INTRODUCTION

In Morocco, the livestock sector is an essential asset in terms of agricultural turnover. It plays a very important role in rural socioeconomic development including food supply, employment, soil fertilization, and crop production. Livestock production systems range from intensive to extensive and mainly involve sheep and goats. The Moroccan national sheep flock is estimated at 29 million head (HCP, 2017) among which 99% depends essentially on pastures and fallows (Boujenane, 2005). Sheep livestock is generally destined for meat production where the majority of the males are intended for the feast of the sacrifice, and about 25% of female lambs are reserved to replace the elderly ewes. The rest are fattened and intended for slaughter to supply the red meat markets throughout the year. Sheep meat production is estimated at 130,000 tons/year, representing 11% of the total national meat production (HCP, 2017).

Quality characteristics of the carcass of Beni-Guil sheep, a Protected Geographical Indication certified product of Eastern Morocco: Preliminary study

Kamal Belhaj1,3,* Farid Mansouri1,2 Aziz Tikent1,3 Abdellah Ouchatbi3 Mohamed Boukharta4 Caid Hana Serghini1 Ahmed Elamrani1

Keywords
Beni-Guil sheep, carcasses, meat quality, designation of origin, Morocco

Summary
The objective of the study was to evaluate, for the first time, the qualitative, objective and subjective characteristics of the carcass and meat of the Beni-Guil sheep breed, originating in Eastern Morocco. The study was conducted with 105 ewes and ewe lambs with a mean age of 21.5 months (8–36 months), and a mean weight of 32.55 kg. pH measurements were taken one hour and 24 hours after slaughter. The mean values obtained were 6.76 and 5.78, respectively. The mean hot (HCW) and cold (CCW) carcass weights and corresponding yields were 15.82 kg (48.6%) and 15.52 kg (47.7%), respectively. Shrinkage loss was 1.9%. Linear measurements showed that the Beni-Guil had a mean carcass length (K) and width (G) of 63.7 and 17.3 cm, respectively, with a carcass compactness index 1 (G/K) and 2 (CCW/K) of 0.27 and 243.60 g/cm, respectively. Finally, according to the EUROP sheep carcass classification grid, the carcasses examined showed conformations between fairly good (O) and good (R), a bright red color, a firm white fat cover, and a fatness score of 3.42. The results highlighted the characteristics of the Beni-Guil ewe carcass, which are sought by professionals and consumers.
one hundred and five carcasses of Beni-Guil ewes and ewe lambs were examined. They had been randomly selected from two slaughter-houses between February and June, 62 in Oujda and 43 in Jerrada, in Eastern Morocco (Figure 2). Sheep belonged to ANOC members (nine farms randomly chosen) and their mean age was about 21.5 months (8–36 months). The animals underwent a resting period under a water diet for 16–24 h before slaughter using the Halal method. In the first hour postmortem, the hot carcass weight (HCW) was recorded. Carcasses were kept in the slaughterhouse at ambient temperature for 3 to 4 h. They were then transferred into a cold storage room at 6°C for 20 h. The cold carcass weight (CCW) was recorded 24 h postmortem.

Objective carcass measurements

The live weight (LW), HCW and CCW were used to calculate the hot and cold carcass yields (HCY and CCY, or hot and cold dressings, respectively), using the following formulas: HCY = (HCW/LW) × 100 and CCY = (CCW/LW) × 100. The hot dressing is the economical yield and the cold dressing is the commercial yield.

The percentage of shrinkage loss was calculated thus: (HCW - CCW) / HCW × 100, using the following formulas: HCY and CCY, or hot and cold dressings,

The meat color was measured 24 hours postmortem on the carcass fresh surface, precisely on the longissimus lumborum muscle between ribs 12 and 13, by a portable pH meter (pH/Cond 340i WTW, Weilheim, Germany) equipped with a penetration electrode.

