Morphostructural Relationships and Productive Functionality of Sheep Breeds Used for Terminal Crossbreeding in Chile

Relaciones Morfoestructurales y Funcionalidad Productiva de Razas Ovinas Usadas para Cruzamiento Terminal en Chile

R. de la Barra*; M. E. Martínez** & A. Carvajal*


SUMMARY: The body shape of an animal population determines ranges of biological functionality and productive use. In sheep, meat productivity is closely related with the body size of the animal. Some sheep breeds are used in terminal crossbreeding to give the lamb favorable dimensional characteristics, but it is necessary to go deeper on the study of the relationships between morphostructure and productive aptitude of these breeds, since discrepancies could be due to the environmental effects or the degree of differentiation between the original pool of different breeds and the local populations. The study aimed to evaluate the morphostructural characters in four sheep breeds in Chile and discuss their relationship with the productive functionality of the body architecture. Two hundred and seventy-eight sheep belonging to Texel, Dorset, Coopworth and Suffolk Down breeds were used. Eleven body measurements (heart girth circumference, rump width, rump length, width of the cranium, length of the cranium, dorsal-ternal diameter, bicostal diameter, longitudinal diameter, cannon bone circumference, height at rump and height at withers) were taken. Nine zoometric indices (body index, cephalic index, thorax index, thorax depth index, pelvic index, longitudinal pelvic index, transverse pelvic index), metacarpal thorax index and metacarpal costal index) were composed from the individual measurements. The most important morphostructural relationships that contribute to explain the variability of the format of the four breeds of sheep studied were expressed by the metacarpal-thoracic index, the metacarpal-costal index, the thorax index and the bicostal index. Moreover, the breeds showed a high dispersion; the zoometric indices only partially explained the variability of the body format, expressing high format heterogeneity in influential variables as the metacarpal-thoracic index, the metacarpal-costal index and the body index. This could be because these racial populations are subjected to processes of differentiation within each breed.

KEY WORDS: Zoometry; Crossbreeding; Sheep.

INTRODUCTION

Efficiency in the production and marketing of sheep meat depends of two main factors. Specific dimensions of the carcasses produced and processed and on farmers and animal breeders agreement with this need (Kirton et al., 1995). In this sense, the body shape of an animal population determines ranges of biological functionality and productive use (Bravo & Sepulveda, 2010; Toro et al., 2010). Body measurements, which give significant information on morphological structure and development ability of animals, are the most influential factors on determining animals that are appropriate for the desired efficiency, and on determination of whether the establishment is in development or recession. Especially, to provide increases in meat productivity, which is closely related with the body size of the animal. It is aimed to bring up animals that are portly and have a long, wide and deep body (Abdel-Moneim, 2009; Kilic & Özbeyaz, 2011). Moreover, body measurements can be considered as morphologic characters that can provide comprehensive information to complete investigations on the performance of sheep breeds (Yakubu, 2010; Cardoso et al., 2013; Parés-Casanova, 2013). Positive genetic and phenotypic correlations indicate that improvement in body measurements both at the genetic and phenotypic levels is expected through selection on body weight and vice versa (Abbasi & Ghafouri-Kesbi, 2011; Thiagarajan & Jayashankar, 2012). Based on these criteria, some breeds are used in terminal crossbreeding to give the lamb favorable dimensional characteristics (Bianchi et al., 2006; Cardoso et al.).
Animal morphostructure is a productive tool that allows projecting the distinctive attributes of an animal population on the results of a farm using phenotypic criteria (Sierra Alfranca, 2001). Therefore, the phenotypic characterization of animal breeds is important, since their use (directly or in crossbreeding) is crucial in the production and the efficiency of use (Kirton et al.; Janssens & Vandeputte, 2004; Bianchi et al.; Cardoso et al.). However, it is necessary to go deeper on the study of the relationships between morphostructure and productive aptitude, since discrepancies could be due to the environmental effects or the degree of differentiation between the original pool of different breeds and the local populations (de la Barra et al., 2015).

This study aimed to evaluate the morphostructural characters in four sheep breeds in Chile and discuss their relationship with the productive functionality of the body architecture.

