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Weaner lambs perform better on saltbush if their mothers grazed saltbush while pregnant

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Abstract. Grazing sheep on saltbush (*Atriplex* spp.) is one of the few ways that farmers in southern Australia can make use of saline land on their farms. Saltbush is a halophytic shrub containing about 20% salt. Grazing pregnant ewes on saltbush can lower supplementary feeding costs during autumn. In rats, high dietary salt during pregnancy can have long term consequences on the offspring's physiology. If similar responses occur in lambs from ewes grazing saltbush, we would expect them to have a lower plasma renin activity (PRA) in their first month of life which may affect their renal development and alter the way they perform on a high salt diet in later life. The experiment involved two treatment groups of lambs whose mothers were fed different diets in the last three months of pregnancy and three weeks after birth: (i) pasture lambs – born to ewes that grazed a clover-based pasture and supplemented with lupins; and (ii) saltbush lambs – born to ewes that grazed saltbush and supplemented with barley. The PRA of ewes grazing saltbush was lower than the control ewes at 130 days gestation ($P < 0.001$). The PRA of the ewe's progeny were not different at birth, however at 3 weeks old, the PRA of saltbush lambs was lower than the control lambs ($P < 0.001$). When the lambs grazed saltbush at 8 months of age, the saltbush lambs gained weight, whereas the pasture lambs lost weight ($P < 0.05$). It is likely that the kidney function and salt balance of the saltbush lambs has been altered by the lower PRA early in life which enables them to cope better with high salt diets, such as saltbush.

Keywords. High salt diet – Pregnancy – Saltbush – Renin – Ewe – Lamb.

Les agneaux sevrés et recevant de l'atriplex ont de meilleures performances si leurs mères pâturent l'atriplex pendant le stade de gestation

Résumé. *L'exploitation des parcours d'*Atriplex *spp. par les ovins est l'une des rares voies à la portée des éleveurs du sud d'Australie permettant de valoriser les terres riches en sel. Les atriplex sont des arbustes halophytes contenant environ 20% de sel. L'exploitation des plantations d'atriplex par des brebis en gestation constitue une alternative simple permettant de réduire le coût d'alimentation du cheptel ovin en automne. Chez les rats en gestation, un régime riche en sel peut avoir des conséquences à long terme sur la physiologie des ratons. Si des réactions analogues se présentent chez les agneaux issus de brebis conduites sur parcours d'atriplex, ces agneaux devraient donc faire état d'une faible activité rénine plasmatique (ARP) au cours de leur premier mois d'existence. Cela peut affecter le développement de leurs reins et leurs performances en présence d'un régime riche en sel plus tard au cours de leur vie. Cette expérience a porté sur deux groupes d'agneaux dont les mères ont été soumises à un régime différent au cours des trois derniers mois de gestation et trois semaines après la mise bas : (i) agneaux au pâturage – les mères ont été nourries par le trèfle et le lupin ; et (ii) agneaux sur parcours d'atriplex – les mères recevaient l'atriplex et l'orge. L'activité rénine plasmatique des brebis conduites sur parcours d'atriplex était inférieure à celle des brebis de contrôle après 130 jours de gestation ($P < 0,001$). L'activité rénine plasmatique des agneaux était identique à la naissance. Toutefois, à trois semaines d'âge, l'ARP des agneaux sur atriplex était inférieure à celle des agneaux du lot témoin ($P < 0,001$). A huit mois d'âge, les agneaux sur atriplex ont gagné du poids alors que les agneaux au pâturage ont maigri ($P < 0,05$). Il semble que la fonction rénale et le taux de sel des agneaux conduits sur parcours d'atriplex ont été altérés par une ARP plus faible plus tôt, ce qui leur a permis de mieux réagir en présence d'un régime riche en sel.*

Mots-clés. *Régime riche en sel – Gestation – Atriplex – Rénine –Brebis – Agneaux.*

I – Introduction

Sheep lose weight or, at best, maintain weight when grazing saltbush, a halophyte shrub that contains about 20% salt (Casson *et al.*, 1996). The high salt content challenges the sheep's renal capabilities such that the intake of organic matter is limited. Evidence in rats suggests that, if mothers consume high salt during pregnancy, their offspring's physiology will be altered such that they will be better able to cope with a salt load than their mothers. The mechanism for increased tolerance to salt is unknown. In the mother, high salt reduces the activity of the renin-angiotensin system (RAS) which may affect their offspring.

