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Avicennia marina foliage as a salt enrichment nutrient for New Zealand dairy cattle

The presence of salt in mangrove leaves is well known (e.g. Baylis, 1940; Macnae, 1968; Tomlinson, 1986; Hogarth, 1999; Gray *et al.*, 2010), and their use as fodder for grazing livestock such as goats, camels, pigs and cattle has been reported, e.g. Hong and San (1993) for Vietnam; Scott (1995) for Qatar; Hogarth (1999) for Arabia and Pakistan; Lin and Fu (2000) for China; Baba (2004) for Iran; and Spalding *et al.* (2010) for Oman. These reports identify *Avicennia marina* as a key fodder species but in all cases these examples of animal grazing are regarded as either unsustainable and/or poorly managed, representing a threat to mangrove wise-use.

Here, we report for the first time, the use of *Avicennia* foliage as an exciting candidate for salt nutrient supplementation in the context of advanced dairy farming in New Zealand, a developed agricultural country.

Salt blocks are often provided as cattle licks for grazing livestock on New Zealand farms since these soils are low in sodium (O'Conner *et al.*, 2000), an essential element for livestock metabolism. Typically, each block weighs 20 kg and contains ~970 g/kg of sodium chloride (Hobson, 2008). Earlier observations of cattle on farms adjacent to stands of mangroves of *A. marina* var. *resinifera* (Tomlinson, 1986; Chapman, 1976) had shown that New Zealand cattle enjoy (selectively graze) mangrove herbage (Maxwell, 1971). *Avicennia* foliage has 0.2–0.3% salt content (Maxwell, 1993; Gray *et al.*, 2012 and pers. comm.). In addition, leaves of *Avicennia* have desirable protein content (Hong & Tuan, 1981), and propagules contain carbohydrates that are sufficiently water soluble. When soaked and boiled, they contribute to their long established status as a human food, sometimes known as 'Sea Pea' (Hu, 2005). Hong and San (1993) reported the use of *Avicennia* propagules as food for the people in Vietnam at times of famine and war. Field (1995) even provided a recipe for processing mangrove propagules into 'olives al' *Avicennia*'. Despite the presence of tannins in mangrove leaves and propagules, these are lower in *Avicennia* compared to *Rhizophora* and *Bruguiera* (Camilleri, 1989), and this aspect of their chemistry contributes to their potential as food for both humans and domesticated vertebrate herbivores.

This paper reports some results from an on-going series of field experiments on a New Zealand dairy support farm (Waikato region, 35° South). Mobs of 50 mostly yearling heifer cattle were given a grazing selection of three types of herbage: freshly collected *A. marina* foliage (leaves, twigs and sometimes propagules), hay (summer-saved pasture) and new break of fresh pasture (rye-grass plus two species of clover) (Figs. 1 and 2).

Fig. 1. Yearling heifer (young female cattle) eating *Avicennia* foliage on a New Zealand dairy support farm, even before it was placed on the grass paddock

Fig. 2. Young cattle actively selecting *Avicennia* foliage (arrows) over pasture and hay

The experiments consisted of three trials, all conducted in late winter or early spring on separated occasions over three alternate years (2008, 2010 and 2012). The protocols involved placing the herbage as fodder in a forage site – a new paddock not visited for 24 days based on a winter rotational grazing regime. Mangrove foliage and hay were placed in a dispersed pattern to enable easy access and opportunities for inspection by the cattle. The cattle thus had three choices of herbage. They had never seen mangrove foliage but had experienced pasture and hay as forage material many times before.

These trials involved observing both initial encounter (inspection) and second encounter (re-visit) of herbage by the cattle. The basis for this method stems from observations that herbivores such as cattle show preferences for specific pasture species when available in sward (e.g. Bohnert *et al*, 1985; Thomas *et al*, 2010). Direct observations were made by 2–3 observers on the number of cattle actively feeding on each herbage type.