MATERIAL AND METHOD

The study was conducted between 2011 and 2012. Two hundred and seventy-eight sheep belonging to four breeds were studied: 56 Texel (TE), 65 Dorset (DO), 46 Coopworth (COO) and 111 Suffolk Down (SU). Eleven body measurements were taken: heart girth circumference (Thp), rump width (Wr), rump length (Rl), width of the cranium (CraW), length of the cranium (CraL), dorsal-sternal diameter (Dd), bicostal diameter (Bd), longitudinal diameter (Ld), cannon bone circumference (CBC), height at rump (Rh) and height at withers (Wh).

Nine zoometric indices were composed from the individual measurements: Body index (BI), Cephalic index (CI), Thorax index (IT), thorax depth index (TDI), pelvic index (PI) longitudinal pelvic index (LPI), transverse pelvic index (TPI), metacarpal thorax index (MTI) and metacarpal costal index (MCI). Data were analyzed by Fisher LSD test and principal component analysis using for the XLSTAT Pro statistical package.

RESULTS AND DISCUSSION

Animal morphostructure is defined by body dimensions and the relationships between them. These relationships determine the productive functionality and suitability of the animal in the meat, milk or dual purpose performance. The zoometric indices represent these relations and show the biological and productive functionality of a given animal biotype (Parés-Casanova, 2009; Bravo & Sepúlveda).

Figure 1 shows the result of principal component analysis of the zoometric indexes in the four breeds evaluated. Figure 1a it shows that the main components cumulatively explained 52.89 % of the variability (F1 30.41 y F2 22.48), indicating that the analyzed breeds had a high
dispersion, and the zoometric indices explain the body format variability only partially. This may be because these populations have racial differentiation processes within each breed due to hybridity, divergent patterns of selection, incomplete absorption or inbreeding (Sierra Alfranca; de la Barra et al., 2010, 2013; Latorre et al., 2011). It can also be seen that Texel, Suffolk Down and Coopworth are separately grouped; however, Dorset does not conform a clear group.

Three groups of indexes appear in Figure 1b. One group clustering MTI, BI and MCI; the second group, in opposition to the former, composed by LTI, IT, LPI and TDI. Furthermore, PI and CI generated a third group, not related to the other two.

Figure 1c shows the variables that contribute most to explain the whole variability. MTI (22.58), MCI (22.16), IT (15.91) and BI (15.59) are the indices that contribute most to explain the body functionality of these sheep breeds. This is consistent with the works that point to such measures as definers of the meat or dual-purpose aptitude of an animal (Parés-Casanova, 2009; Bravo & Sepúlveda; Carneiro et al., 2010; Abbasi & Ghafouri-Kesbi; Mujica et al., 2012).

The correlations between zoometric indices are showed in Table I. BI had a high positive correlation (0.906) with MTI. IT showed a high negative correlation (-0.720) with MCI. These indices are relevant and defining on the F1 component (Fig. 1). These variables associated with meat ability and their functional relationships define the body pattern of pure or crossbred lambs (Parés-Casanova, 2009; Bravo & Sepúlveda; Carneiro et al., 2010; Abbasi & Ghafouri-Kesbi; Mujica et al., 2012).

For MCI, several groups with significant differences were also formed. The biggest MCI was found in SU, followed by DO and the group of TE and COO, who had the lower values, without significant differences.

According to the MCI values obtained, the four breeds had a high aptitude for meat production (Janssens & Vandepitte; Bravo & Sepulveda), which is reinforced with the ranges of the values achieved by TDI, LPI and TPI (Bravo & Sepulveda; Carneiro et al.). Very high coefficients of variation were observed in TE, DO and SU, revealing problems in the format homogeneity for these breeds, possibly due to hybridity, divergent pattern selection, incomplete absorption or inbreeding (Sierra Alfranca; de la Barra et al., 2010, 2013; Latorre et al.).