The RAS is important for blood pressure control and salt balance. Renin is the rate limiting enzyme in the RAS and its release is affected by salt balance in the body and the activity of the sympathetic nervous system (Reid and Chiu, 1995; Beierwaltes, 2003). Renin plays a pivotal role in renal development, therefore it is most active at birth when the kidney is rapidly adjusting to extra-uterine life (Pipkin *et al.*, 1974; Balbi *et al*., 2004). If pregnant animals are fed a high salt diet, their RAS will be lower which may, in turn suppress the RAS activity of their offspring, causing renal abnormalities (Ingelfinger *et al.*, 1998; Guron and Friberg, 2000; Dodic *et al*., 2001; Lefroy, 2002). Some of these abnormalities may be a faster rate of salt excretion and a lower water intake, which would allow the animal to tolerate a high salt diet better. If this is the case, lambs born to mothers grazing saltbush may cope better with the high salt content of saltbush when grazing it in later life. In this experiment we tested the hypothesis that pregnant ewes grazing saltbush would have lower renin activity than ewes grazing clover-based pasture and, subsequently, their lambs would also have a lower renin activity at birth and 3 weeks after birth. We also hypothesized that lambs from ewes that grazed saltbush during pregnancy would gain more weight when grazing saltbush than lambs born to mothers grazing pasture during pregnancy.

To test these hypotheses, ewes grazed either saltbush or clover-based pasture from day 60 of gestation to 3 weeks into lactation. The treatments were imposed in the last 3 months of gestation and 3 weeks after birth because this is the critical period for kidney development in the offspring (Roseboom *et al.*, 2001). The last 3 months of pregnancy in ewes also coincide with autumn, which is the time farmers usually graze their sheep on saltbush (Bathgate and O'Connell, 2001). After 3 weeks of age, lambs from both treatments grazed together until 8 months of age, and then they all grazed saltbush for 2 months. The results presented in this paper are preliminary and form part of a larger experiment on the physiological consequences on the offspring from mothers consuming a high-salt diet during pregnancy.

II – Materials and methods

Seventy ewes aged 2 years were artificially inseminated in January to the same sire. They were pregnancy scanned at day 55 of pregnancy and, until treatments began at day 60, they grazed the clover-based pasture. Ewes from each treatment were divided into 3 groups, 2 of single bearing ewes (12 ewes in each) and 1 group of twin bearing ewes (11 ewes).

1. Saltbush ewes

The 3 groups of saltbush ewes were rotationally grazed on 12, 1 hectare, saltbush plots. From day 60 to day 108 they were grazed on River saltbush (*Atriplex amnicola*) and, from day 108 to week 3 of lactation, they were grazing Oldman saltbush (*Atriplex nummularia*). Ewes grazing saltbush were supplemented with barley to meet their energy requirements to maintain their conceptus-free weight throughout pregnancy (SCARM, 1990).

2. Pasture ewes

The two groups of single-bearing ewes in the pasture treatment were grazing a subterranean clover-based pasture in two separate plots. These ewes were supplemented with lupins to try to

match the higher protein intake of the saltbush ewes. The twin group was grazing crop residue (stubble) and supplemented with lupins and barley to maintain their conceptus-free weight (SCARM, 1990).

The diets of the treatment groups were designed so there would be little difference between them in protein and energy content (approximately 14% crude protein and 11 MJ/kg energy). Ewes were weighed every two weeks and the level of supplementary feeding was adjusted according to weight change. Therefore, all ewes maintained their conceptus-free weight throughout pregnancy and lactation. Ewes were blood sampled at day 130 of gestation. Within 24 hours after birth lambs were weighed and 5-10 ml of blood was taken from the jugular vein of the lambs. Lambs were again blood sampled when they were taken off the treatments at 3 weeks of age. All blood samples were put in ice, centrifuged for 15 min at 3500 rpm and frozen at –20°C until analysed for plasma renin activity using a commercially available kit (DiaSorin, GammaCoat Plasma Renin Activity).

Ewes and lambs were taken off their treatments after week 3 of lactation and grazed together in a sub-clover/ryegrass based pasture. Lambs were mulesed at 5 weeks of age and weaned at 4 months. Lambs were grazed together on sub-clover based pasture until 8 months of age when they were moved onto saltbush plots. All lambs grazed river saltbush for 1 month, then grazed Oldman saltbush for 1 month. Lambs were weighed before grazing saltbush and 10 days after they came off the saltbush plots to allow the amount of water in their body to return to normal levels for a more accurate reflection of actual body weight.

Analysis of variance (ANOVA) was calculated using the statistical program Genstat with the diet of the mother used as the explanatory variable (saltbush or pasture).

III – Results and discussion

The plasma renin activity of the ewes grazing saltbush was lower ($P < 0.001$) than ewes grazing pasture on day 130 of pregnancy (Table 1). This supports the hypothesis that the renin-angiotensin system of ewes grazing saltbush is suppressed by their high-salt diet.

