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Body-, protein- and essential amino acid composition of male Merino and Dohne Merino lambs

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Abstract

The weight and protein distribution, as well as the essential amino acid composition of the carcass, internal and external offal of Merino and Dohne Merino male lambs were investigated. Differences in the weight and protein distribution, as well as the essential amino acid composition of specific parts of the whole empty body illustrated the inadequacy of a single body component as a predictor of amino acid requirements for growth of lambs and also stressed differences in amino acid requirements between breeds.

Keywords: Amino acid, whole empty body, carcass, internal offal, external offal
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Introduction

The efficiency of protein utilisation is not only dependent on the quantity of protein, but also on the amino acid profile available for absorption (Cole & Van Lunen, 1994). A deficiency of a single amino acid will inhibit the responses to those in adequate supply (Cole & Van Lunen, 1994), while amino acids in excess to the limiting amino acid(s) will be degraded and excreted, with a subsequent wastage of energy and nitrogen (Cromwell, 1996). Therefore, the ideally absorbed amino acid supply must be available in the small intestine. Chen & Ørskov (1994) and Boisen *et al.* (2000) stated that the ideal protein represents the perfect ratio among individual amino acids that allow maximum utilisation efficiency and optimal performance.

According to the ARC (1981), the amino acid composition of lean meat could serve as an example of the amino acid balance of the ideal absorbed protein. In contrast, Loëst *et al.* (1997) and Ferreira *et al.* (1999) argued that because the carcass accounted for only 57% of the live weight gain and 47.8% of the incremental nitrogen deposition in growing South African Mutton Merino lambs, it might not be representative of the essential amino acid requirements for growing lambs.

This study was conducted to establish possible differences in weight, protein and essential amino acid distribution in the whole empty body of Merino and Dohne Merino male lambs. Secondly, the purpose was to determine whether the essential amino acid composition of any body component was representative of the whole empty body essential amino acid pattern of growing lambs.

Material and Methods

Five male Merino and Dohne Merino lambs each were slaughtered at average (± s.d.) respective live weights of 28.7 ± 1.2 kg and 29.7 ± 2.2 kg, and at a corresponding body condition score for both breeds of 2.4 ± 0.314. Five more male lambs of each breed were fed a feedlot diet (Nolte & Ferreira, 2004) and slaughtered at an average condition score of 2.8 ± 0.35. Body condition score was used to indicate slaughter, in order to ensure comparable physiological ages between the breeds. The final live weights for the Merino and Dohne Merino lambs receiving the feedlot diet were 43.2 ± 0.8 kg and 41.9 ± 1.4 kg, respectively. The lambs were weighed immediately before slaughter, exsanguinated and weighed again. A 500 mL blood sample was collected and frozen immediately for amino acid analysis with the internal offal. Blood volume was calculated by difference before and after exsanguination. The stomachs and intestines were emptied and washed with water to exclude digesta in the calculation of the whole empty body (WEB) weight (total body weight excluding digesta). Each organ and body part was weighed and the WEB divided into the carcass (warm carcass weight), internal offal (metabolic organs, empty gastro intestinal tract and blood) and external offal (head, feet, skin and wool). The carcasses were hung overnight at 4 °C and divided into two equal halves by cutting longitudinally through the median. The right halves and the internal and external offal were frozen at –20 ºC and milled separately through a carcass mill. A kg representative sample was collected from each component and fat extracted from a sub-sample with di-methyl ether (AOAC, 1995). The fat free components were frozen again at –10 ºC, lyophilised, and ground to pass a one mm screen. The blood samples were also lyophilised and proportionally added to the internal offal. These three components were analysed for Kjeldahl nitrogen (N) according to the AOAC (1995). Essential amino acid analysis on each component was done with a Beckman System 7300 amino acid analyser after 22 h of acid hydrolysis (6 N HCl) at 110 °C (AOAC, 1995). Analysis of variance was performed on the data, according to the GLM procedures of SAS (2000). The main effects were breed, carcass, internal offal and external offal. Weight and protein contribution were the response variables.

Results and Discussion

The contribution of the carcass to the total whole empty body weight did not differ between Merino and Dohne Merino lambs (P = 0.25; Table 1). However, Merino lambs had smaller relative internal offal and larger relative external offal weights than Dohne Merino lambs (22.5 *vs.* 25.4%; 26.7 *vs.* 22.8%; P ≤ 0.001). The larger external offal of Merino lambs might indicate a higher wool contribution.

The relative protein concentration of the Merino carcasses was lower (P = 0.03) than that of Dohne Merinos (Table 1). This result suggests that the Dohne Merino carcasses may have higher protein concentrations, since the relative weights of the carcasses from the two breeds did not differ. These values correspond well with results of MacRae *et al.* (1993), but were considerably lower than for goats (Ferreira; unpublished data). The Dohne Merino lambs had higher protein concentrations in the internal offal, but lower in the external offal than the Merino lambs (P ≤ 0.01). This trend supports a suggestion that Merino lambs might have a larger wool contribution in the external offal.

