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Live weight parameters in Dorper, Damara and Australian Merino lambs subjected to restricted feeding

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Seasonal weight loss (SWL) is the most serious constraint to ruminant production systems in tropical and Mediterranean climates. SWL is usually controlled through the use of supplementation schemes that are costly and difficult to implement in extensive production systems in remote areas. Another alternative to hinder SWL is the use of sheep breeds that show a natural adaptation to tropical climates, namely hair and fat tailed sheep. Albeit a fifteen year presence in Australia, little is known on how Dorper and Damara sheep compare to the most widely used sheep breed in Australia, the Australian Merino, particularly in aspects related to productive performance. In this trial, the responses of the Damara, Dorper and Merino breeds to nutritional stress were compared during a 42 day trial in Merredin, WA, Australia. Seventy-two ram lambs, 24 from each breed, were randomly allocated to either a growth diet (gaining 100 g/day) or a restricted diet (losing 100 g/day, approximately 85% of maintenance). Animals were weighed twice weekly. Individual rations were calculated from bodyweight, with individual animals confined to eat their ration daily. The breeds were compared for bodyweight changes as a percentage of their initial weight for three periods (Days 0-10, 10-21 and 21-42). The only significant differences between breeds in the percentage growth rates were that the Damara breed lost more weight than the other breeds on the restricted diet during Days 10 to 21 and gained less weight on the growth diet during Days 21 to 42. For all other periods the Damara, Dorper and Merino breeds were not significantly different. By day 24 of the trial all breeds had stopped losing weight on the restricted diet. This trial concludes that under confined feeding of restricted and growth diets and considering the growth parameters, Damara, Dorper and Merino ram lambs perform similarly.

Live weight parameters in Dorper, Damara and Australian Merino lambs subjected to restricted feeding

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Abstract

Seasonal weight loss (SWL) is the most serious constraint to ruminant production systems in tropical and Mediterranean climates. SWL is usually controlled through the use of supplementation schemes that are costly and difficult to implement in extensive production systems in remote areas. Another alternative to hinder SWL is the use of sheep breeds that show a natural adaptation to tropical climates, namely hair and fat tailed sheep. Albeit a fifteen year presence in Australia, little is known on how Dorper and Damara sheep compare to the most widely used sheep breed in Australia, the Australian Merino, particularly in aspects related to productive performance. In this trial, the responses of the Damara, Dorper and Merino breeds to nutritional stress were compared during a 42 day trial in Merredin, WA, Australia. Seventy-two ram lambs, 24 from each breed, were randomly allocated to either a growth diet (gaining 100 g/day) or a restricted diet (losing 100 g/day, approximately 85% of maintenance). Animals were weighed twice weekly. Individual rations were calculated from bodyweight, with individual animals confined to eat their ration daily.

The breeds were compared for bodyweight changes as a percentage of their initial weight for three periods (Days 0-10, 10-21 and 21-42). The only significant differences between breeds in the percentage growth rates were that the Damara breed lost more weight than the other breeds on the restricted diet during Days 10 to 21 and gained less weight on the growth diet during Days 21 to 42. For all other periods the Damara, Dorper and Merino breeds were not significantly different. By day 24 of the trial all breeds had stopped losing weight on the restricted diet. This trial concludes that under confined feeding of restricted and growth diets and considering the growth parameters, Damara, Dorper and Merino ram lambs perform similarly.

Key words: Merino, Damara, Dorper, weight loss, growth traits

1. Introduction

Food restriction and seasonal weight loss (SWL) are the major constraints to animal production in regions with seasonal wet and dry periods, such as Mediterranean and Tropical environments (Almeida *et al.* 2006, 2007). The study of the adaptation to food restriction in domestic animals, particularly ruminants, can be a useful approach to identify novel options and approaches to animal selection. In particular, breeds and types that have evolved in regions where SWL is common could be well adapted to other areas of Mediterranean and Tropical climates.