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Subjective carcass measurements

Sheep carcasses were subjectively scored by a trained assessor under the supervision of a veterinarian, according to notation scales: i) the fatness scale (1 = very low, 2 = low, 3 = average, 4 = high, 5 = very high) (Colomer-Rocher et al., 1988; D’Alessandro et al., 2013); ii) the conformation scale from 1 (poor) to 5 (excellent) according to EUROPE classification (E = excellent, U = very good, R = good, O = fair, P = poor) (Colomer-Rocher et al., 1988; D’Alessandro et al., 2013); iii) the carcass color according to European Union photographic standards (1 = very light red, 2 = light red, 3 = bright red, 4 = dark red) (Moëvi, 2006); iv) the cover fat quality according to...
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the European scales established by the Centre interrégional d’information et de recherche en production ovine (color: 1 = very white, 2 = slightly colored, 3 = partially colored, 4 = strongly colored; firmness: 1 = hard, 2 = firm, 3 = soft, 4 = very soft and oily) (Carrasco et al., 2009; Sagot and Pottier, 2011a; Sagot and Pottier, 2011b). The results were the means and standard deviations of the subjective and objective measurements recorded for carcasses and meat quality parameters (pH, temperature, meat color). Meat quality parameters were carried out in triplicates.

RESULTS

Objective carcass characteristics

Table I shows the mean values of the live sheep, and hot and cold carcass weights (32.55 kg, 15.82 kg, and 15.52 kg, respectively), and the percentage of hot and cold dressings, and shrinkage loss (1.9%). Table II shows the mean values of carcass measurements and indexes.

Subjective carcass characteristics

Professionals of the meat market seek well-muscled carcasses with an elevated percentage of lean meat and a medium degree of fatness. In

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Mean ± SD</th>
<th>Min.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Live weight (kg)</td>
<td>32.55 ± 9.33</td>
<td>17.35</td>
<td>48.58</td>
</tr>
<tr>
<td>Hot carcass weight (kg)</td>
<td>15.82 ± 4.8</td>
<td>7.91</td>
<td>25.31</td>
</tr>
<tr>
<td>Cold carcass weight (kg)</td>
<td>15.52 ± 4.7</td>
<td>7.77</td>
<td>24.1</td>
</tr>
<tr>
<td>Hot dressing (%)</td>
<td>48.60 ± 0.01</td>
<td>43.1</td>
<td>51.03</td>
</tr>
<tr>
<td>Cold dressing (%)</td>
<td>47.68 ± 0.01</td>
<td>41.89</td>
<td>49.96</td>
</tr>
<tr>
<td>Shrinkage loss (%)</td>
<td>1.90 ± 0.8</td>
<td>0.66</td>
<td>2.91</td>
</tr>
</tbody>
</table>

SD: standard deviation; Min.: minimum; Max.: maximum

Table II

Mean values of carcass measurements and calculated carcass indexes of Beni-Guil sheep (n = 105), Eastern Morocco

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Mean ± SD</th>
<th>Min.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carcass width (G) (cm)</td>
<td>17.28 ± 2.56</td>
<td>13</td>
<td>23</td>
</tr>
<tr>
<td>Carcass length (K) (cm)</td>
<td>63.70 ± 6.34</td>
<td>56</td>
<td>75</td>
</tr>
<tr>
<td>Leg length (F) (cm)</td>
<td>30.59 ± 2.39</td>
<td>26</td>
<td>35</td>
</tr>
<tr>
<td>Leg compactness index (G/F)</td>
<td>0.56 ± 0.10</td>
<td>0.47</td>
<td>0.63</td>
</tr>
<tr>
<td>Carcass compactness index1 (G/K)</td>
<td>0.27 ± 0.20</td>
<td>0.17</td>
<td>0.32</td>
</tr>
<tr>
<td>Carcass compactness index2 (CCW/K) (g/cm)</td>
<td>243.6 ± 52.76</td>
<td>138.75</td>
<td>277.75</td>
</tr>
</tbody>
</table>

SD: standard deviation; Min.: minimum; Max.: maximum; CCW: cold carcass weight
our study, as indicated in the methods, a trained assessor had been in charge of subjective carcass evaluation (fatness state, conformation, color, and cover fat). Table III shows the observed subjective traits of Beni-Guil carcasses. According to EUROP fatness scale, the carcass fatness ranged from average to high (mean of 3.42), the conformation was fair to good (mean of 2.39), and the cover fat was white and firm.

