Comparison of Immunosuppression in Dry and Lactating Awassi Ewes due to Water Deprivation Stress

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ABSTRACT

In seminomadic farming practice, dry and lactating ewes are exposed to different degrees of water deprivation, leading to stress followed by various disease outbreaks. This study compares quantitatively the immunosuppression to Salmonella Enteritidis (SE) fimbriae (14 and 21 kDa) and other major polypeptides (28.9, 37.7, 42.9, 68.0, 92.6 and 96.8 kDa) in water-deprived dry and lactating ewes. Sixteen dry and lactating multiparous Awassi ewes were divided into four treatment groups (A, A’, B and B’). Ewes in groups A and B were lactating, whereas ewes in groups A’ and B’ were dry. All ewes were administered a killed SE vaccine, subcutaneously in the neck, at the initiation of the experiment. The water availability for ewes in groups B (lactating) and B’ (dry) was ad libitum, while that for ewes in groups A (lactating) and A’ (dry) was once every 4 days. A serum sample was collected from the jugular vein of each ewe at zero time (initiation of the experiment, when SE bacterin was delivered) and at 2, 9, 12, 15 and 18 days post SE vaccination. The percentage reduction in the level of humoral antibody response to polypeptides of ≥21 kDa was more apparent in water-deprived lactating ewes of group A between 9 and 18 days post initiation of thirst. In this period, immunosuppression to polypeptides ≥21 kDa was present in 14 out of 16 observations in group A (water-deprived lactating), with significant immunosuppression in 9 observations in relation to the respective control (p<0.05), while it was present in only 4 out of 16 observations in group A’ (water-deprived dry), with significant immunosuppression in 2 observations (p<0.05). In conclusion, immunosuppression to polypeptides of ≥21 kDa is more significant in lactating water-deprived ewes in the period 9–18 days post initiation of thirst, a result that will influence our future sheep welfare awareness programmes targeting an elimination of the practice of water deprivation in seminomadic sheep farming.

Keywords: bacterial polypeptides, dry and lactating ewes, immunosuppression, water deprivation stress

Abbreviations: NCM, nitrocellulose membrane; SE, Salmonella Enteritidis; SEF, Salmonella Enteritidis fimbriae; SDS-PAGE, sodium dodecyl sulphate-polyacrylamide gel electrophoresis

INTRODUCTION

The seminomads of the Middle East graze sheep in the heat of the day, in temperatures that can reach 40°C, claiming that sheep can survive water deprivation for 3–5 days. In Australia, Merino sheep survived a 10-day period without water (MacFarlane, 1964); in contrast, Barki sheep of Egypt did not survive a water deprivation period of 3 days (Farid et al., 1979), while desert bighorn sheep withstood water deprivation for up to 15 days (Turner, 1979).
Reports have shown that *Salmonella* Enteritidis (SE) is among more than 2000 serotypes that during the last 15 years have developed the highest adaptability to a wide range of hosts, including cattle, pigs, poultry and sheep (Rodriguez et al., 1990; Centers for Disease Control, 1993; Saeed, 1999).

A higher immune response in the host to protective immunogens on salmonellae, including fimbriae, will result in proper protection against infection by these organisms (Muller et al., 1991; Kwang and Littledike, 1995; Nagaraja and Rajashekar, 1999). The role of antibodies against SE fimbriae of 14 kDa and 21 kDa (Aslanzadeh and Paulissen, 1992; Barbour et al., 2000a) and against other SE polypeptides in host protection against infection has been described previously (Disiderio and Campbell, 1985; Barbour et al., 2000 a,b).

The success or failure of the host immune system in responding to protective immunogens present on the microorganism included in the vaccine can be influenced by environmental or management-associated stressors (Coppinger et al., 1991; Minton et al., 1992; Hanlon et al., 1995; Rhind et al., 1999; Sevi et al., 2001).

To our knowledge, this is the first attempt to compare quantitatively the immunosuppression to *Salmonella* Enteritidis (SE) fimbriae and other major polypeptides in dry and lactating Awassi ewes subjected to water deprivation in relation to dry and lactating controls offered drinking water *ad libitum*.

MATERIALS AND METHODS

*SE vaccine*

The SE cells included in the vaccine were originally propagated from a highly virulent strain possessing a 38 MDa plasmid (Chart et al., 1989; Cowden et al., 1989). The aqueous phase of the vaccine contained formalin-killed SE cells adjusted to 3% light transmission at a wavelength of 540 nm. The volume ratio of Freund’s incomplete adjuvant to aqueous phase was 1:1, forming a water-in-oil emulsion, as previously described (Barbour et al., 1993).

*Ewes and experimental design*

A total of 16 dry and lactating multiparous Awassi ewes, ranging in age between 2 and 3 years and average weight of 57.4 kg, were selected randomly from the sheep flock at the Agricultural Research and Educational Center (AREC) of the American University of Beirut, in a semi-arid region located at 33° 54’ N 35° 28’ E. The ewes were divided evenly into four treatment groups – A, A’, B, B’ – in two respective pens of the same building. The building was 7 x 5 x 4 m, with windows located at a height of 2 m. Each ewe was administered 4 ml of the SE bacterin, subcutaneously in the neck, at the initiation of the experiment. The water availability for ewes in groups A, A’, B and B’, according to the common practice in seminomadic sheep, was once every 4 days for groups A and A’, and 24 h availability for groups B and B’. The average of the 18-day