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Chemical Composition, Quality Characteristics and Nutritive Value of Goat Kids Meat from Egyptian Baladi Breed

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ABSTRACT

Due to the emphasis placed on the nutritive value of food by consumers, a great need exists for information on composition, quality attributes and nutritive value of goat kid's meat. In this study samples of Longissimuss dorsi (LD) *muscles* from Egyptian Baladi breed were taken to determine the proximate composition, chemical indices and physical properties of meat as well as a water-to-protein ratio, energy value, levels of amino acids in protein, fatty acid profile in intramuscular fat (IMF), and mineral composition. Microbiological and sensorial qualities were also investigated. The results indicated thatChevon (meat from goat kids)has a high WHC, tenderness, cooking yield, and iron content. Besides, a desirable water-to-protein ratio, it has attractive bright color;a low sodium, TBARS and TVBN values. Moreover, values for protein,ash, and amino acid contents in goat meat were almost similar to that from other conventional meat animals. The results also demonstrated thatgoat kids meat has good microbiological quality; no *Salmonella spp.* Was detected, also no *Staphylococcus aureus or* fungal were found in goat meat samples. Additionally, cooked meat got high scores for sensory categories which confirmed good eating quality.Due to a high protein content, and low levels of IMF, a low energy value was observed, added to these merits,the protein of meat had a desirable essential amino acid/non-essential amino acid (EAA/NEAA) ratio, while intramuscular fat contained a satisfactory unsaturated fatty acid/saturated fatty acid (UFA/SFA), and desirable fatty acid to undesirable fatty acids (DFA/OFA) ratios. Based on the above physical, chemical, sensorial and microbiological parameters and due to its hig hnutritive value, meat from Egyptian Baladi goat breed may be an ideal choice for today's trend towards lighter diets and healthy food.

Key words: Goat Meat,Capretto, Chevon, Chemical Indices, Quality Attributes, Nutritive Value.

Introduction

Goats are widely distributed around the world with high demand to their meat, milk and skins (Anaeto *et al.*, 2010 and Yangilar, 2013). Goat meat is popular with the greatest production and consumption in many subtropical and developing countries including Egypt whose government has a policy to increase goat meat production to alleviate animal protein shortage (El-Hanafy *et al.*, 2010). Ten different breeds of domestic goat (*Capra hircus*) can be found in Egypt. The Barki or Sahra wiis the smallest local breed of goat. The Zaraibi is father to the popular Anglo-Nubian goat breed for its healthy milk. Other local breeds include the Sharkawi, Wahati, Angora, Saidi and Black Sinai. The Egyptian Baladi goats, is the major breed of total goat population (4.55 million head; FAO Statistics, 2011). Goats are distributed in villages across the country, especially dense in the Nile valley and delta and with lower concentration in the north-western coastal region and at oases (Agha *et al.*, 2008).

For marketing purposes goat meat has been divided into two distinct classes; these being Capretto, which is obtained from milk-fed, suckling kids 4-11 weeks of age and has pink flesh color; and Chevon, which is from older goats, yet kids, 3-9 months of age and light in color (Dhanda *et al.*, 1999and Pena *et al.*, 2009). Castration of male goat is widely used not only to eliminate or reduce the unwanted 'goaty' odors but can improve its meat quality, as well as facilitating easier handling of these animals (El-Waziry *et al.*, 2011andSolaiman *et al.*, 2011). Nutritionally, goat is an important source of high quality proteins, healthy fats, and with low calorie, intramuscular fat, saturated fat, and sodium contents. Additionally, goat meat has high levels of iron, potassium and essential amino acids, which should range it within the category of high quality meat (Sheridan *et al.*, 2003; Argüello, 2005; McMillin and Brock, 2005; Givens *et al.*, 2006; Lee *et al.*, 2008 and Horcada *et al.*, 2012).

The fatty acids play an important role in human nutrition; all unsaturated fatty acids plus stearic fatty acid (UFA+C18:0) are categorized as desirable fatty acids "DFA", while all saturated fatty acids minus stearic fatty acid (SFA-C18:0) are considered as hypercholesterolemic; or undesirable fatty acids "OFA" (Rhee, 1992). Unsaturated fatty acids (UFA) present a hypocholesterolemic action; while, saturated fatty acids (SFA) tend to

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increase cholesterol levels in plasma (Solaiman *et al.*, 2011). However, not all SFA have equivalent effects. Lauric (C12:0), myristic (C14:0) and palmitic acids (C16:0) are hypercholesterolemic; whereas, the saturated stearic (C18:0), does not raise blood cholesterol levels and is considered 'neutral' (Banskalieva *et al.*, 2000). Generally, the high UFA/SFA and DFA/OFA ratios in goat meat demonstrate the potential of goats for the production of high-quality meat (Brzostowski *et al.*, 2008and Pena *et al.*, 2009).