The sheep grazing system in South-Western Australia, similarly to other regions of the world, particularly Southern Africa, the Mediterranean basin and South-West United States, face an extreme seasonal fluctuation in the quantity and quality of pasture on offer. During the Australian winter-spring (May to October) growing season the green pastures comprise a mix of annual grasses, such as annual ryegrass (*Lolium rigidum*), legumes, such as subterranean clover (*Trifolium subterraneum*), and broadleaf species, such as capeweed (*Arctotheca calendula*). The quantity is largely dependent on rainfall and ground temperature. Rainfall in the growing season peaks in June and July, and ground temperatures begin to increase in August leading into peak production in spring (September-November). Once the annual pastures begin to dry off in mid October, the liveweight gains and wool growth of grazing

sheep rapidly slow. This is due to a drop in the dry matter digestibility of the pasture, which by December can fall below 55%, resulting in an inability to maintain liveweight independent of the quantity of dry matter on offer (Stewart *et al.* 1961). Typically the digestibility of pastures reach a minimum of approximately 45% in March and the sheep are supplementarily fed with grain. This period of supplementary feeding is termed the autumn feed gap. Supplementation is an extremely expensive practise, particularly in resource-limited countries where it is frequently inaccessible. To cope with such problems several strategies are often suggested, namely the introduction of breeds that display some level of tolerance to nutritional stress.

In South-Western Australia sheep production has revolved around wool and meat production using Merino sheep breeds. Merino sheep introduced to Australia in 1804 has since then become the primary sheep breed for animal production (Massy, 2007). However, with declines in wool prices (Bardsley, 1994), increases in cereal grain cropping (Trewin, 2005) and welfare issues related to the *mulesing* practice (Rothwell *et al.* 2007), there has been an increased interest in alternate breeds. Particularly valued aspects include: tolerance to SWL and ability to adapt to harsh climates, absence of wool (or hair sheep with no shearing needs) that can satisfy local and export market needs. This situation is similar in several regions of the world that have relevant Merino based wool production sectors, namely the Iberian Peninsula, South Africa and Argentina. There is a wide variety of sheep breeds adapted to different environmental and production conditions. The Southern Africa Damara and Dorper are two of such sheep breeds that have recently gained an increased popularity under Australian conditions.

The Damara sheep is a large non-wool breed from southern Africa (SW Angola and Namibia). This breed has an accumulation of fat at the level of the hind-quarters and is therefore classified as fat tailed sheep, a group of animals particularly adapted to semi-desert conditions (Almeida, 2011a). The breed has been imported to Australia since the mid-nineties to produce lamb and mutton in semi-desert and low rainfall environments (von Wielligh 2001), with a special aim at the live-animal export trade, for the Middle East and Persian Gulf markets. Despite being present in the Australian sheep industry for 15 years, little scientific information is available regarding the productive characterization of the Damara in Australia, with the exception of wool

contamination issues (Fulwood *et al.* 2002). The Damara breed was the object of a recent review by Almeida (2011b).

The Dorper is a non-wool meat breed developed in South Africa as a composite breed combining the hardiness of the fat rump Blackhead Persian with the mutton production and carcass conformation capability of the Dorset Horn (Cloete *et al.* 2000). This breed has gained an increased popularity outside South Africa, and is now present in several semi-arid environments of the world. Previously, in South African productivity trials, the Dorper has been shown to reach slaughter weights earlier than Merinos, with a 44% higher average daily gain (Schoeman 2000). In Australia, however, little information is to be found in scientific literature regarding the performance of this breed, especially in comparison to other breeds.

Sheep that lose less weight during the autumn feed gap would be more desirable. Thus, the aim of this study was to determine whether the Damara and Dorper will lose less weight than the Merino sheep when fed a restricted diet designed to cause a weight loss of approximately 100 grams per day (85% of maintenance). The Damara and Dorper are also expected to gain more weight than the Merino sheep under a growth diet designed to cause a weight gain of 100 grams per day. To the best of our knowledge, it is the first time that such a study was conducted. The results obtained here are of relevance to extensive animal production systems in dry regions, in both Australia and other countries.

