RESULTS indicated that... 4.55 million head; FAO Statistics, 2011).

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 Longissimus 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 that Chevon (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 that goat kid 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 high nutritive 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 wis 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., 1999 and 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., 2011 and Solaaiman et al., 2011). Nutitionally, 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...
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., 2008 and 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 (Madruaga 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 (Madruja et al., 2008). On the other hand, the appearance, tenderness, flavor, and juiciness properties are important categories affecting goat meat acceptability (Dhand et al., 1999 and 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; 4.5 kg) from three castrated male goats at 5 months old and 13-15 kg carcass weight were from Egyptian Baladi goat breed, as per abattoir’s and butcher’s information. Meat samples were packed in polyethylene bags and kept in the 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 indication of physiological maturity (Brzostowski 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 mm id. and 0.25 µm film thickness). 1.0 µL 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 and Horcada 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 determination, 100 mL distillate water was added on 10 g 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 outer zones (cm²/0.3g) following the filter press method (Soloviev, 1966), using PlacomDigetalPlanimeter (KP-90N), and calculated as % of bound water from the following equation:

\[
\% \text{Bound Water} = \frac{\% \text{Moisture} - \text{(Outer area cm}^2 \times 0.4 \times 100)}{\text{(0.3 x 1000)}} \times 100
\]

whereas one cm² of the outer zone area is equivalent to 8.4 mg free 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 expressed as the percentage loss related to the initial weight (Pena et al., 2009).

Shear Force (Kg/cm²):

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. Reston, VA). 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, which were 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 samples were cooked using the same cooking method as applied for cooking loss measurements. Cooked samples were 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, 3.28 and 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), whereas Australian 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 and Toplu et al., 2013).

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

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

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 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 5.2 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 of Ardhi 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 trial 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 Capacity (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 (8.4cm²/0.3g; results not shown), was consistent with the findings of Brzostowski et al., (2008) who reported 8.09 and 7.02 cm²/0.3g 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 and Todaro 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 percentages for 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/cm²), which is equal to 58.76 N/cm² was similar to those observed by Pena et al., (2009) using CriolloCordobes kids (62.86 N/cm²), Werdi Pratiwi et al., (2007) for Australian feral goat kids (56.1 N/cm²), 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 (Table 2) were higher as compared to the findings obtained by Atayet 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.

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

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 and 11.50 (Table 2). 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 (Atayet 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 CriolloCordobes 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 (Solaíman 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 Egyptian Baladi 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, Brzostowskiet 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.

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

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 Table 4 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). 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 Egyptian Baladi goat kids.

<table>
<thead>
<tr>
<th>Mineral composition</th>
<th>mg/100g meat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iron (Fe)</td>
<td>2.97</td>
</tr>
<tr>
<td>Sodium (Na)</td>
<td>69.17</td>
</tr>
<tr>
<td>Potassium (K)</td>
<td>240.22</td>
</tr>
<tr>
<td>Calcium (Ca)</td>
<td>12.35</td>
</tr>
<tr>
<td>Magnesium (Mg)</td>
<td>21.41</td>
</tr>
</tbody>
</table>

Results of Table 4, 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 +
(C14:0x4) + 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 Brzostowskiet 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.

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 Australian feral goats, but lower than that reported for French Alpine kids (Brzostowskiet 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 Cordobes kids (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/SFA in 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 for CC (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 Banskalievaet al., (2000). The PUFA: SFA ratio reported for beef and lamb was 0.11 and 0.15; respectively (Ensér 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 Egyptian Baladi 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 swayed from 4.7 x 10^3 to 6.1 x 10^4 cfu/g flesh, while the total coliform count (CC) ranged from 2.3 x 10^3 to 3.4 x 10^2 cfu/gflesh; respectively. In this concern, Okonko et al., (2010) reported that the mean microbial load on the fresh meat ranged between 2.62 x 10^3 and 4.84 x 10^4 cfu/g flesh, whereas the total coliform count were between 1.05 x 10^3 - 3.72 x 10^2 cfu/g. However, TVBC and CC counts in the present study were lower as compared to the findings obtained by Datta et al., (2012) and Eze and Iwuoma, (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 of Egyptian Baladi goat meat (cfu/g flesh).

<table>
<thead>
<tr>
<th>Microbiological analysis</th>
<th>Total Microbial Count</th>
<th>Mean ±SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salmonella spp. detection (SSD)</td>
<td>Negative</td>
<td>0.00</td>
</tr>
<tr>
<td>Staphylococcus aureus Count (SAC)</td>
<td>Nil</td>
<td>0.00</td>
</tr>
<tr>
<td>Fungal Count (FC)</td>
<td>Nil</td>
<td>0.00</td>
</tr>
<tr>
<td>Coliform Count (CC)</td>
<td>2.3 x 10^5, 2.8 x 10^5, and 3.4 x 10^2</td>
<td>2.83 x 10^3 ± 0.55 x 10^2</td>
</tr>
<tr>
<td>Total Viable Bacterial Count (TVBC)</td>
<td>4.7 x 10^5, 5.3 x 10^3, and 6.1 x 10^4</td>
<td>5.37 x 10^3 ± 0.70 x 10^4</td>
</tr>
</tbody>
</table>

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 Iwuoma, 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 breed were 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 CC and 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 Werdi Pratiwi 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 cooked LD muscle of Egyptian Baladi goat kids.

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Score</th>
</tr>
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<tbody>
<tr>
<td>Appearance</td>
<td>6.94 ± 0.58</td>
</tr>
<tr>
<td>Flavor</td>
<td>8.02 ± 0.46</td>
</tr>
<tr>
<td>Tenderness</td>
<td>7.53 ± 0.51</td>
</tr>
<tr>
<td>Juiciness</td>
<td>7.70 ± 0.72</td>
</tr>
<tr>
<td>Overall Acceptability</td>
<td>7.85 ± 0.52</td>
</tr>
</tbody>
</table>

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 and Solaiman 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 by Dhanda 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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Reference