Meat quality is important for consumers when it comes to making purchasing decisions,the quality is a combination of chemical, microbial and sensorial attributes (Madruga*et al.*, 2009). Several factors can affect the quality characteristics of goat meat such as slaughter age, breed, castration, nutrition and butchering methods (Costa *et al.*, 2008 and Toplu *et al.*, 2013). Meat from goats has gained acceptance mainly because of its lower fat content than beef and lamb meat.Therefore, it requires low-heat and slow cooking to preserve tenderness and juiciness (Madruga *et al.*, 2008). On the other hand, the appearance, tenderness, flavor, and juiciness properties are important categories affecting goat meat acceptability (Dhanda *et al.*, 1999and Silva *et al.*, 2011).

In recent years, the demand for low-fat meat and meat products has been increased in order to avoid health risks associated with excessive fat intake.The goat is known to produce relatively lean meat; information on the characteristics of goat meat and its products for the goat meat industry in Egypt is still limited and needs more study.Likewise, publications addressing the fatty acid composition are the subject of a large number of investigations with ruminants, but not yet with Egyptian Baladi goat breed. Furthermore, published information related to the quality and nutritive value of meat from this breed of goat is scarce.Therefore, the present study attempts to evaluate chemical, physical, nutritional, microbiological and sensorial qualities of Baladi goat kid's meat, raised under Egyptian conditions.

Materials and Methods

Goat Meat Source:

Longissimus dorsi muscles (LDM; 4.5kg) from three castrated male go at kids were purchased from El-Araby butcher shop at Giza after chilling at 2-5°C for 24 hr (Werdi Pratiwi *et al.*, 2007). Kids of about 6-7 months old and 13-15 kg carcass weight were from EgyptianBaladigoat breed, as per abattoir's and butcher's information. Meatsamples were packed in polyethylene bags and kept in ice box on the way back to the Food Science & Technology Department at the National Research Centre for analysis. On arrival to the laboratory, the external fat, bone and connective tissues were removed from goat meat, and then samples were divided into two portions, one for chemical, microbiological and nutritive value analyses, and the other for physical and sensorial determinations. All analyses were performed at least in triplicate. The chemical and microbiological determinations were made on finely ground samples.

Analytical Methods:

Chemical Analysis:

Proximate composition(moisture, protein, intramuscular-fat and ash contents) was determined for raw goat meat samples using standard analytical methods (AOAC, 1995), while the amount of total carbohydrates was calculated by differences. Caloric value (Food Energy), on the basis of protein and lipid contents was calculated using the specific calorie factors of USDA (1989) as follows:(Total K. calories = g protein x 4.27 + g fat x 9.02).Moisture-to-protein (W/P) ratio was calculated as an indic ation of physiological maturity(Brzostowsk *et al.*, 2008).

Mineral Composition:

A dry ashing procedure was used for mineral analysis. Iron (Fe), potassium (K), sodium (Na), calcium (Ca) and magnesium (Mg) were measured using Atomic Absorption Spectrophotometer "Vanon" according to the methods recommended by the AOAC (1995) at the Central Unit of Analysis and Scientific Services, National Research Centre, Egypt.

Amino Acids:

Amino acids except for tryptophan were determined in dried fat-free sample at the Central Laboratory for Food & Feed, Agricultural Research Centre using a Beckman Amino Acid Analyzer (Model 7300) as described by Moore *et al.*, (1958).

Fatty Acid Analysis:

Five grams of minced LD muscle was extracted (Folch *et al.*, 1957). Fatty acid methyl esters (FAME) were prepared using 5 mL from the previous chloroform-methanol extract. The methylation process was assigned based on AOAC (1995). Separation and quantification of the FAME were performed using a Hewlett-Packard (HP) 6890 series gas chromatograph(GC) equipped with a flame ionization detector(FID), and a fused silica capillary column DB (30 m long x 0.25 mmi.d. and 0.25 µm film thickness), 1.0µL of the sample was injected into the GC at 275°C., at the Central Laboratory for Research, Faculty of Agriculture, Cairo University. Individual fatty acids were identified by comparing their retention times with authenticated standards,and quantified as a percentage of total fatty acids identified (Pena *et al.*, 2009 andHorcada *et al.*, 2012).

Chemical Indices:

Both lipid oxidation and protein breakdown were determined according to the methods of Pearson (1991) by measuring thiobarbituric acid reactive substances (TBARS) as mg malonaldehyde (MA)/kg flesh, and total volatile basic nitrogen (TVBN) as mg N/100 g flesh; respectively. For ultimate pH_{24} determination, 100 mL distillate water was added on 10g sample and homogenized in mixer,and pH 24 hr *post mortem* was held with Hanna, HI 9002 pH-meter (Atay *et al.*, 2011).

Physical Evaluation:

Water-Holding Capacity (WHC):

WHC expressed as percentage of liquid expelled, was determined by measuring the area of the outerzones (cm^2/0.3g) following the filter press method (Soloviev, 1966), using PlacomDigetalPlanimeter (KP-90N), and calculated as % of bound wate rfrom the following equation**:**

$$[\%\text{BoundWater} = \frac{\%Moisture - (Outer\ area\ \text{cm}^2 x\ 8.4\ x\ 100)\ /\ (0.3\ x\ 1000)}{\%\ Moisture} \text{x100}];$$

whereas one cm^2 of the outer zone area is equivalent to 8.4 mgfree water.