Data in Fig. 3 showed strong preference for mangrove foliage. Typically, once the cattle had made their herbage choice, they consumed all the available *Avicennia* foliage before feeding on the pasture (next choice) or hay (last choice). Mangrove material was almost totally defoliated and gnawing of bark was evident (Fig. 4). Bark gnawing was exhibited on 90% of twigs inspected from 60 branches used in the three trials.

Fig. 4. Bark gnawing by cattle (arrow) on twigs of *Avicennia marina*

The findings reported here clearly indicate that even high quality cattle from top producing dairy herds in the technologically advanced agriculture of New Zealand, can enjoy the salty leaves of *A. marina*. In coastal areas on the northern half of the North Island at and north of 38° South (the biogeographic limit of mangroves; Chapman, 1976; Spalding *et al*, 2010), the use of mangrove foliage in a manner described here could contribute to the sensible and sustainable resolution of a growing dysfunctional conflict between two factions of

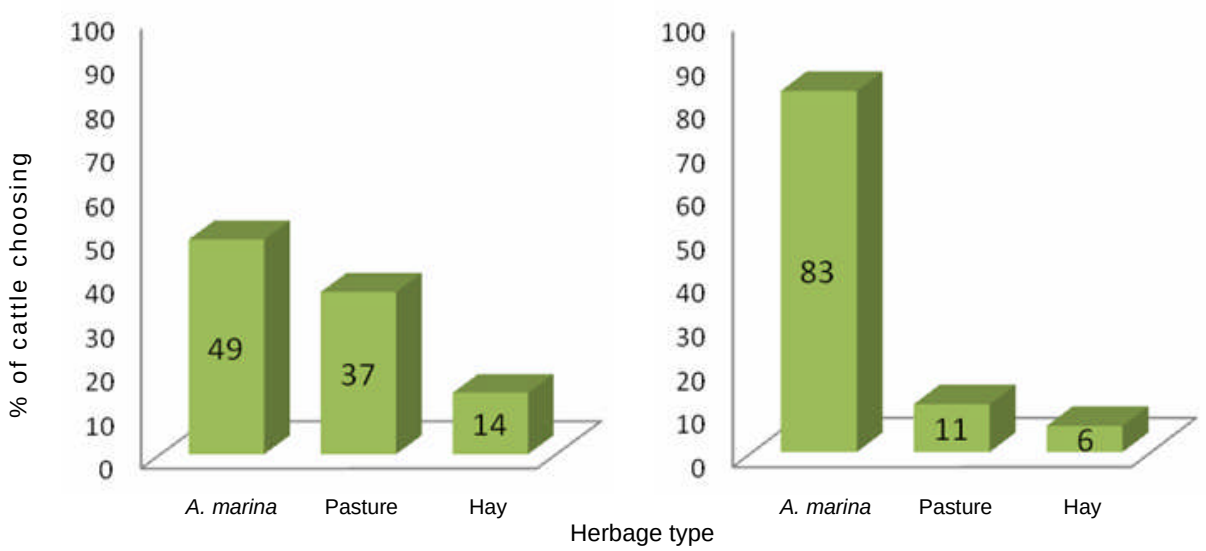

Fig. 3. Percentage of cattle selecting herbage types on their initial encounter (left) and second encounter (right)

the New Zealand society today. There are those who wish to eradicate *A. marina* and those who wish to see its many values (Maxwell, 2010). Details of this sociological and ecological situation are the subject of a separate paper.

Salt blocks cost money and present the desired sodium as a concentrated mass. Foliage of *A. marina* is nutritional presenting salt and essential nutrients such as proteins, carbohydrates and other minerals. In the promotion of optimal grazing and the conversion of pastures into economically important animal products, the use of mangrove foliage as livestock feed may well optimise feeding in cattle by reducing expenditure of energy and handling costs

(O'Regain, 1993), and increasing nutrient reward with diet diversity. The use of *Avicennia* foliage may be especially helpful during the winter months, when pasture growth is inhibited by the cooler temperatures.

We conclude that the sustainable use of mangroves in New Zealand as livestock feed could be a win-win eco-economic solution with benefits for dairy farming and conservation of mangrove ecosystems. Such a management strategy warrants a fresh re-assessment in the country.

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