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Review

The role of saltbush-based pasture systems for the production of high quality sheep and goat meat☆

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ABSTRACT

This review examines the roles of halophytic forage shrubs such as saltbush (*Atriplex* spp.) in the production of high quality sheep or goat meat. It is apparent that saltbush-based pastures have the potential to produce a carcass with proportionately more carcass lean (with less fat) and boost muscle vitamin E to levels that benefit meat colour stability. With careful consideration of production targets to minimise liveweight loss, this review has outlined potentially useful ways in a farming system to generate these meat quality benefits. Significant research is needed to understand the grazing conditions and periods needed to positively alter carcass composition and boost vitamin E levels above the threshold needed for benefits to meat colour without compromising animal production and eating quality. Difficulties arise because forage halophytes are associated with low to moderate energy values, so they are incapable of supporting the levels of liveweight gain required to produce commercially desirable carcass weights, unless the animals are supplemented with either high quality pasture or grains. This review has highlighted the untapped potential for the goat meat industry to derive a meat product from halophytic forage shrubs. Goats may have an increased potential for liveweight gain and higher carcass lean and achieve a similar elevation in muscle vitamin E levels to sheep because of their browsing ability.

1. Introduction

Halophytic forage shrubs such as saltbush (*Atriplex* spp.) are grown for ruminant feed across a range of saline and arid production environments where they are generally used as a drought reserve or to fill annual feed shortages within grazing systems (Le Houerou, 1992). For example, saltbush fodder is used to fill the summer/autumn feed gap typical of Mediterranean-type climates in southern Europe (Papanastasis et al., 2008), Syria (Osman et al., 2006) and Australia (Morcombe et al., 1996), and to fill an early winter feed shortage in the Mendoza plain area of Argentina (Guevara et al., 2003). In other systems saltbush fodder is integrated into the diets of animals throughout the year (Abu-Zanat, 2005; Ben Salem et al., 2008). The most commonly planted species is reported to be oldman saltbush (*Atriplex nummularia*) (Vallance, 1989). While saltbush is used extensively, a number of grazing studies have demonstrated that sheep can not maintain liveweight on saltbush alone (Wilson, 1966; Ben Salem et al., 2008; Pearce et al., 2008a). The ability of animals to grow when grazing saltbush-dominat pastures is limited by low digestible energy levels and high salt levels (often in excess of 25% DM) which limits intake (Masters et al., 2001; Norman et al., 2010) and the leaves and stems provide a low to medium quality fodder source all year round on marginal land (see Masters et al., 2001) for review on the nutritional value of

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Atriplex with the most widespread plantation stands based on *Atriplex nummularia* (Vallance, 1989).

There is widespread anecdotal evidence from Australian pastoralists that sheep with access to native saltbush produce carcasses that are leaner and the meat from these animals is thought to be more tender, tastier and juicer (Anon, 1996). These claims have resulted in the establishment of several niche brands in Australia. Similarly in France the meat from lambs grazing salt-tolerant pastures regularly flooded by seawater is renowned for its particular flavour (Prache, 2007) and is branded as 'Agneau Pre-Sale' (salt-marsh lamb). In this system, brand compliance requires that the lambs must be finished according to specific specifications (Prache, 2007).

Despite these anecdotal claims and the increasing areas planted to saltbush, there has only been modest research to assess the carcass and eating quality of meat from sheep fed saltbush and even less from goats grazing saltbush. Is it really possible to utilise these currently unproductive and marginal areas of land to produce a high quality meat product? Recent research in Australia suggests that utilising saltbush-based pasture systems for meat production may present an invaluable opportunity to diversify a farm enterprise. Firstly, the important traits for high quality sheep and goat meat products within the Australian (and possibly international) context are:

- High carcass weights: for sheep, a carcass weight of above 18 kg is desirable with some markets requiring a 23 kg+ carcass. For goats, the carcass weight is 14 kg on average for the Australian domestic market (Goat Industry Council of Australia, 2008).
- Optimal carcass composition: Carcass composition is the proportion of lean (protein) and fat in a carcass. Processors desire a high protein and low fat content. The costs of fat denudation are high so the lower the fat content, the higher the profit per animal (e.g. Hopkins, 1995). For farmers there are feed (energy) savings from producing leaner carcasses (Warriss, 2000). Consumers also prefer to purchase meat with less visual fat (Hopkins et al., 1985) despite a positive correlation between eating quality and fat content (Thompson, 2002). By contrast to sheep, the inherent leanness of goat carcasses (Toohey et al., 2008) means they do not require extensive trimming during processing.
- Optimal eating quality: including tenderness, juiciness and flavour.
- Meat that stays redder in colour on supermarket shelf for longer (Morrissey et al., 2008) resulting in less value deterioration as a result of product price markdown, product conversion and rework, product discard, lowered stock inventory, and inefficient use of labour.
- Meat with healthy attributes, higher vitamin content, less saturated fat and higher omega-3 fatty acid content (National Health and Medical Research Council, 2006).

This paper is a review of recent literature on the potential for systems based on forage halophytes to produce a high quality sheep or goat meat product. As much of the research in this area is dominated by the use of saltbushes, this review focuses on the place that these shrub species can play in meeting the commercial criteria outlined above.

2. Can optimal carcass weights and liveweight gains be achieved from saltbush-based pasture systems?

2.1. Achieving necessary hot carcass weights

A number of studies have demonstrated that halophytes such as saltbush are an ineffective system for finishing lambs to commercially desired carcass weight (Pearce et al., 2008a). The literature suggests that saltbush alone will only support maintenance of liveweight (Warren et al., 1995; Morcombe et al., 1996; Warren and Casson, 1996). This response can be attributed to a low to moderate availability of energy substrates, low voluntary feed intake, the reduction in digestibility associated with high salt diets and the energy that is required process high salt diets (Pearce et al., 2008b). Voluntary feed intake of saltbush forage is limited by salt accumulation. Sheep stop eating high salt forage after they have ingested approximately 200 g of salt in a day (Masters et al., 2005). The concentration of salt in saltbush ranges from 154 to 350 g/kg EDM (edible dry matter) (Beadle et al., 1957; Watson et al., 1987), although values greater than 250 g/kg DM are more commonly reported. Oxalates and high sulphur accumulations are also likely to impact on voluntary feed intake and performance (Norman et al., 2004). Abou El Nasr et al. (1996) found that ensiling saltbush could lead to increased growth rates however this is not a practical approach for extensive grazing systems.

Saltbushes comprises of high levels of crude protein (14–19%) (Wilson, 1966; Norman et al., 2004) however much of the nitrogen is associated with non-protein compounds such as nitrates, glycinebetaine and proline. These non-protein compounds may be converted into microbial protein in the rumen, but the extent to which this occurs depends on the availability of metabolisable energy. In the absence of energy, these compounds are converted to ammonia in the rumen, which is absorbed by the animal, converted to urea and excreted in the urine. Feeding a high-energy supplement can improve the feeding value of saltbush pastures by providing energy to ruminal microbes to produce microbial protein, stimulate carbohydrate digestion and detoxify secondary compounds (Hassan and Abdel-Aziz, 1979; Benjamin et al., 1992; Mayberry et al., 2008; Norman et al., 2008). Supplements including grains and hay and the inter-row species (plants growing between the rows of saltbush) such as grasses and clovers provide an increased biomass and metabolisable energy intake for an animal grazing saltbush (Atiq-ur-Rehman et al., 1999). It must be noted that use of inter-row pastures species alone to supplement saltbush is unreliable as low rainfall years may result in reduced growth and nutritive value of these plants and these inter-row species are also of low nutritive value during summer and autumn (Atiq-ur-Rehman et al., 1999). This same scenario exists where saltbushes are grown in rangelands and where there are many other interspersed plant types including native grasses and shrubs (Vallance, 1989). In the situations where sheep are grazed more intensively on areas of saltbush plantations they need to be supplemented with hay and or