Cooking Loss (CL%):

Meat sample (50 g) was placed in tightly sealed polyethylene oven bag and heated in a water bath at 75°C until an internal temperature of 71˚C (as indicated by a thermocouple)was achieved.Cook-out was drained and the cooked mass was cooled, dried with filter paper and reweighed. Cooking loss (CL)was expressedas the percentage loss relatedto the initial weight (Pena *et al.*, 2009).

Shear Force (Kg/cm^2):

Measurement for shear force value as indication of meat tenderness was carried out using Warner-BratzlerShear force (WBS) apparatus.LDM samples were cooked into polyethylene bags in a water bath using the same cooking method as for cooking loss determination. After cooling 3–5 muscle cores (1 cm x 1 cm x 3 cm) were cut parallel to the long axis of the muscle fibres, and WBS values were taken on the cores (Werdi Pratiwi *et al.*, 2007; Pena *et al.*, 2009).

Color Profile:

Instrumental color evaluation was determined after allowing the muscle surface to bloom for 30 min., using a Hunter Lab Scan XE Colorimeter (Hunter Laboratory Inc. Restonva). Three readings per sample were taken and the mean values of lightness (**L***), redness (**a***), and yellowness (**b***) were calculated.

Microbiological Quality:

The microbiological quality and safety of meat were assessed on the basis of total viable bacterial count (TVBC), coliform count (CC), *Staphylococcus aureus* count (SAC),fungal count (FC) and *Salmonella spp*.detection (SSD), using plate count agar (PCA), MacConkey agar (MCA), Staph. Media (SM-110), potato dextrose agar (PDA) and Salmonella agar (SA); respectively. Diluted meat samples in normal saline were spread onto these plates and incubated at 37°C for 24 hr. except count of fungi, whichwere incubated at 25°C for 5 days, following the methods recommended by American Public Health Association (APHA, 2001). Microbial counts were expressed as mean colony forming unit per gram(cfu/g).

Sensory Panel Evaluation:

Sensory evaluation was carried out on cooked LDM of Chevon samples by ten semi-trained panellists. Meat samp les were cooked using the same cooking method as applied for cooking loss measurements. Cooked sampleswere cut into uniform sized pieces,coded and served warm for testing. A 9-point hedonic scale was used to assess the following categories of cooked goat meat: appearance, flavor, tenderness, juiciness and overall acceptability.Scores were assigned with 9 being 'like extremely' and 1'dislike extremely' (Dhanda *et al.*, 1999).Semi-trained panelist received two pieces of cooked meat samples with different code number to be appraised. Water was provided for each panelist to freshen their mouth between each sample.

Statistical Analysis:

For data analysis except for nutritive value, means and standard deviation (M±SD) from triplicate determinations were used according to PC-STAT, 1985. While for sensorial evaluation, all values reflect the mean and standard deviation (n=10).

Results and Discussion

1. Chemical Properties:

1.1. Proximate Analysis:

Average moisture, protein, intramuscular fat and ash contents of kid's meat from Egyptian Baladi breed were, respectively found as 75.32, 19.97,3.28and 1.13% in this study(Table 1). Unfortunately, no data are available concerning proximate composition and quality attributes of this breed of goat.However,our results are close to the findings obtained by Atay *et al.*, (2011) on Hair goat crossbreeds, who reported 75.69, 18.91, 3.23, and 1.04%, for moisture, protein, fat and ash contents, respectively.In this respect, Ardhi goat kids contained 71.6, 18.5, 8.6 and 1.1% (El-Waziry *et al.*, 2011), whereasAustralian feral goat kids exhibited 75.6, 21.1, 1.5 and 1.1% (Werdi Pratiwi *et al.*, 2007) for the same mentioned proximate constituents; respectively. Regarding proximate composition, Dhanda, (2001) reported that goat meat on average consists of 72.3% moisture, 21.0% protein, 4.7% fat and 1.1% ash per 100 g of fresh meat.Generally, the often quoted standard composition of normal adult mammalian muscle is 75% water, 19% protein, 2.5% fat and 0.65% minerals (Lawrie, 1998). These values may vary considerably with factors such as breed, age, sex, weight, and nutritional history (Banskalieva *et al.*, 2000 andToplu *et al.*, 2013).

Table 1: Meat quality traits of LD muscle of Egyptian Baladi goat kids.

Constituents	On fresh wt. basis
Moisture(%)	75.32 ± 0.41
Protein(%)	19.97 ± 0.12
Int. Fat (%)	3.28 ± 0.13
Ash (%)	1.13 ± 0.08
Carbohydrate (%)	0.30 ± 0.17
Moisture / Protein (W/P) ratio	3.77 ± 0.05
Caloric value (K calorie /100g)	114.86 ± 1.71
Ultimate pH_{24}value	5.73 ± 0.04
TVBN as mg N/100g flesh	9.83 ± 0.21
TBARS as mg MA/kg meat	0.1562 ± 0.04

Values are given as mean ± S.D. from triplicate determinations.