**Meat quality assessment**

Table IV shows the pH and color-parameter mean values obtained for Beni-Guil sheep meat.

### Table III

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Mean ± SD</th>
<th>Min.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>EUROP conformation</strong>&lt;sup&gt;1&lt;/sup&gt;</td>
<td>2.39 ± 0.49</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td><strong>EUROP fatness</strong>&lt;sup&gt;2&lt;/sup&gt;</td>
<td>3.42 ± 0.52</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Fat color</td>
<td>White</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Fat firmness</td>
<td>Firm cover fat</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Carcass color&lt;sup&gt;3&lt;/sup&gt;</td>
<td>3.41 ± 0.48</td>
<td>2</td>
<td>4</td>
</tr>
</tbody>
</table>

SD: standard deviation; Min.: minimum; Max.: maximum

<sup>1</sup> E = 5, U = 4, R = 3, O = 2, P = 1; 1 = very low; 2 = low; 3 average; 4 = high; 5 = very high.  
<sup>2</sup> 1 = very light red, 2 = light red, 3 = bright red, 4 = dark red  
<sup>3</sup> Scales: a<sup>°</sup> and b<sup>°</sup>; –60 to 60; L<sup>°</sup>: 0 to 100; Chromaticity: 0–60; Hue: 0°–360°

### Table IV

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Mean ± SD</th>
<th>Min.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature (°C)</td>
<td>34.89 ± 1.10</td>
<td>31.70</td>
<td>36.70</td>
</tr>
<tr>
<td>pH1</td>
<td>6.76 ± 0.70</td>
<td>6.67</td>
<td>6.91</td>
</tr>
<tr>
<td>pH24</td>
<td>5.78 ± 0.10</td>
<td>5.63</td>
<td>5.89</td>
</tr>
<tr>
<td>L° (lightness)&lt;sup&gt;1&lt;/sup&gt;</td>
<td>41.54 ± 0.41</td>
<td>40.04</td>
<td>42.02</td>
</tr>
<tr>
<td>a° (redness)&lt;sup&gt;1&lt;/sup&gt;</td>
<td>21.09 ± 0.47</td>
<td>19.28</td>
<td>22.27</td>
</tr>
<tr>
<td>b°(yellowiness)&lt;sup&gt;1&lt;/sup&gt;</td>
<td>7.66 ± 0.47</td>
<td>5.96</td>
<td>8.77</td>
</tr>
<tr>
<td>Chromaticity&lt;sup&gt;2&lt;/sup&gt;</td>
<td>22.44 ± 0.49</td>
<td>20.18</td>
<td>23.45</td>
</tr>
<tr>
<td>Hue angle&lt;sup&gt;3&lt;/sup&gt;</td>
<td>19.93 ± 1.23</td>
<td>17.17</td>
<td>22.55</td>
</tr>
<tr>
<td>a°/b°</td>
<td>2.77 ± 0.19</td>
<td>2.41</td>
<td>3.23</td>
</tr>
</tbody>
</table>

SD: standard deviation; Min.: minimum; Max.: maximum

<sup>1</sup> Scales; a<sup>°</sup> and b<sup>°</sup>; –60 to 60; L<sup>°</sup>: 0 to 100;  
<sup>2</sup> Chromaticity; 0–60;  
<sup>3</sup> Hue; 0°–360°

**DISCUSSION**

In this preliminary study, which aimed to obtain the average data on the objective and subjective quality characteristics of the Beni-Guil sheep carcass, no consideration was given to differences in rearing conditions, slaughter age or slaughter period. Therefore, the collected data represented a general average, without taking into account the possible variations according to the above-mentioned criteria.

The average values of live weight at slaughter, and hot and cold carcass weights showed that the carcass size was small to medium. This carcass type is often sought after in local markets and by consumers in Eastern Morocco. In livestock destined for slaughter, the dressing is a valuable criterion for the quality assessment of sheep carcasses.