Table 1. Plasma renin activity (ng/ml/h) of ewes at 130 days gestation that were grazing either pasture or saltbush and the renin activity of their lambs at birth and 3 weeks of age

	Pasture	Saltbush	Significance
Ewes at 130 days gestation	0.8 ± 0.14	0.12 ± 0.04	***
Lambs at birth	19.1 ± 1.58	19.70 ± 2.28	ns
Lambs at 3 weeks	4.6 ± 0.49	0.70 ± 0.12	***

***$P < 0.001$; ns = $P > 0.05$.

Plasma renin activity of lambs within 24 hours after birth was not different ($P \geq 0.05$) between the treatment groups, a result that was not anticipated. However, at 3 weeks of age the plasma renin activity of the saltbush lambs was lower than that of the pasture lambs ($P \leq 0.001$) again supporting our hypothesis (Table 1).

The most likely explanation for the plasma renin of the lambs being similar at birth, but then different at 3 weeks of age is stress. Stress increases the activity of the sympathetic nervous system, which in turn stimulates the kidneys to release renin (van de Kar and Blair, 1999). At birth, the lambs had to be caught in the paddock and in most cases their mothers left with the rest of the mob leaving lambs isolated and stressed, as indicated by frequent bleeting and fast heart rate. By contrast, when the blood sample was taken at 3 weeks, the lambs were in a small pen with their mothers and appeared much less stressed. Therefore, an effect of salt in the diet of the mother was only seen at 3 weeks of age and not at birth.

It is unclear whether the lower renin activity of saltbush lambs at 3 weeks old is a result of their environment *in utero,* or is being influenced by the composition of their mother's milk. In rats, salt intake of the mother does influence milk electrolytes (Vijande *et al.*, 1996). Therefore, it is possible that milk from saltbush ewes has a higher sodium concentration that is lowering the renin levels of their lambs.

There was no difference in birth weights of the lambs from pasture and saltbush ewes, nor was there any differences in their growth rates up to 8 months of age (P ≥ 0.05) (Fig. 1).

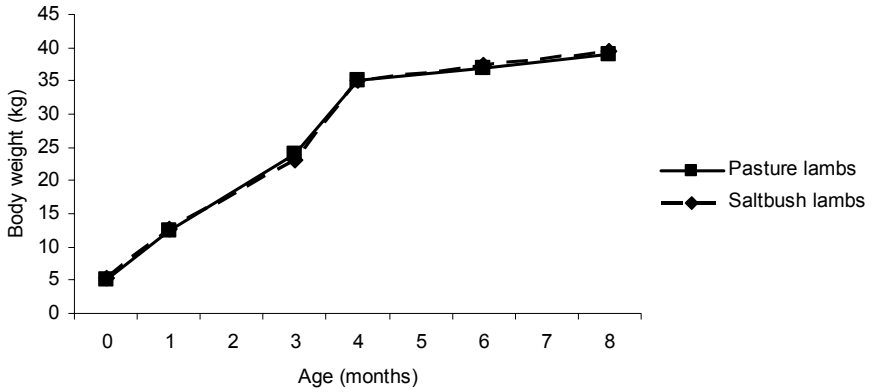

Fig. 1. Body weight of lambs from birth until 8 months of age whose mothers consumed either pasture or saltbush during the last 3 months of pregnancy until 3 weeks after birth.

At eight months of age, all the lambs grazed saltbush for two months, supplemented with barley and the change in their body weights were measured. High water intake of sheep grazing saltbush confounded the actual body weight changes (Casson *et al*., 1996). Therefore, the lambs were weighed 10 days after they stopped grazing saltbush so their body water could return to normal levels. The saltbush lambs gained weight when grazing saltbush (22 ± 12.8 g/d), whereas the pasture lambs lost weight (–18 ± 14.3 g/d) (P < 0.05).

We think that the saltbush lambs handle a salt load better than lambs from the mothers grazing pasture because they may be able to excrete a salt load more rapidly, drink less water and maintain their feed intake when challenged with a salt load. These changes in excretion and salt and water balance are most likely to underpin the enhanced weight gain of saltbush lambs when grazing saltbush. The lower renin activity of the saltbush lambs at 3 weeks of age is likely to have caused these physiological changes that enable them to cope with the high salt content of saltbush better and, consequently gain more weight when grazing the forage in later life.

IV – Conclusion

Grazing pregnant ewes on saltbush during the last 3 months of pregnancy and first 3 weeks of lactation lowers the plasma renin activity of their lambs at 3 weeks of age. This is likely to cause physiological changes in the lambs that enable them to cope better with a high salt load. Therefore they gain weight when grazing saltbush, whereas lambs born to ewes that grazed pasture during pregnancy lose weight when grazing saltbush.

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