1.2. Caloric value, W/P ratio and Chemical indices:

Table 1 also reveals that goat kids meat is characterized by a high protein (19.97%) and a low intramuscular fat (3.28%) contents, consequently, a low energy value (114.86 Kcal/100g) was observed. Furthermore, it contains only a limited amount of carbohydrates (0.30%). Besides a desirable water-to-protein (W/P) ratio (3.77) which may indicate a high level of physiological maturity. Generally, the lower the W/P ratio, the better the quality of the meat (Pearson, 1991). These results confirmed the findings obtained by Brzostowski*et al.*, (2008) who reported that goat meat from purebred French Alpine and Boer crossbred kids exhibited low caloric values (96.36 and 101.47 kcal/100g) and a desirable water-to-protein ratios (3.89 and 4.18); respectively.

Results depicted in Table 1 also reveal that TBARS values of the samples were found as 0.1562 mgMA/kg meat in average. This value is considerably lower than 0.9 mg malonaldehyde per kg accepted as the critical value of lipid oxidation for meat and meat products, and is consistent with the results reported for fresh Hair goat crossbreeds by Atay *et al.*, (2011). From the same given results of Table 1, it is evident that TVBN of goat kids meat were found as 9.83 mg N/100g flesh in average, which well below the critical value of 20.0 mgN/100g flesh, as recommended for meat and meat products (Pearson, 1991). Results of Table1 indicated that, goat kid's meat has a desirable protein content and W/P ratios, whereas, it has a low IMF and caloric values. Moreover, the low average values of chemical indices indicated that raw goat meat was normal meat without defect and had very good meat quality.

1.3. Meat pH:

A key determinant of meat quality is pH.The ultimate pH_{24} values of goat kid's meat were found as 5.73 in average (Table 1). It was observed that this value is in agreement to the values (5.71- 5.75) found by Pena *et al.*, (2009) for Criollo Cordobes and Anglonubian kids, Atay *et al.*, (2011) in hair goat kids,and Werdi Pratiwi *et al.*, (2007) in Australian feral goats.On the other hand,pH_{24} in LDM of Egyptian Baladi breed (Table1) was lower than that of South African indigenous goats reported by Simela *et al.*, (2004; pH: 5.88-6.03), and that ofArdhi goat kids reported by El-Waziry *et al.*, (2011; pH: 5.84-5.86). The ultimate pH is important to the chilled meat because it affects its shelf life; color and quality, a high ultimate pH (above 5.8) can indicate stressed animals during pre-slaughter handling and generally means lower quality of meat (Lawrie, 1998 and Dhanda *et al.*, 2003). However, the ultimate pH in this trail was in acceptable range recorded (5.5-5.8) and considered optimal for high-quality goat meat (Herold *et al.*, 2007 and Solaiman *et al.*, 2011).

2. Physical Properties:

2.1. Water-Holding Capcity (WHC):

WHC always linked to sensory and technological properties of meat such as tenderness, juiciness and cooking yield (Pena *et al.*, 2009). As shown in Table2, WHC (calculated as bound water %), with an average value of 68.77%, was almost similar to those found by Arain *et al.*, (2010; WHC 63.36%) for goat meat, but was higher than those observed by Pena *et al.* (2009) in Criollo Cordobes (CC) and Anglonubian (AN) kids. Also the outer zone area measured for Egyptian Baladi kids meat ($8.4cm^2/0.3g$; results not shown), was consistent with the findings of Brzostowski *et al.*, (2008) who reported 8.09 and 7.02 $cm^2/0.3g$ for Boer crossbred and purebred French Alpine kids; respectively. The present results (Table2) show that goat kid's meat has a high WHC typical of the meat of young animals (Todaro *et al.*, 2004). WHC in the present experiment also confirmed the findings obtained by Babiker *et al.*, (1990) who reported that Desert goat muscles were found to have superior WHC, which resulted in lower cooking loss than lamb muscles. A decrease in WHC with an increase in slaughter weight of Canary Caprine kids has been noted (Marichal *et al.*, 2003).

2.2. Cooking Loss (CL %):

Cooking loss is considered as the most important technological properties from the economic point of view, it reflects the WHC of meat and meat products (Lawrie, 1998). Results of Table2 reveal that the average cooking loss value obtained for LD muscles of Egyptian Baladi goat kids was 27.9%, which is within the normal range for goat meat (Dhanda *et al.*, 2003 andTodaro*et al.*, 2004). Cooking loss in the present study was similar to those observed by Pena *et al.*,(2009; CL: 25-28.8%) using LD muscles of CriolloCordobes (CC) and Anglonubian (AN) kids; respectively,Wattanachant *et al.*, (2008; CL: 27.77%) using Anglonubian x Thai native goats, and El-Waziry*et al.*, (2011; CL: 26.8-27.5%) for intact and castrated LD muscles of Ardhi kids. Cooking loss percentagesfor Egy.Baladi goat meat were lower as compared to the studies of Werdi Pratiwi *et al.*, (2007; CL: 35%) for Australian feral goat kids at similar slaughter weight. Concerning cooking loss Dhanda *et al.*, (1999) recorded higher cooking losses in Chevon compared to Capretto. In general, the lower the cooking loss, the better the juiciness of the meat. This is another valuable quality trait observed in Egyptian Baladi breed goats useful in market promotion efforts.