Farmers ought to know the importance of carcass yield and chilling loss. In addition, the dressing percentage gives professionals information on potential commercial transactions and profitability. Slaughterhouse traders and butcher retailers often pay for carcass yield.

The 47.7% cold dressing value was similar to that of 46.5% recorded in Kivircik sheep, a Turkish breed (Ekiz et al., 2013), and of 49.4% in Spanish Florida sheep (Peña et al., 2007). Carcass postmortem chilling losses are a major problem in the meat industry. It is caused by drip loss and water evaporation. From an economic point of view, the assessment and mastering of this critical parameter are very important. In this study, the average rate of shrinkage loss was 1.9% with a minimum of 0.66% and a maximum of 2.91%. Thus it was low for the Beni-Guil compared to those of 4.92% for the Chilote Chilean (Ramírez-Retamal et al., 2013), 3.24% for the Kivircik Turkish (Ekiz et al., 2013), and 2.35% for the Lecese Italian breeds (D’Alessandro et al., 2013). The low shrinkage loss for the Beni-Guil can be explained by the cover fat quality of carcasses and fatness state, which are related to the breed as an endogenous factor, and to many exogenous factors such as late weaning, animal feeding (grazing contributes to the cover fat hardness), cooling room management, and carcass chilling.

The conformation score is an important parameter for carcass quality assessment (Flamant and Boccard, 1966). In our study the average value of 2.39, with 28.1% in R-conformation and 71.9% in O-conformation, reflected a fair to good muscle development. Linear and weight measurements enabled calculating the compactness indexes which confirmed the subjective conformation observed. Furthermore these results showed that Beni-Guil carcasses exhibited good compactness indexes (LCI and CCI2) compared to those reported by Mebrouk-Boudechiche et al. (2008) for the Berber Algerian breed. Nevertheless, LCI, CCI1 and CCI2 values for Beni-Guil sheep were lower than those reported by Alexandre et al. (2008) for the Martink French breed.

The meat industry requests well-muscled carcasses with a high proportion of lean meat and some degree of fatness to prevent weight loss during cold storage (Peña et al., 2007). The mean fatness score of Beni-Guil carcass was 3.42 according to EUROP fatness scale, with rates of 1.5% in class 2, 54.7% in class 3, and 43.8% in class 4. The cover fat showed that Beni-Guil carcass had a high fat quality (white and firm), a characteristic well appreciated by professionals and consumers. These results were comparable to those reported by Carrasco et al. (2009) for the Churra Spanish PGI breed.

Meat pH is a determinant factor for its quality. It affects meat organoleptic properties (color, juiciness, tenderness, and flavor). The mean values of pH1 (6.76) and pH24 (5.78) showed normal postmortem glycolysis of Beni-Guil sheep meat, and reflected normal (stressless) slaughter conditions in Eastern Moroccan slaughterhouses. These results are comparable to values reported by other authors (Zgar et al., 2003; Mazzette et al., 2005; Sen et al., 2011). Similarly, color is the best indicator for meat quality and freshness (Cinquinart et al., 2000; Coibion, 2008). Consumers often use it as a quality index as it varies depending on the muscle pH evolution. The ultimate pH (pH24) is closely related with meat color, because it has a direct influence on muscle protein weft (superficial state of the meat) and consequently on light penetration into muscle. A pH24 close to the pH1 (isoelectric) of meat protein allows a good light reflection, thus the bright red meat color sought after by meat markets.

In this study, the subjective results obtained for the carcass meat color matched the objective measurements. There was a predominance of the red color (a°/b° ratio), oxymyoglobin richness (hue angle), and optimal meat color (chromaticity) (Salifou et al., 2013). Our results for meat color agreed with those of Moëvi (2006) who reported values of 28–30 for dark red meat and 50–55 for very light red meat.
The halal slaughtering method can partially explain this result as it enables blood evacuation and thus decreases muscle pigment concentration. Calnán et al. (2016) observed that an increase in myoglobin concentration increases the red color intensity.