2. Materials and Methods

2.1 Location and Animals

The trial was carried out on the Merredin Dryland Research Institute in Western Australia (31 degrees 30.01 minutes S, 118 degrees 13.36 minutes E) from the 9th of October until the 21st of November 2007. Three sheep breeds, Damara, Dorper, and Merino, were compared across two nutritional treatments, a growth and restricted diet. Six month old Damara and Dorper ram lambs were obtained from registered stud breeders within the state of Western Australia. While six month old Merino lambs were sourced from a Department of Agriculture and Food Western Australia (DAFWA) research station. Twenty four lambs from each breed were randomly assigned to one of the two diets, in a total of 72 animals involved in the trial.

Australian (Western Australian Animal Welfare Act 2002 underpinned by the Australian Code of Practice for the Care and Use of Animals for Scientific Purposes 7th edition 2004) and European Union regulations (European Legislation n°86/609/CEE) and guidelines on care, use and handling of experimental animal were followed. All aspects of the experiment were monitored and approved by competent veterinary authorities of the State of Western Australia (Perth, WA, Australia 07ME06). Author A.M Almeida holds a FELASA (Federation of European Laboratory Animal Science Associations) grade C certificate, which enables designing and conducting animal experimentation under European Union standards.

2.2 Arrival and adaptation

The 72 animals comprising the three breeds arrived on the Merredin Research Station prior to their first weighing on the 23rd of September 2007. After weighing the animals were confined to a paddock of 5 hectares that had been chemically fallowed to remove all vegetative dry matter. For 10 days the animals had *ad libitum* access to water and the commercial feed pellet (Macco 101, Macco Feeds, Williams, WA, Australia) that was to be used for the duration of the trial in the paddock. The feed pellet used provided a nutritionally complete diet, with 9.3 mega joules (MJ) of metabolisable energy (ME) and 11.5% crude protein (CP), all the essential macro and trace minerals and vitamins, with adequate fibre length to encourage rumination and maintain good rumen health. The nutritional composition of the pellets is shown in Table 1.

Table 1: The composition of feed pellets fed to animals for the period of the trial and adaption periods.

Parameter	Macco 101 Pellet
Dry Matter (DM, % as received)	91.2
Crude Protein (CP, %)	11.5
Acid Detergent Fibre (ADF, %)	29.1
Digestible Dry Matter (DDM, %)	65.9
Metabolisable Energy (ME, MJ/Kg)	9.3
Phosphorus (P, g/Kg)	2.0
Potassium (K, g/Kg)	7.2
Sulphur (S, g/Kg)	2.1
Sodium (Na, g/Kg)	0.9
Calcium (Ca, g/Kg)	7.4
Magnesium (Mg, g/Kg)	1.6
Copper (Cu, mg/Kg)	7.0
Zinc (Zn, mg/Kg)	45
Manganese (Mn, mg/Kg)	75
Iron (Fe, mg/Kg)	306
Boron (B, mg/Kg)	8.0
All parameters, except Dry Matter (DM) expressed in Dry matter basis.	

The paddock was adjacent to the sheep yards where the weighing and trial feeding pens were located. To adapt the sheep further to the trial conditions a period of 6 days was allowed for the sheep to eat an individual maintenance ration while in individual feeding pens, purposely designed and build for the trial. All pens had a height of 1m, and had an area of 0.75m² (50 cm x 150 cm).

On the 3rd of October the sheep were weighed and a maintenance ration of feed for each individual was calculated using the Freer equation (see Equation 1 ; Freer *et al.* 2007), and then sheep were confined to individual pens for an hour to eat their feed. In between feeding sessions all animals were run as a single group and had continuous access to water in the bare paddock.