2.3. Shear Force:

Tenderness, evaluated as the maximum shear force necessary to cut the meat perpendicular to the fibres (Pena *et al.*, 2009). Average shear force values obtained in this study ($4.83\ kg/cm^2$, which is equal to 58.76 N/cm^2) was similar to those observed by Pena *et al.*, (2009) using CriolloCordobes kids (62.86 N/cm^2), Werdi Pratiwi *et al.*, (2007) for Australian feral goat kids (56.1 N/cm^2), and Babiker *et al.*, (1990) using Desert goats

(4.0 kg/cm^2) but was lower as compared to the studies of Simela *et al.*, (2004) in South African indigenous goats (74.8 N/cm^2). Warner-Bratzler shear force (WBS) for Egy. Baladi breed (Table2) were higher as compared to the findings obtained by Atay*et al.*, (2011) for Hair goat crossbreeds (32.9 N/cm^2), and that of Ardhi goat kids reported by El-Waziry *et al.*, (2011;WBS: 3.59 kg/cm^2).Dhanda *et al.*, (1999) reported that Capritto had meat that was less tough (2.9-3.8 kg/cm^2) than Chevon (4.3-4.6 kg/cm^2).Goat meat tenderness was reported to be lower than sheep and beef (Johnson *et al.*, 1995). However, meats tested by shear force measurement with values exceeding 5.5 kg/cm^2 are considered to be tough by consumers (Shackelford *et al.*, 1991). Therefore, the shear force values obtained from this study suggested that meat from goat kids will be attain a highly acceptable degree of tenderness.

Table 2: Physical properties of LD muscle of Egyptian Baladi goat kids.

Measurements	On fresh wt. basis
Water-Holding Capacity (WHC) %	68.77 ± 0.90
Cooking loss (CL) %	27.90 ± 0.43
Tenderness (WBS) Kg/cm^2	4.83 ± 0.12
Color Profile	
(L*) Value	48.36 ± 2.01
(a*) Value	14.75 ± 0.48
(b*) Value	11.50 ± 0.11

Values are given as mean ± S.D. from triplicate determinations.

2.4.Color Profile:

Meat color is an important parameter in meat quality,average L*, a* and b* values were, respectively recorded as 48.36, 14.75 and11.50 (Table2).It was reported that these values are lower than L*(50.24) and a*(15.97) values but similar to b*(11.39) value obtained in a study held in Hair goat crossbreeds (Atay*et al.*, 2011), while higher than L*(42.54) and a*(10.78) values but lower than b*(15.23) value found by Pena *et al.*, (2009) for CrielloCordobes kids. L*, a* and b* values in another study held on Ardhi goat kids were 49.74, 15.58 and 11.11; respectively (El-Waziry *et al.*, 2011). Werdi Pratiwi *et al.*, (2007) recorded 46.8, 19.6 and 4.7 for castrated Australian feral goat kids.Hunter L*, a*, and b*values from Boer goat kids were 28.05, 17.35 and 16.82 (Solaiman *et al.*, 2011), whereas Desert goats exhibited lower colorimetric values (34.8, 13.1 and 4.9) than those obtained in this study (Babiker *et al.*, 1990). This is because muscle color is greatly influenced by the concentration and chemical nature of haemoprotein present in the muscle (Dhanda *et al.*, 1999).

3.Nutritive Value of goat meat:

3.1.Amino Acid Composition:

Goat meat is a very good source of protein, certain minerals, and essential fatty acids. Furthermore, it contains only a limited amount of carbohydrates. Amino acid composition (g/16gN) for goat kid's meat is shown in Table 3, from which it is apparent, that goat meat exhibited almost similar pattern in amino acid composition to other animal proteins (Pellett and Young, 1990; Beserra *et al.*, 2004). Goat meat also provides a high quality protein; skeletal muscle is a good source of all essential amino acids as seen in Table 3.

Results depicted in Table 3 also reveal that, among 17 amino acids identified in goat LD muscles protein, glutamic acid is present in the highest amounts. These results are in accordance with the findings of Webb *et al.*, (2005), Williams, (2007), and Brzostowski *et al.*, (2008). In fact, goat meat contains more arginine, leucine and isoleucine compared to mutton and beef, thereby indicating that goat meat is comparable to other types of red meats in terms of the quality of protein (Srinivasan and Moorjani, 1974). In addition, studies comparing sheep and goat meat based on their protein contents and quality have revealed that goat meat is not inferior to sheep nor is it from other red meat species (Beserra *et al.*, 2004 and Niedziółka *et al.*, 2006).

From a nutritional point of view, it is important to evaluate the ratio between essential and non-essential amino acids. The protein of meat from LDM of EgyptianBaladi breed exhibited desirable ratio (0.8), despite the essential amino acid namely tryptophan was not determined in the present study(Table 3), consequently this ratio should be more than '0.8'.In this concern,Brzostowski*et al.*, (2008) reported that Boer mix crossbred kids had a more desirable ratio between essential and non-essential amino acids than the protein of meat from FA purebred kids (0.89 vs. 0.84). A comparable ratio between both groups of amino acids (0.90) in goat meat was reported by Elgasim and Alkanhal (1992), while a higher one was recorded by Webb *et al.*, (2005).In addition, Arguello,(2005), and Lee *et al.*, (2008) indicated that goat meat is an important source of high quality proteins with high level of essential amino acids.

