CARCASS AND EATING QUALITY OF SHEEP GRAZING
SALTBUSSH BASED SALINE PASTURE SYSTEMS

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DECLARATION

I declare that this is my own account of my research and contains its main content work which has not been submitted for a degree at any tertiary educational institution.

..........................................................

Kelly Lynne Pearce
Abstract

Forage halophytes such as saltbush (*Atriplex* spp) are being widely used to revegetate Australian saline land and can also provide a medium quality fodder source. There is widespread anecdotal evidence that sheep grazing on saltbush are leaner, tastier and juicer. This thesis investigated the potential to produce a high quality carcass with improved eating quality from grazing sheep on saltbush on saline land.

The first experimental chapter in this thesis details an animal house experiment investigating the carcass, eating and wool quality and physiological responses of sheep ingesting a 60:40 dried saltbush (*Atriplex nummularia*):barley grain (S+B), ration verses a 33:25:42 lupin grain:barley grain:oaten hay ration (Control, C) for 10 weeks prior to commercial slaughter (Chapter 4). Subsequently, two field experiments were conducted to examine the effects of grazing saltbush on saline land compared to dry senesced pasture on carcass and eating quality of lambs (Goomalling 2003) and hoggets (Wickepin 2004) (both chapter 6) for 14 weeks. Both chapters demonstrated that the ingestion of saltbush resulted in significantly less fat and in the 2 field experiments the ingestion of saltbush resulted in more lean on the carcass compared to sheep grazing a stubble/pasture (control) ration. These are positive findings for processors as costs of fat denudation are high so the lower the fat content and for farmers because less fat is deposited on the carcass per unit of liveweight gain. The decreased deposition of fat was attributed to the higher protein:energy ratio available for production, secondary compounds in saltbush and lower circulating insulin and higher growth hormone of the S+B fed sheep compared to the control fed sheep. Further work is needed to determine if these beneficial improvements in carcass composition can be achieved without compromising animal production. The long term grazing of saltbush did not result in commercially desirable hot carcass weights unless the sheep were
supplemented with a high energy source such as barley. The low growth rates are attributed to a decreased availability of energy substrates, low feed intake and increased energy output of sheep fed high salt diets. The low energy intake of the S+B fed sheep also resulted in a significantly lower percentage of unsaturated fat and unchanged levels of saturated fat in the fat depots compared to the C treatment.

Consumer taste tests conducted on meat from experiments in both chapter 4 and 6 indicated no difference between the treatments for any of the eating quality traits assessed. This can be considered a positive result as sheep can be finished on saltbush without any detriment to eating quality. High vitamin E levels in the meat may have also prevented the development of rancid flavours and aroma. It can be speculated that saltbush does not impart beneficial flavour and aroma volatiles as previously thought; instead the high vitamin E levels inhibit off-flavour and aroma development compared to meat from sheep grazed on dry pasture.

The long term ingestion of saltbush also resulted in significantly lower urine specific gravity (USG), muscle dry matter and higher urine weights suggesting that the saltbush fed sheep had a better hydration status compared to control fed sheep. However, this finding did not correspond with higher hot carcass weight or dressing percentages. The increases in muscle fluid content of the saltbush fed sheep were attributed to changes in body composition. The saltbush fed sheep had a higher lean and lower fat content which corresponded with a greater body fluid content as found in the animal house study.

Under conditions where the body composition of sheep remains the same, the use of short term strategic feeding of components of saltbush was investigated (mimicked in the form of salt and betaine) to reduce dehydration and subsequent reductions in carcass weight and dressing.
percentages (Chapter 7). Salt and or betaine were fed for 1 week either prior to a 48 h period of water deprivation or prior to 48 h commercial slaughter process where water was available in lairage from 24-48 h. Under both scenarios the diets did not result in improved dressing percentages, hot carcass weights, muscle dry matter or muscle weights. The ingestion of high salt diet prior to slaughter, did increase fluid retention in the extracellular spaces prior to slaughter however by 48 h both groups were at a similar physiological and therefore similar hydration status. Therefore similar levels of fluid were present in the muscles and no difference in carcass weight or dressing percentage could be expected. An important observation from the second experiment was that the high salt group drunk more water than the low salt fed sheep but the low salt group consumed fluid in lairage also. The low salt fed sheep may have been encouraged to drink water after observing the frequent drinking patterns of the high salt group.

This thesis has also shown that saltbush contains high levels of vitamin E (α-tocopherol) (193 mg/kg dry matter). As a result the concentration of α-tocopherol in plasma, liver and muscle of the saltbush fed sheep was elevated compared to those grazing dry pasture. The high muscle concentrations of vitamin E in the saltbush-grazed sheep resulted in improved meat colour stability. The high vitamin E levels did not influence the drip and cooking loss of the meat despite a decrease in the muscle dry matter of the meat. The browning of meat and increased drip loss results in large losses to the meat industry due to value deterioration at the supermarket. There is also great potential for the high vitamin E content in saltbush to be used for the prevention of nutritional myopathy instead of using expensive and labour intensive synthetic supplements.

In conclusion, this thesis has provided an insight into the carcass and eating quality of sheep grazed on saltbush based saline pasture systems. The most significant findings were that
ingesting saltbush can reduce the carcass fat content, improve meat colour stability and not result in any detriment to eating quality. A potentially useful way to incorporate these results into an Australian farming system may be to use saltbush on a short term basis, not for the length of period grazed in this thesis. The short term use of saltbush should provide sufficient grazing time for an elevation of vitamin E levels in the muscle to improve meat colour stability, increase the amount of lean and decrease fat levels of a carcass all without changing eating quality and decreasing liveweight. Further work is needed to ensure that these benefits can be achieved without compromising animal production. The opportunity to utilise saltbush to produce leaner carcasses with better colour stability may encourage farmers to consider previously unproductive land planted to saltbush to be a highly useful enterprise.
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And finally, who can forget the 400 sheep that died for the sake of this thesis….
### List of abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>CWG</td>
<td>Clean wool growth</td>
<td>SM</td>
<td>musculus semimembranosus</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(Semimembranosus muscle)</td>
</tr>
<tr>
<td>DXA</td>
<td>Dual x-ray absorptiometry</td>
<td>ST</td>
<td>musculus semitendinosus</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(Semitendinosus muscle)</td>
</tr>
<tr>
<td>FER</td>
<td>Fractional excretion rate</td>
<td>USG</td>
<td>Urine specific gravity</td>
</tr>
<tr>
<td>GH</td>
<td>Growth hormone</td>
<td>VFA</td>
<td>Volatile fatty acids</td>
</tr>
<tr>
<td>IGF</td>
<td>Insulin-like growth factor.</td>
<td>PUFA</td>
<td>Polyunsaturated fatty acids</td>
</tr>
<tr>
<td>LL</td>
<td>musculus longissimus thoracis et.</td>
<td>NSW</td>
<td>New South Wales</td>
</tr>
<tr>
<td></td>
<td>lumborum (also referred to as the Loin)</td>
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<td></td>
</tr>
<tr>
<td>ME</td>
<td>Metabolisable energy</td>
<td>SA</td>
<td>South Australia</td>
</tr>
<tr>
<td>N</td>
<td>Nitrogen</td>
<td>CP</td>
<td>Crude protein</td>
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