Equation 1:

$$ME_m(\text{MJ/d}) = KSM (0.28W^{0.75} \exp(-0.03A))/k_m + 0.1ME_p + ME_{\text{Graze}} + E_{\text{Cold}}$$

$K = 1.0$ for sheep and goats, 1.2 for *B. indicus*, or 1.4 for *B. taurus*;

$S = 1.0$ for females and castrates and 1.15 for entire males (rams, goats, bulls);

$M = 1 + (0.23 \times \text{proportion of DE from milk})$;

W = live weight (kg), excluding conceptus and, for sheep, the fleece;

A = age in years, with a maximum value of 6.0 , when $\exp(-0.03A) = 0.84$;

k_m = net efficiency of use of ME for maintenance;

ME_p = the amount of dietary ME (MJ) being used directly for production;

MEI = total ME intake (MJ);

ME_{Graze} = additional energy expenditure (MJ) of a grazing animal compared with a housed animal, divided by k_m ;

E_{Cold} = additional energy expenditure (MJ) when the ambient temperature is below the animal's lower critical temperature.

2.3 Nutritional treatments

The phases of the trial were assigned to capture the aspects of the relevant feeding regimes on growth of the animals.

Table 2: Assessment periods of the feeding trial.

Phase	Time Period	Date (2007)	Phase description
1	Day -16 to -7	23 rd September	Paddock adaptation
2	Day -6 to -1	3 rd October	Pen adaptation
3	Day 0 to 10	9 th October	Start of feeding trial
4	Day 10 to 21	19 th October	Start of double weighing
5	Day 21 to 42	30 th October	Adapted to diet

The maintenance ration (i.e. zero growth rate) was used from Day -6 (3rd October) was calculated in the Freer equation (Freer *et al.* 2007), for each individual using a standard reference weight of 60 kilograms.

At the end of the adaptation period the animals from each breed were randomly allocated after stratification on live weight to either the growth or restricted diet. At the start of Phase 3 of the trial the average weight of the sheep in the trial was 38.3kg. Table 3 describes the live weight characteristics of the animals used in the trial.

Table 3: General statistics for the three sheep breeds used in the trial; Damara, Dorper and Merino at the start of the feeding trial.

Start of Trial	Damara	Dorper	Merino
Mean live weight			
(kg)	42.5	38.7	33.5
Standard Deviation	7.1	7.0	4.6
Min (kg)	33.0	29.5	21.5
Max (kg)	57.0	57.5	42.5

Twelve animals per breed were allocated at random after stratification on live weight to a ration calculated to provide a growth rate of 100 g/day for the growing diet and a restricted diet growth rate of -100 g/day.

The animals were weighed twice a week, on Tuesdays and on Fridays. The weighing on the Tuesday was used to calculate adjustments to individual rations, and the Friday measure to allow additional observation of changes in bodyweight. From Day 10 animals were weighed at least twice at each weighing to obtain an average weight. If an individual varied more than 1kg between the two weightings, it was weighed again until a consistent representative weight was assigned.

Changes to the ration were made at 6 intervals: 9th to 16th October (days 0 to 7); 17th to 23rd October (days 8 to 14); 24th to 30th October (days 15 to 21); 31st October to 6th November (days 22 to 28); 7th to 14th November (days 29 to 36); and 15th to 22nd November (days 37 to 42). The requirement for a change in the amount of feed was based upon the rate of change in bodyweight meeting the target of 100g/day.

2.4 Measurements and euthanasia

The bi-weekly weightings were necessary for the calculation of the feed ration as well as the monitoring of the animals progress under their dietary regimes. In order to follow the progress of the trial, monitoring of the condition score when weighing was also performed. Condition score uses manual palpation of tissue cover (muscle and fat) over the backbone and the short ribs (loin) immediately behind the last long ribs. Importantly, assessors also integrate the shape/fullness of the eye muscle between the backbone and ends of the short ribs with their assessment of tissue cover to allocate a score between 1 (very thin) and 5 (very fat) (Jefferies 1961; Russel *et al.* 1969)

At the completion of Day 42 (20th November) weightings animals were transported via road to a licensed commercial Abattoir (Tammin, WA, Australia). On the 21st of November (day 43) the animals were pre-stunned and euthanized following commercial procedures.