Table 3: Amino Acids Composition (g/16gN) of LD muscle of Egyptian Baladi goat kids.

Essential Amino Acid	g/16gN	Non-Essential Amino Acid	g/16gN
Threonine	4.65	Aspartic Acid	5.58
Valine	4.58	Serine	4.15
Methionene	3.04	Glutamic Acid	16.89
Isoleucine	4.36	Proline	4.11
Leucine	8.52	Glycine	5.28
Phenylalanine	4.29	Alanine	6.53
Histidine	2.68	Cystine	1.07
Lysine	8.94	Tyrosine	2.42
Tryptophan	Not determined	Arginine	5.80
Total EAA	41.06	Total NEAA	51.83

Mineral composition:

Mineral composition of LDM of goat kids is shown in Table 4. The results indicated that goat meat is rich source of various minerals (Mioc, *et al.*, 2000). The most common macro elements include potassium (K), sodium (Na), magnesium (Mg), and calcium (Ca). Whereas the important trace element determined in the present study is iron (Fe). Similar to other livestock species reared for meat production, the major mineral in goat muscle is potassium (K). These results are in accordance with the findings obtained by Casey, (1992), and Anaeto *et al*., (2010).

Results in Table4 also reveal that goat meat can be regarded as a good source of iron (2.97 mg/100g) and calcium (12.35 mg/100g); they are important elements for preventing iron-deficiency anemia, as well as for bone development, secretory functions, buffers, and certain co-enzymes (Keeton and Eddy, 2004). Table 4 further indicates that, goat meat is also a good source of potassium (K; 240.22 mg/100g) and Magnesium (Mg; 21.41 mg/100g); both are necessary for many essential biochemical reactions (Mioc, *et al.*, 2000). Moreover, the low sodium content (Na; 69.17 mg/100g) of goat meat has an advantage for those who prefer a low sodium diet.

Table 4: Mineral composition (mg/100g.) of LD muscle of Egyp.Baladi goat kids.

Mineral composition	mg/100g meat
Iron (Fe)	2.97
Sodium (Na)	69.17
Potassium (K)	240.22
Calcium (Ca)	12.35
Magnesium (Mg)	21.41

Results ofTable4, regarding mineral composition of goat meat are comparable to the findings obtained by Sheridan *et al.*, (2003),Argüello,(2005), and Lee *et al.*, (2008). Additionally,it is worth mentioning that, on comparing the nutritive value of cooked goat meat to that of beef, it was reported that goat meat has lower fat, and sodium contents; similar protein and iron; and higher calcium, magnesium, and potassium (Johnson *et al.*, 1995); this further lends support to the view that goat meat offers an attractive alternative to other types of red meat.

3.3. Fatty Acids Profile:

Individual fatty acid composition of the LD muscles from Egyptian Baladi goat kids is presented in Table 5. Similar to other meat animals, the major fatty acids identified from the IMF were oleic (C18:1), palmitic (C16:0) and stearic (C18:0) acids with percentages as 41.90%, 23.94% and 14.20%; respectively, which accounted about 80% of total fatty acids, in agreement with studies by Beserra *et al.*, (2004), Werdi Pratiwi *et al.*, (2007), and Silva *et al.*, (2011). Table 5 also reveals that,oleic acid had the highest percentage compared to other fatty acids. However, slight differences in fatty acid profiles in literatures could be due to the use of different goat breeds, type of feed or slaughter weight (Dhanda *et al.*, 2003; Lee *et al.*, 2008; Pena *et al.*, 2009; Toplu *et al.*, 2013).

According to Desai *et al.* (2008), the fatty acids (C12:0 and C14:0) together with (C16:0) are the major atherogenic fatty acids, which directly related to the risk of cardiovascular disease. From the fatty acid profile we calculated the atherogenicity index according to Ulbricht and Southgate, (1991), as follows: [AI = (C12:0 +

(C14:0×4) + C16:0) / (UFA)].As can be seen from Table 5 that, the atherogenicity index for LDM of Egy.Baladi goat (AI: 0.71) was similar to those obtained by Brzostowski*et al.*, (2008; AI: 0.73) for French Alpine (FA) purebred kids, and Werdi Pratiwi *et al.*, (2007; AI: 0.76) for Australian feral goat kids. While, it was higher compared to that obtained (AI: 0.67) for CC, but lower than those (AI: 0.94) reported for AN goat kids (Pena *et al.*, 2009).

It has been reported that palmitic acid (C16:0) increases blood cholesterol, stearic acid (C18:0) has no effect, and oleic acid (C18:1) decreases blood cholesterol content. Banskalieva *et al.*, (2000) and Rhee *et al.*, (2000), suggested that the ratio of (C18:0 + C18:1)/C16:0), which ranging from 2.1 to 3.6 for goat meat, could be useful in describing the potential health effects of different types of lipids. In the present study this ratio was 2.34 for LD muscles of Egy. Baladi breed, which was higher than the value 2.20 reported for Australian feral goats (WerdiPratiwi*et al.*, 2007), and similar to 2.36 reported for the Anglonubian breed (Pena *et al.*, 2009), whereas it was lower compared to Boer goats (Silva *et al.*, 2011; 2.42). In this context, meat from Egyptian Baladi goats with value 2.34 indicate that this meat has high nutritional qualities.

