Y S, Hae In Yong H I, Lee J H, Kim J K and Jo C (2013). Comparison of quality traits of meat from Korean native chickens and broilers used in Two different traditional Korean cuisines. *Asian-Australasian Journal of Animal Sciences* 26 (7): 1038-1046.
- Jimenez-Colmenero F, Herrero A, Cofrades S and Ruiz-Capillas C (2012). Meat and functional foods. In: Hui YH, editor. *Handbook of meat and meat processing*. Boca Raton (FL): CRC Press; p. 225–248.
- Jung S, Lee K H, Nam K C, Jeon H J, Choe J H and Jo C (2014). Quality assessment of the breast meat from WoorimatdagTM and broilers. *Korean journal for Food Science of Animal Resources* 34 (5): 709-716. doi:10.5851/kosfa.2014.34.5.709.
- Kim B H, Lee H S, Jang Y A, Lee J Y, Cho Y J and Kim C (2009). Development of amino acid composition database for Korean foods. *Journal of Food Composition Anal* 22: 44-52.
- Kralik G, Kralik Z, Grcevic M and Hanžek D (2018). Quality of chicken meat. In: *Animal Husbandry and Nutrition* <http://dx.doi.org/10.5772/intechopen.72865>.
- Kris-Etherton P M, Harris W S and Appel L J (2002). Fish consumption, fish oil, omega-3 fatty acids, and cardiovascular disease. *Circulation* 106(21): 2747-2757. doi: 10.1161/01.CIR.0000038493.65177.94.
- Küçükyılmaz K, Bozkurt M, Çatli A U, Herken E N and Çınar M (2012). Chemical composition, fatty acid profile and colour of broiler meat as affected by organic and conventional rearing systems. *South African Journal of Animal Science* 42: 360-368. <http://dx.doi.org/10.4314/sajas.v42i4.4>.
- Laudadio V, Nahashon S N and Tufarelli V (2012). Growth performance and carcass characteristics of guinea fowl broilers fed micronized-dehulled pea (*Pisum sativum* L.) as a substitute for soybean meal. *Poultry Science* 91: 2988–2996. <http://dx.doi.org/10.3382/ps.2012-02473>.
- López-Pedrouso J M, Cantalapiedra J, Munekata P E S, Lorenzo J M, Franco D and Barba F J (2019). (eds.), *More than beef, pork and chicken. The production, processing, and quality traits of other sources of meat for human diet*. *Meat Science* 49: 447-457. https://doi.org/10.1007/978-3-030-05484-7_10.
- Marangoni F, Corsello G, Cricelli C, Ferrara N, Ghiselli A, Lucchin L and Poli A (2015). Role of poultry meat in a balanced diet aimed at maintaining health and wellbeing: an Italian consensus document. *Food and Nutrition Research* 59:27606 doi:10.3402/fnr.v59.27606.
- Milicevic D, Vranic D, Mašić Z, Parunovic N, Trbovic D, Trailovic J N and Petrovic Z (2014). The role of total fats, saturated/unsaturated fatty acids and cholesterol content in chicken meat as cardiovascular risk factors. *Lipids in Health and Disease*

- 13:42.
- Molee W, Puttaraksa P and Khempaka S (2012). Effect of rearing systems on fatty acid composition and cholesterol content of Thai indigenous chicken meat. *International Journal of Biological, Biomolecular, Agricultural, Food and Biotechnological Engineering* 6(9).
- Moreki J C and M V Radikara (2013). Challenges to commercialization of guinea fowl in Africa. *International Journal of Scientific Research* 2(11): 436-440.
- Motsepe R, Mabelebele M, Norris D, Brown D, Ones Ngambi J and Ginindza M (2016). Carcass and meat quality characteristics of South African indigenous chickens. *Indian Journal of Animal Research* 50(4): 580-587. doi:10.18805/ijar.11159.
- Musundire M T, Halimani T E and Chimonyo M (2017). Physical and chemical properties of meat from scavenging chickens and helmeted guinea fowls in response to age and sex. *British Poultry Science* 58: 390-396.
- Ovesen L, Brot C and Jakobsen J (2003). Food contents and biological activity of 25- hydroxyvitamin D: A vitamin D metabolite to be reckoned with?? *Annals of Nutrition and Metabolism* 47: 107-113. DOI: 10.1159/000070031
- Owens C M, Cavitt L C, and Meullenet C J F (2004). Tenderness Evaluation in Poultry Meat. *Proceedings of the 57th American Meat Science Association Reciprocal Meat Conference* (pp. 115-121) June 20-23, 2004, Lexington, Kentucky, www.meatscience.org.