2.5 Statistical Analysis

For each animal a linear analysis (broken stick), was fitted to the liveweights of each of the 72 animals allowing a different linear trend for the following periods: Days 0 to 10; Days 10 to 21; and Days 21 to 42. For each period, the percentage liveweight change between breeds was compared by analysis of variance using GenStat version 11 (Genstat, 2008). This was done separately for the restricted and growth diets. The weight analysis was performed on the percentage change in liveweight as conducted previously (Almeida *et al.* 2006; Almeida *et al.* 2004; Almeida *et al.* 2002), in studies comprising marked breed differences in live weight (Almeida *et al.* 2010). The percentage of feed refused from Days 0 to 42 was also compared between breeds by analysis of variance, and was also used as a covariate in the liveweight breed comparisons.

3. Results

The percentage of feed refused from Day 1 to 42 was not significantly different between breeds on the restricted diet, but the breeds did differ on the growth diet (Table 4). With the restricted diet most animals from each breed had zero refusals.

The feed intake of the restricted diet had little variation over the trial from Day 10 to Day 42, once the variation in the bodyweights was accounted for, as shown in Figure 1. The growth diet did show some changes in the intakes of the individual breeds; especially in the Merino breed early in the trial, and the Dorper at the end of the trial, as presented in Figure 1. Noticeable in Figure 1 is also a drop in feed intake on both diets for the period 30th of October until the 6th of November (days 21 to 28).

Table 4: Percentage of feed refusal during the 42 day feeding trial.

Breed	Restricted (%)	Growth (%)
Damara	0.7	9.8
Dorper	1.0	2.5
Merino	0.4	14.7
p-value	n.s.	< 0.001

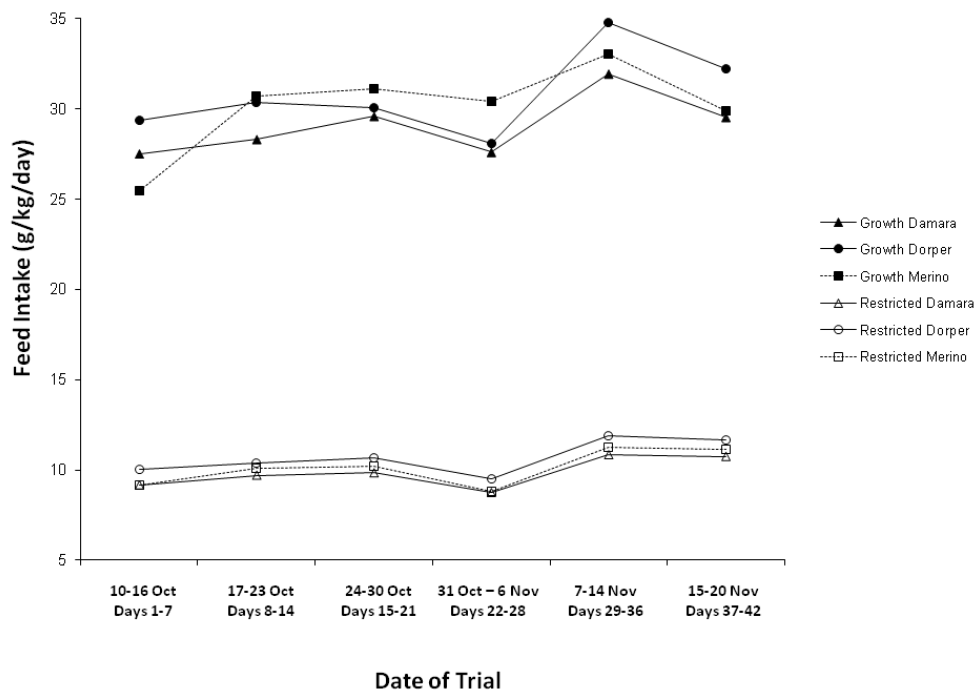


Figure 1: Intake of feed relative to bodyweight per day for the six periods with different dietary intakes.

With the analysis of liveweight change for the growth diet, percentage of feed refused was used as a covariate, as it had a weak relationship evident as lower growth from higher refusals.