Table 5: Fatty acids as percentage of total fatty acids in LD muscle of Egy. Baladi goat kids

Fatty acid (FA)	%	FA Indices	% & Ratio
C10: 0 Capric	0.14	SFA	44.6%
C12: 0 Lauric	0.12	MUFA	45.1%
C14: 0 Myristic	3.84	PUFA	10.3%
C15: 0 Pentadecanoic	0.82	UFA	55.4%
C16: 0 Palmitic	23.94	PUFA/SFA	0.23
C17: 0 Heptadecanoic	1.54	MUFA/SFA	1.01
C18: 0 Stearic	14.2	UFA/SFA	1.24
C16: 1 Palmitoleic	3.2	AI	0.71
C18: 1 Oleic	41.9	(18:0+18:1)/16:0	2.34
C18: 2 Linoleic	6.5	DFA	69.6%
C18: 3 Linolenic	1.7	OFA	30.4%
C20: 4 Arachidonic	2.1	DFA:OFA	2.29

Whereas: Desirable Fatty Acid (DFA), (DFA = MUFA + PUFA + C18:0).
Hypercholesterolemic or undesirable fatty acids (OFA), (OFA = SFA – C18:0).
Atherogenicity Index (AI), [AI = (C12:0 + (C14:0×4) + C16:0) / (UFA)].

Results of Table 5 further indicate that the proportions of SFA (44.6%) observed for LD muscles of Egy. Baladi breed is in agreement with studies by Werdi Pratiwi *et al.*, (2007; SFA: 43.9%) for Austrlian feral goats, but lower than that reported for French Alpine kids (Brzostowski*et al.*, 2008; SFA: 49.26%), and that found for Boer goats (46.36%) by Silva *et al.*, (2011). On the other hand, Pena *et al.*, (2009) came to the conclusion that, the proportions of SFA were higher in Criollo Cordobeskids (40.09%) than in Anglonubian(37.91%) one. Generally, SFA in goat studies cited is not different from that in lamb and beef (Banskalieva *et al.*, 2000).

The ratio of UFA/SFAin the present study (1.24) was higher as compared to those reported for Australian feral goats (1.17) by Werdi Pratiwi *et al.*, (2007), but lower than those recorded forCC (1.46) and AN (1.61) by Pena *et al.*, (2009). Moreover,the ratio of PUFA/SFA (0.23) was consistent with the value (0.20) obtained by Werdi Pratiwi *et al.*, (2007) for Australian feral goat kids, but lower than those found for CC and AN goat kids as reported by Pena *et al.*, (2009).These ratios are within the range of 0.16-0.49 reported in literature reviewed by Banskalieva*et al.*, (2000). The PUFA: SFA ratio reported for beef and lamb was 0.11 and 0.15; respectively (Enser *et al.*, 1998), whereas it was 0.33 for goat meat (Rhee *et al.*, 2000), this can be a positive marketing asset for goat meat.However,less saturated fats and a relatively high proportion of total unsaturated fats make goat a very healthy meat choice.

Desirable fatty acids (DFA) in the present study (69.6%) was within the range of 61 to 80% reported in literature reviewed (Werdi Pratiwi *et al.*, 2007; Pena *et al.*, 2009; Silva *et al.*, 2011; and Horcada *et al.*, 2012), and confirm, under the nutritional point of view, the excellence of the EgyptianBaladi goats. On the other hand, goat meat in the present study (Table 5) exhibited lower percentage of undesirable fatty acids (OFA; 30.4%), which according to Rhee (1992) have cholesterol -raising affect.However, OFA percentage is within the range of 26-31% reported in goat literature (Werdi Pratiwi *et al.*, 2007; Madruga *et al.*, 2009; Pena *et al.*, 2009; Silva *et al.*, 2011). Consequently, a satisfactory DFA/OFA ratio(2.29) was observed for Egyptian Baladigoats.

4.Microbiological quality of goat kids meat:

Microbiological analysis of LDM of goat kids is shown in Table 6, from which it is clear that,none of the samples contained *Salmonella spp., Staphylococcus aureus* or fungal; this is in accordance with the results of Datta *et al.*, (2012) who proved that neither *Salmonella* spp. was detected, nor *Staphylococcus aureus* or fungal were isolated from fresh slaughter goat samples, indicating the quality of raw meat and other hygienic processing including the quality of the water used in processing.

Table 6 further shows that, the total viable bacterial count (TVBC) from triplicate determinations of goat muscle svaried from 4.7 x 10^4 to 6.1 x 10^4cfu/g flesh, while the total coliform count (CC) ranged from 2.3 x 10^2 to 3.4 x 10^2cfu/gflesh; respectively. In this concern,Okonko *et al.*, (2010) reported that the mean microbial load on the fresh meat ranged between 2.62x$10^4$and 4.84x10^4cfu/g flesh, whereas the total coliform count were between 1.05 x 10^3 - 3.72 x 10^3cfu/g. However, TVBC and CC counts in the present study (Table 6)were lower as compared to the findings obtained by Datta *et al.*, (2012) and Eze and Ivuoma, (2012) for fresh goat meat samples, indicating hygienic and good sanitary conditions for the goat meat samples under investigation.