Table 1 The whole empty body composition and proportional protein contribution (LS Means ± s.e.m.) of the carcass, internal offal and external offal to the whole empty body of Merino (36.0 ± 7.3 kg) and Dohne Merino (35.8 ± 6.1 kg) lambs at a similar live weight

Item	Merino	Dohne Merino	s.e.m.	P
		Whole Empty Body Composition (%)		
Whole Empty Body	100	100		
Carcass	50.75	51.79	0.44	0.25
Internal Offal	22.54	25.38	0.46	< 0.001
External Offal	26.71	22.83	0.57	< 0.0001
		Protein contribution (%)		
Whole Empty Body	100	100		
Carcass	46.89	49.29	0.58	0.03
Internal Offal	24.27	26.93	0.59	0.01
External Offal	28.84	23.79	0.68	< 0.0001

For the Merino lambs the phenylalanine and valine concentrations did not differ between the carcass and external offal, and were lower than in the internal offal (Table 2). Leucine concentrations in the carcass and external offal and threonine levels in the internal and external offal of Dohne Merino lambs were similar.

Table 2 The essential amino acid concentrations (g EAA[1]/100 g crude protein) of the carcass, internal offal and external offal of Merino and Dohne Merino lambs (LS Means ± s.e.m.)

EAA[1]	Merino Carcass	Merino Internal Offal	Merino External Offal	Dohne Merino Carcass	Dohne Merino Internal Offal	Dohne Merino External Offal	s.e.m.
Arginine	6.91[c]	5.09[d]	9.24[a]	6.92[c]	5.33[d]	8.77[b]	0.21
Histidine	2.19[d]	5.02[a]	1.19[e]	2.42[c]	4.53[b]	1.14[e]	0.20
Isoleucine	3.86[a]	2.04[d]	3.07[b]	4.04[a]	2.27[c]	3.00[b]	0.10
Leucine	6.90[d]	11.25[a]	7.96[c]	7.21[d]	10.79[b]	7.22[d]	0.23
Lysine	7.14[c]	9.09[a]	4.01[d]	7.62[b]	8.78[a]	3.73[d]	0.28
Methionine	1.98[a]	1.40[c]	0.74[d]	2.06[a]	1.57[b]	0.74[d]	0.07
Phenylalanine	3.54[cd]	5.84[a]	3.66[c]	3.63[c]	5.59[b]	3.40[d]	0.13
Threonine	3.76[b]	4.56[a]	3.36[c]	3.85[b]	4.58[a]	4.55[a]	0.07
Tryptophan	1.04[c]	1.67[a]	0.75[d]	0.95[c]	1.33[b]	0.77[d]	0.05
Valine	4.68[bc]	7.82[a]	5.04[b]	4.32[c]	7.63[a]	4.84[b]	0.19

[1]Essential amino acid, [abcd] Row means with common superscripts do not differ ($P > 0.05$)

All the other amino acid concentrations between the components within each breed displayed remarkable differences. Lawrie (1991) also reported a lower incidence of sulphur-containing amino acids in connective than contractile tissue, which is supported by the methionine concentration in the components of both breeds. These results imply that different body components have characteristic amino acid patterns, confirming earlier suggestions to this effect by Bikker *et al.* (1994). This variation in the amino acid patterns of different body components emphasises the limitations of using a single body component as a predictor of the ideal protein requirement. In accordance, Boisen *et al.* (2000) reported that muscle protein is considerably lower in sulphur amino acids and threonine than endogenous protein and hair, which contributes to maintenance amino acid requirements, and therefore underestimates the respective amino acids. Ferreira *et al.* (1999) also reported that carcass essential amino acid concentrations of South African Mutton Merino lambs appeared to be a poor representation of the essential amino acid requirements for whole empty body growth.

It is evident that the carcass amino acid composition of Merino and Dohne Merino lambs is remarkably similar, differing only in histidine and lysine concentrations (Table 2). Internal offal between the two breeds displayed more differences and was only similar for arginine, lysine, threonine and valine. The external offal displayed differences in the concentrations of arginine, leucine, phenylalanine and threonine.

Conclusion

Although the carcass (of which the essential amino acid composition is remarkably similar for the two breeds) is the main site for protein deposition, it contributes less than 50% of the total whole empty body protein. The amino acid patterns of the remainder of the whole empty body differ from that of the carcass, as well as between breeds. Therefore, the whole empty body will present the most accurate estimate of the amino acid requirements for growth. Requirements may, however, differ between breeds. More research on the whole empty body amino acid composition of specific sheep breeds is required.

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