As presented in Table 5, the sheep on the growth diet did not start growing until Day 10, with no difference between breeds for rate of growth. The final period from Days 21 to 42 had the highest growth changes, with the Damara breed having a significantly lower weight gain.

Table 5: Changes in body weights of the three breeds fed the growth diet and presented as percentages for each of the three time periods of the trial.

Breed	Day 0 to 10 (%)	Day 10 to 21 (%)	Day 21 to 42 (%)
Damara	-3.1	4.2	7.3
Dorper	-2.7	4.7	10.6
Merino	-1.0	5.7	10.9
p-value	n.s.	n.s.	< 0.05

As presented in Table 6, the sheep on the restricted diet lost more weight in the initial period of Days 0 to 10 than the growth diet, with no differences between breeds. In the second period from Days 10 to 21 the rate of weight loss had decreased with the Damara breed losing significantly more than the Dorper and Merino. In the final period from Days 21 to 42 the breeds were all gaining weight slightly, having adapted to the restricted diet, with no differences between breeds.

Table 6: Changes in body weights of the three breeds fed the restricted diet and presented as percentages for each of the three time periods of the trial

Breed	Day 0 to 10 (%)	Day 10 to 21 (%)	Day 21 to 42 (%)
Damara	-6.2	-6.0	0.9
Dorper	-8.2	-1.0	0.7
Merino	-11.4	-1.5	0.7
p-value	n.s.	< 0.05	n.s.

The change in the bodyweights of the breeds, from their introduction to the feed pellets, until the end of the trial, relative to their bodyweight at Day 0, is presented in Figure 2. The first ten day period of the adaptation period (day –16 to day -6) was a period of weight gain, with the sheep being introduced to the feed pellet in the paddock. The next six days growth became neutral, as they were introduced to feeding in pens on individual maintenance rations. The first seven days on the trial diets all breeds, regardless of restricted or growth rations, lost weight. The animals on the growth diet adapted to the diet by Day 10 and then growth can be seen. With the restricted diet all breeds had stopped losing weight by Day 24 of the trial followed by a plateau of bodyweight (Figure 2).

As stated earlier, statistical analysis was focused on the changes in relative liveweight for the 6 experimental groups. For merely descriptive purposes however, the evolution of liveweights of the animals is presented in Table 7.

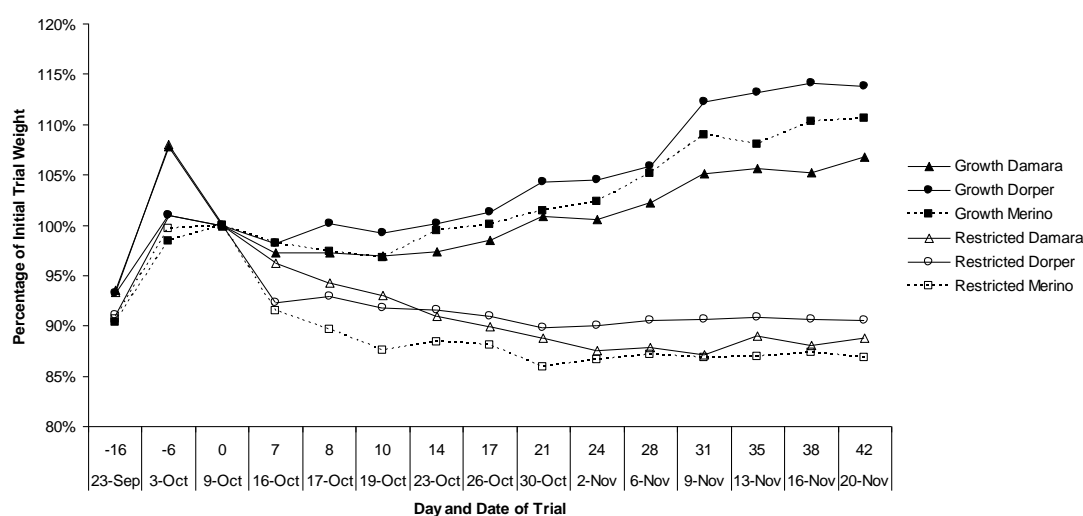


Figure 2: Changes (%) in bodyweight relative to Day 0 of the trial for the Damara, Dorper and Merino breeds assigned to either a restricted or growth diet. Measurements are indicated for the time period from the introduction to the feed pellet on the 23rd September until trial completion on the 20th November.