Table 6: Microbiological Quality of LD muscle ofEgyptian Baladi goat meat (cfu /g flesh).

Microbiological analysis	Total Microbial Count	Mean ±SD
Salmonella spp. detection (SSD)	Negative	0.00
Staphylococcus aureus Count (SAC)	Nil	0.00
Fungal Count (FC)	Nil	0.00
Coliform Count (CC)	2.3x10^2, 2.8x10^2, and 3.4x10^2	2.83 x 10^2 ±0.55x10^2
Total Viable Bacterial Count (TVBC)	4.7x10^4, 5.3x10^4, and 6.1x10^4	5.37 x 10^4 ±0.70x10^4

Values are given as mean ± S.D. from triplicate determinations.

Concerning microbiological quality and safety, it has been observed that the inner tissues of healthy animals are sterile; however, contamination comes from external sources during bleeding, handling skinning and processing (Eze and Ivuoma, 2012). Generally, the TVBC and CC of goat meat (Table 6) were well below the incipient spoilage level (Solberg *et al.*, 1986). The finding of present study reflected the hygienic status of meat production.However, raw meat and meat products should be handled under strict hygienic condition and stored in cool places to avoid contamination and safeguard the health of consumers.

It can be deduced from the microbiological analysis (Table 6) that no growth of food borne pathogens or spoilage microorganisms in goat kid's meat samples and hence, the samples were being accepted for human use with regards to its microbiological quality. These results confirmed that, the inspection at the abattoir ensures only healthy animals and top quality meat reaches consumers and hence, no potential serious health problems will result from its consumption.

5. Sensory quality of cooked goat meat:

Taste panel evaluations for the cooked goat meat are presented in Table 7. Overall acceptability scores indicate that all samples were organoleptically acceptable. The sensory attributes were perceived by the members of the panel with medium-high intensity. Chevon samples from Egyptian Baladi breedwere in good agreement to that reported by Dhanda *et al.*, (1999) for six goat genotypes, and Werdi Pratiwi *et al.*, (2004) for Boer goat kids. The present evaluations were better in all criteria scores than those recorded by Pena *et al*,. (2009) in CCand AN breed kids, and Silva *et al.*, (2011) for Boer breed kids.However, sensory evaluation supports the chemical indices as well as the microbiological quality (Tables 1,6), and confirmed good eating quality for goat meat under investigation.

In the present study it is apparent that, intramuscular fat (marbling) increases juiciness, thereby increasing the perceived tenderness (7.53).Tenderness is one of the important factors that contribute to overall acceptance of cooked meat. Similar results were achieved on Boer goats by WerdiPratiwi *et al.*, (2007), indicating that these eating quality variables can be considered as important factors contributing to the general acceptance by panellists. However, a decrease in tenderness with slaughter weight has already been observed by Dhanda*et al.*, (2003).

Table 7: Eating Quality Scores of cookedLD muscle of Egyptian Baladi goat kids.

Measurement	Score
Appearance	6.94 ± 0.58
Flavor	8.02 ± 0.46
Tenderness	7.53 ± 0.51
Juiciness	7.70 ± 0.72
Overall Acceptability	7.85 ± 0.52

All values reflect the mean and standard deviation, (n=10).

As shown in Table 7, the average score of the appearance was the lowest(6.94). Dias *et al.*, (2008) mentioned that the color of goat meat has lower score because consumers associate dark meat with meat taken from older animals. In a study by Babiker *et al.*, (1990), it was reported that goat meat was leaner, darker in color and had lower acceptance compared to lamb. While, Dhanda *et al.*, (1999) found that meat obtained from six goat genotypes was well accepted by the panelists. Table 7 further shows that, flavor as expected got the highest score (8.02), it was also reported that, better acceptance for goat meat flavor was achieved from castrated compared to intact male goats (El-Waziry *et al.*, 2011 andSolaiman *et al.*, 2011). Whereas, breed and slaughter weight had no effect on flavor scores (Dhanda *et al.*, 2003;Costa *et al.*, 2008 and Madruga *et al.*, 2008).

Results depicted in Table 7, also indicated that cooked meat samples from Egyptian Baladi breed got higher scores for juiciness (7.70). These results confirmed the findings obtained byDhanda *et al.*, (1999), Brzostowski *et al.*, (2008) and Silva *et al.*, (2011). According to Webb *et al.*, (2005), juiciness is influenced by the moisture and intramuscular fat of meat in addition to the saliva produced during tasting. The juiciness of meat is also influenced by the method of cooking and the end-point temperature attained (Dhanda *et al.*, 2003). Babiker *et al.*, (1990) reported that *Longissimus* dorsi muscle from Desert goat was less juicy than that from lamb; these differences may be due to variation in fat contents.

Conclusions:

As indicated by gross chemical composition, chemical indices, physical properties, amino acids and fatty acids profiles, mineral composition, as well as microbiological and eating qualities, it is concluded that goat kid's meat from Baladi breed raised under Egyptian conditions is an excellent source of healthy red meat alternative to other kinds of meat.

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