- Owens C M, Alvarado C Z, and Sams A R (2010). *Poultry Meat Processing*. CRC Press. Boca Raton, FL.
- Packard R (2014). *Comparison of Production Parameters and Meat Quality Characteristics of South African Indigenous Chickens*, MSc Thesis, Stellenbosch University, South Africa.
- Pambuwa, W, and Tanganyika, J (2017). Determination of the chemical composition of normal indigenous chickens in Malawi. *International Journal of Avian and Wildlife Biology* 2(3): 86–89. doi: 10.15406/ijawb.2017.02.00024.
- Pearson A M and Gillet T A (1996). *Reduced and low-fat meat products. Processed Meats*. Chapman and Hall, New York.
- Quaresma M A G, Pimentel F B, Ribeiro A P, Ferreira J D, Alves S P, Rocha I and Oliveira M B P P (2016). Lipid and protein quality of common pheasant (*Phasianus colchicus*) reared in semi-extensive conditions. *Journal Food Compos Anal* 46: 88–95.
- Ristic M (2005). Influence of breed and weight class on the carcass value of broilers. In *Proceedings of the XVIIth European Symposium on the Quality of Poultry Meat 2005*, Doorwerth, The Netherlands, 23–26 May 2005; World's Poultry Science Association: Beekbergen, The Netherlands; 194–199.
- SAS (Statistical Software System). (2009). *SAS User's Guide, Statistics*. SAS Institute, Inc., Cary, NC. USA.
- Sebola N A, Mlambo V, Mokoboki H K, Hugo A and Muchenje V (2018). Comparison of meat quality parameters in three chicken strains fed moringa oleifera leaf meal-based diets. *Journal of Applied Poultry Research* 27:332–340. doi:10.3382/japr/pfy001.
- Simopoulos A P (2002). The importance of the ratio of omega-6/omega-3 essential fatty acids. *Biomedicine and Pharmacotherapy* 56(8): 365-379. doi: 10.1016/S0753-3322(02)00253-6.
- Susanto E, Badriyah N and Rosyidi D

- (2019). Amino acids profile of the Indonesian endogenous meat's antioxidant peptides. IOP Conf. Series: Earth and Environmental Science, The 1st Animal Science and Food Technology Conference (AnSTC), doi:10.1088/1755-1315/372/1/012048.
- Tougan U P, Youssao I A K, Yayi E L, Kpodekon M T, Heuskin S (2018). Fatty acids composition of meat of five native chicken (*Gallus gallus*) ecotypes of Benin reared under organic or conventional system. *Journal of Experimental Food Chemistry* 4: 137. doi:10.4172/2472-0542.1000137.
- Turner T D, Jensen J Pilfold J L, Prema D, Donkor K K, Cinel B, Thompson D J, Dugan M E R and Church J S (2015). Comparison of fatty acids in beef tissues from conventional, organic and natural feeding systems in western Canada. *Canadian Journal of Animal Science* 95:49-58.
- USDA-United States Department of Agriculture (2016). National Nutrient Database for Standard Reference Release 28 [Internet]. Available from: <https://ndb.nal.usda.gov/ndb/search/list>.
- van Waardenburg D A, de Betue C T, Luiking Y C, Engel M and Deutz N E (2007). Plasma arginine and citrulline concentrations in critically ill children: strong relation with inflammation. *American Journal of Clinical Nutrition* 86: 1438–1444.
- Wattanachant S (2008). Factors affecting the quality characteristics of Thai indigenous chicken meat. *Journal of Science and Technology* 15: 317-322.
- Wattanachant S, Benjakul S and Ledward D A (2004). Composition, colour, and texture of Thai indigenous and broiler chicken muscles. *Poultry Science* 83(1): 123-128.
- WHO (World Health Organization) (2007). Protein and amino acid requirements in human nutrition: World Health Organization Report, Geneva, Switzerland.
- Yildirim A, Eleroglu H and Duman M (2020). Meat Physico-chemical composition of guinea fowl fed organic diets supplemented with dry oregano leaf. *Large Animal Review* 26: 173-180.
- Zotte D A, Elizabeth G, Daniel F Marco C and Lorenzo J M (2020). "Proximate composition, amino acid profile, and oxidative stability of slow-growing indigenous chickens compared with commercial broiler chickens". *Foods* 9(5): 546. <https://doi.org/10.3390/foods9050546>.