<table>
<thead>
<tr>
<th>Variables</th>
<th>BI</th>
<th>CI</th>
<th>IT</th>
<th>TDI</th>
<th>PI</th>
<th>LPI</th>
<th>TPI</th>
<th>MTI</th>
<th>MCI</th>
</tr>
</thead>
<tbody>
<tr>
<td>BI</td>
<td>1.00</td>
<td>0.103</td>
<td>-0.147</td>
<td>-0.051</td>
<td>-0.115</td>
<td>-0.088</td>
<td>-0.140</td>
<td>0.906</td>
<td>0.219</td>
</tr>
<tr>
<td>CI</td>
<td>0.103</td>
<td>1.00</td>
<td>-0.061</td>
<td>-0.087</td>
<td>0.887</td>
<td>-0.206</td>
<td>0.083</td>
<td>0.147</td>
<td>0.062</td>
</tr>
<tr>
<td>IT</td>
<td>-0.147</td>
<td>0.061</td>
<td>1.00</td>
<td>0.116</td>
<td>0.223</td>
<td>0.177</td>
<td>0.193</td>
<td>-0.273</td>
<td>-0.722</td>
</tr>
<tr>
<td>TDI</td>
<td>-0.051</td>
<td>-0.087</td>
<td>0.116</td>
<td>1.00</td>
<td>-0.039</td>
<td>0.260</td>
<td>0.087</td>
<td>-0.187</td>
<td>-0.453</td>
</tr>
<tr>
<td>PI</td>
<td>-0.115</td>
<td>0.887</td>
<td>0.223</td>
<td>-0.039</td>
<td>1.00</td>
<td>0.024</td>
<td>0.383</td>
<td>-0.076</td>
<td>-0.104</td>
</tr>
<tr>
<td>LPI</td>
<td>-0.088</td>
<td>-0.206</td>
<td>0.177</td>
<td>0.260</td>
<td>0.024</td>
<td>1.00</td>
<td>-0.632</td>
<td>-0.113</td>
<td>-0.187</td>
</tr>
<tr>
<td>TPI</td>
<td>-0.140</td>
<td>0.083</td>
<td>0.193</td>
<td>0.087</td>
<td>0.383</td>
<td>0.632</td>
<td>1.00</td>
<td>-0.063</td>
<td>-0.017</td>
</tr>
<tr>
<td>MTI</td>
<td>0.906</td>
<td>0.147</td>
<td>-0.273</td>
<td>-0.187</td>
<td>-0.076</td>
<td>-0.113</td>
<td>-0.063</td>
<td>1.00</td>
<td>0.526</td>
</tr>
<tr>
<td>MCI</td>
<td>0.219</td>
<td>0.062</td>
<td>-0.722</td>
<td>-0.453</td>
<td>-0.104</td>
<td>-0.187</td>
<td>-0.017</td>
<td>0.526</td>
<td>1.00</td>
</tr>
</tbody>
</table>

Bolded numbers indicate statistical significance (p ≤ 0.05)
CI is more useful in breed diagnosis than in the definition of productive capabilities, since its variation is not influenced by environmental factors or handling (Sierra Alfranca; Parés-Casanova, 2009). In this study, we determined that CI statistically separated every breed from the others. COO presented the lowest value, with a head close to a square format, and at the higher belonged to TE, with an elongated rectangular head format. DO and SU were intermediate. The striking variation coefficients of TE, DO and SU were to a square format, and at the higher belonged to TE, with an intermediate. The striking variation coefficients of TE, DO and SU were to square format, and at the higher belonged to TE, with an intermediate.

Table II. Mean and standard deviation of morphostructural measurements in four sheep breeds of Chile.

<table>
<thead>
<tr>
<th>Index</th>
<th>TE Mean±SD v.c.</th>
<th>DO Mean±SD v.c.</th>
<th>COO Mean±SD v.c.</th>
<th>SU Mean±SD v.c.</th>
</tr>
</thead>
<tbody>
<tr>
<td>BI</td>
<td>68.08±5.02b</td>
<td>9.47</td>
<td>69.16±3.89b</td>
<td>5.63</td>
</tr>
<tr>
<td>CI</td>
<td>164.55±24.20a</td>
<td>14.71</td>
<td>82.27±7.30d</td>
<td>8.88</td>
</tr>
<tr>
<td>IT</td>
<td>91.80±7.67a</td>
<td>11.02</td>
<td>84.71±7.10b</td>
<td>8.38</td>
</tr>
<tr>
<td>TDI</td>
<td>19.17±4.18b</td>
<td>5.66</td>
<td>53.38±2.77a</td>
<td>5.14</td>
</tr>
<tr>
<td>PI</td>
<td>347.53±60.94a</td>
<td>14.20</td>
<td>165.50±15.85d</td>
<td>9.58</td>
</tr>
<tr>
<td>LPI</td>
<td>29.10±4.28b</td>
<td>9.27</td>
<td>31.46±2.91a</td>
<td>9.24</td>
</tr>
<tr>
<td>TPI</td>
<td>29.96±3.13a</td>
<td>9.14</td>
<td>28.55±2.03b</td>
<td>7.11</td>
</tr>
<tr>
<td>MTI</td>
<td>9.89±1.85b</td>
<td>21.54</td>
<td>9.68±0.77b</td>
<td>8.00</td>
</tr>
<tr>
<td>MCI</td>
<td>35.41±7.68c</td>
<td>25.07</td>
<td>37.13±2.94c</td>
<td>7.92</td>
</tr>
</tbody>
</table>