**CONCLUSION**

These results constitute a preliminary study on carcass and meat characterization of Beni-Guil sheep reared and slaughtered in Eastern Morocco. This breed has an average conformation, a medium to high fitness state and a high quality of carcass cover fat. Protected by the PGI label, it is well adapted to shepherding transhumance and constitutes the main source of food and income for rural farmers in the area, particularly for local people who continue to live in a very traditional way as nomadic breeders.

**Acknowledgments**

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**Conflicts of interest**

The authors declare that there are no conflicts of interest associated with this study.

**Author contributions statement**

KB and AE conceived and designed the work; KB, AT and AO collected the data; KB and FM analyzed and/or interpreted the data; KB and AE drafted the article; CHS and MB critically revised the article.

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Caractéristiques qualitatives de la carcasse d’ovin Beni-Guil

Revue d'élevage et de médecine vétérinaire des pays tropicaux, 2020, 73 (1): 21-26
Résumé


L’objectif de l’étude a été d’évaluer pour la première fois les caractéristiques qualitatives, objectives et subjectives de la carcasse et de la viande de la race ovine Beni-Guil, originaire de l’est du Maroc. L’étude a été réalisée avec 105 agnelles et brebis âgées en moyenne de 21,5 mois (8–36 mois) et d’un poids moyen de 32,55 kg. Les mesures du pH ont été prises une heure et 24 heures après l’abattage. Les valeurs moyennes obtenues ont été respectivement de 6,76 et 5,78. Les poids moyens de la carcasse chaude (PCC) et froide (PCF), et les rendements correspondants ont été respectivement de 15,82 kg (48,6 %) et 15,52 kg (47,7 %). La perte de poids au refroidissement a été de 1,9 %. Les mesures linéaires ont montré que la Beni-Guil avait en moyenne une longueur (K) et une largeur (G) de carcasse respectivement de 63,7 et 17,3 cm, avec des indices de compacité de carcasse 1 (G/K) et 2 (PCF/K) respectivement de 0,27 et 243,60 g/cm. Enfin, selon la grille de classification des carcasses ovines EUROP, les carcasas examinées ont présenté des conformations les situant entre les classes assez bonne (O) et bonne (R), une couleur rouge vif, une couche de grasse blanche et ferme, et une note d’engraissement de 3,42. Les résultats ont révélé les caractéristiques de la carcasse de la brebis Beni-Guil, lesquelles sont recherchées par les professionnels et les consommateurs.

Mots-clés : ovin Beni-Guil, carcasse, qualité de la viande, appellation d’origine, Maroc

Resumen


El objetivo del estudio fue evaluar, por la primera vez, las características objetivas y subjetivas de la calidad de la carcosa y la carne de la raza de ovejas Beni-Guil, originaria del este de Marruecos. El estudio se condujo con 105 ovejas y corderos hembras con una edad promedio de 21,5 meses (8-36 meses), y con un peso medio de 32,55 kg. Se tomaron medidas de pH una hora y 24 horas después del sacrificio. Los valores promedio obtenidos fueron 6,76 y 5,78 respectivamente. Los pesos medios de las carcasas calientes (PCC) y frías (PCF) y correspondientes rendimientos fueron 15,82 kg (48,6 %) y 15,52 kg (47,7 %). La pérdida por contracción fue de 1,9 %. Las medidas lineales mostraron que las Beni-Guil presentaron una longitud media de la carcasa (K) y un ancho (G) de 63,7 y 17,3 cm respectivamente, con un índice de compactibilidad de 1 (G/K) y 2 (PCF/K) respectivamente de 0,27 y 243,60 g/cm respectivamente. Finalmente, según la tabla de clasificación EUROP, las carcasas examinadas mostraron conformaciones entre bastante buena (O) y buena (R), un color rojo vivo, una capa de grasa blanca firme y un índice graso de 3,42. Los resultados subrayan las características de las carcasas de ovejas Beni-Guil, apreciadas por profesionales y consumidores.

Palabras clave: ovino Beni-Guil, canal animal, calidad del aire, denominación de origen, Marruecos