Table 7: Evolution of live weights (kg) for the Damara, Dorper and Merino breeds assigned to either a restricted or growth diet.

Day	Restricted Feeding Diet			Growth diet		
	Merino	Damara	Dorper	Merino	Damara	Dorper
0	32.90±4.9	42.00±7.0	37.90±6.0	34.20±4.4	43.10±7.4	39.50±7.9
14	29.08±3.4	38.18±5.5	34.71±6.1	33.96±4.5	41.95±5.9	39.60±8.4
31	28.60±3.3	36.60±5.3	34.37±5.9	37.90±5.0	42.27±5.7	44.40±7.7
42	28.60±3.1	37.30±5.3	34.30±5.6	37.70±4.5	46.00±5.6	45.00±7.5

4. Discussion

The Merino sheep breed has been the dominant breed in Australian agriculture since its introduction in 1804, with subsequent breeding programs adapting the Merino to the Australian conditions (Massy 2007). Interest in the South African meat breeds of the Damara and Dorper in Australia as possible alternatives better suited to the Australian autumn feed gap have until now, and to the best of our knowledge, been untested. The Damara and Dorper breeds are thought to be more adapted to nutritional stress than European breeds such as the Merino (Schoeman 2000; von Wielligh 2001, Almeida 2011b). In this trial we aimed to study differences in weight of these three sheep breeds under situations of weight loss and weight gain.

The bodyweight measures of the 3 breeds suggest that the only significant differences were when the Dorper and Merino were compared to the Damara breed. The Damara lost more percentage weight than the other two breeds on the restricted diet for the middle period of the trial (Days 10 to 21, Table 6). The Damara also grew less than the other breeds on the growth diet in the last period of the trial (Days 21 to 42, Table 5). However, the Damara did perform best in the initial period on the restricted diet (Table 6), although this was not significant due to the large variation in the individuals from all breeds in this period. On the growth diet, the breeds performed similarly for the first two time periods. In the final time period, Days 21 to

42, the Dorper and Merino grew at a similar rate, suggesting little difference between the two breeds.

The adaptation to the restricted and growth diets in the first week of the trial was very variable. In fact, while all the animals had been previously exposed to both the pen feeding and the pellets used in the trial, according to general guidelines for farm animal experimentation, the change to the new daily intakes saw an approximate halving of the intakes of animals on the restricted diet and an approximate doubling of the intakes for the growth diet. This large change would have been better spaced out over a week, to allow the animals to adjust their intakes to achieve the growth/loss targets of 100 g/head/day. As a result individual weights varied greatly for the first ten days. This was due to the adaptation to the new diets. The animals on the growth diet would only consume part of their feed one day and then all of it the next day (averaging out to the weekly averages presented in Figure 1). This affected the measurements in that the dry pellets would encourage greater water consumption on the days of higher feed consumption.

The refusals of feed were mostly confined to the growth diet, but there were minimal amounts of feed not eaten by the animals on the restricted diet (Table 4). Differences in refusals of feed were only seen on the growth diet, with Merinos refusing the most and Damaras the second most. The initial week had many individuals refusing, as their presented feed intake had approximately doubled from the previous week. Over the course of the trial refusals became less frequent individually, although still not uncommon amongst the Damara and Merino breeds. There are several possible causes of refusals for the periods of Days 10 to 21 and 21 to 42. The amounts of the dry feed pellet provided to the growth group was more than animals would typically consume in one time period, as their intake would normally be spaced out over the course of a day. The feed amounts were also based upon allocated target growth rates for the animals, and did not account for daily satiety levels. Animals may have eaten enough feed on previous days and required less on subsequent days. The individual daily refusals suggest that this could be a possible explanation, as few animals regularly refused feed in a week after Day 10.