CI is more useful in breed diagnosis than in the definition of productive capabilities, since its variation is not influenced by environmental factors or handling (Sierra Alfranca; Parés-Casanova, 2009). In this study, we determined that CI statistically separated every breed from the others. COO presented the lowest value, with a head close to a square format, and at the higher belonged to TE, with an elongated rectangular head format. DO and SU were intermediate. The striking variation coefficients of TE, DO and SU were to a square format, and at the higher belonged to TE, with an intermediate.

CONCLUSIONS

The most important morphostructural relationships that contribute to explain the variability of the format of the four breeds of sheep studied were expressed by the metacarpal-thoracic index, the metacarpal-costal index, the thorax index and the bicostal index. Moreover, the breeds showed a high dispersion; the zoometric indices only partially explained the variability of the body format, expressing a high format heterogeneity in influential variables as the metacarpal-thoracic index, the metacarpal-costal index and the body index. This could be because these racial populations are subjected to processes of differentiation within each breed.

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To Consorcio Ovino S.A. and to sheep breeders, for their active collaboration.


RESUMEN: La forma del cuerpo de una población animal determina rangos de funcionalidad biológica y su uso productivo. En las ovejas, la productividad de la carne está muy relacionada con el tamaño del cuerpo del animal. Algunas razas de ovejas se utilizan en cruzamientos terminales para dar al cordero características dimensionales favorables, pero es necesario profundizar en el estudio de las relaciones entre morfoestructura y aptitud productiva de estas razas, ya que las discrepancias podrían deberse a los efectos del medio ambiente o al grado de la diferenciación entre la piscina original de diferentes razas y las poblaciones locales. Este trabajo tuvo como objetivo evaluar los caracteres morfoestructurales en cuatro razas de ovinos en Chile y la relación de la funcionalidad productiva con la arquitectura del cuerpo. Se utilizaron 278 ovejas, raza Suffolk Down, pertenecientes a Texel, Dorset, Coopworth. Se tomaron 11 mediciones en el cuerpo (circunferencia del corazón, ancho del lomo, rabadilla, ancho del cráneo, longitud del cráneo, diámetro esternal dorsal, diámetro bicostal, diámetro longitudinal, circunferencia de hueso de la caña, altura de cadera y altura a la cruz). Nueve índices zoométricos (índice corporal, índice cefálico, índice de tórax, índice de profundidad del tórax, índice de la pelvis, índice pélvico longitudinal, índice transversal de la pelvis, índice metacarpiano del tórax e índice metacarpiano costal) fueron determinados a partir de mediciones individuales. Las relaciones morfoestructurales más importantes que contribuyen a explicar la variabilidad del formato de las cuatro razas de ovejas estudiadas se expresaron por el índice metacarpiano-torácico, el índice metacarpiano-costal, el índice de tórax y el índice bicostal. Por otra parte, las razas mostraron una alta dispersión de los índices zoométricos que explican sólo parcialmente la variabilidad del formato de cuerpo, la alta heterogeneidad de formato en las variables influyentes como el índice metacarpiano-torácico, el índice metacarpiano-costal y el índice del cuerpo. Esto podría ser debido a que estas poblaciones raciales son sometidas a procesos de diferenciación dentro de cada raza.

PALABRAS CLAVE: Zoometría; Cruce; Oveja.
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