As previously described (Greeff et al., 1986a, 1986b), up to a certain level, sheep have been reported to adapt to restricted diets and to not continue to lose weight. Data obtained in this study seem to confirm this observation, as by Day 24 all breeds had stopped losing bodyweight on the restricted diet. This suggests that the Damara,

Dorper and Merino sheep breeds are all adapted to periods of nutritional stress, but also that they down-regulate their metabolism to allow survival on a restricted intake. Changes in metabolism have been evidenced previously in mammals exposed to nutritional conditions below standard requirements. This leads to differences in the activity of metabolic enzymes, protein and metabolic profiles (Almeida *et al.* 2006; Almeida *et al.* 2004; Cardoso and Stock 1998; Moibi *et al.* 2000; van Harten *et al.* 2003). These differences may be due to the expression of different genes and subsequently proteins under nutritional stress. Studies in mice muscle cells indicate that more than 94% of the expressed genes did not change in feed restriction conditions, but rather the pattern of gene expression (Jagoe *et al.* 2002).

The similarity between the Australian Merino and the meat breeds of the Damara and Dorper under this nutritional trial suggest that the Merino performs similarly to periods of nutritional stress as breeds from arid climates. The breeding of the Merino in Australia since 1804 (Massy 2007) has resulted in a hardy breed showing some similarity to breeds from arid climates. The lack of pasture for grazing during summer and autumn in the Mediterranean regions of Australia provides a period of nutritional stress for sheep, which is obviously similar enough to arid areas for a similar level of adaptation. Without any distinct advantage of the Damara or Dorper over the Merino under a restricted or growth diet, the breeds must be chosen on their fit to the farming system. The dual enterprise production of the Merino, producing both wool and meat, seems to display a distinct advantage over the Damara and Dorper breeds that are hair sheep (Kilminster and Greeff, 2011).

There are, however, aspects that require research in future nutritional stress trials for industry applicable results. This current trial was run over 42 days, which is significantly shorter than the feed gap period which lasts several months. While adaptation to the restricted diet was seen in this trial period, a longer trial period to investigate responses would elucidate further breed responses to nutritional stress. Additionally, the breeds may also be compared by blood lines, so as to compare robustness of lines developed by the industry. Finally, it would be very important to describe the carcass characteristics resulting from the conditions of this trial, which will be the objective of a subsequent paper. Additional information on the economics aspects of a putative substitution of the currently available large Merino flock by meat producing hair sheep, would also be interesting, particularly considering the

conditionings such as mulesing, high shearing costs and inadequacy of Merino carcasses to major importing markets.

Previous productivity comparisons of Dorper to Merinos have contrasted forage ability (Brand 2000). Comparison of the three breeds for their productivity when foraging under Australian conditions would be a necessary knowledge for the sheep industry. Further research on growth rates and production under differing management conditions to effectively understand production efficiency would provide valuable information for sheep production in dry areas and feedlots worldwide.

5. Conclusion

This trial concludes that under confined feeding of restricted and growth diets and considering the growth parameters, Damara, Dorper and Merino ram lambs have similar growth evolutions. These results seem to be contrary to the general accepted hypothesis that fat tailed breeds such as the Damara have a higher tolerance to nutritional stress (Almeida, 2011b). Nevertheless, Damaras are reputed for having higher browser ability than European or composite breeds such as Merino or Dorper (Almeida, 2011b). Further research, in the form of field trials using production conditions, is therefore needed in order to assess if such browser aptitude is strongly related with tolerance to nutritional stress. Additionally, it would be extremely important to compare the effect of food restriction in the three breeds, specifically at the level of carcass and meat traits (Almeida et al., 2006), as well as other physiological measurements related to the nitrogen (Almeida et al., 2004; Almeida et al., 2010) and lipid metabolism (van Harten et al., 2003).

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