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Immunological effects of feeding different sources of vitamin E and seaweed in a sheep herd during the winter season

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Abstract

In winter fed organic raised sheep inadequate plasma vitamin E levels is common and therefore supplementation is recommended. The objective of the present work was to test the supplementation of natural vitamin E and seaweed meal on the immune status of ewes and their offspring.

Forty Norwegian White Sheep ewes were randomly allocated to three supplementation treatments: natural vitamin E, synthetic vitamin E, seaweed meal, and control. The feeding experiment lasted the entire indoor feeding period. Ewes and newborn lambs were vaccinated against different environmental microorganisms and pathogens. Different immunological parameters were measured.

Supplementing the ewes with natural vitamin E had positive effect on immunity against Mycobacterium bovis in lambs. Seaweed, on the other hand, had negative effect on the passive transfer of maternal antibodies in lambs the first week after birth. The adaptive immunity was not affected by seaweed supplementation.

Key words: Ascophyllum nodosum, macroalgae, antioxidant, immunological parameters, α-tocopherol, nutrient element

Introduction

Ruminants fed on preserved forages are dependent of vitamin E and antioxidant supplementation in order to optimize milk and meat quality, immune function, reproduction traits and animal health. There is an aim in organic production to avoid synthetic vitamins, and therefore a need for knowledge on potential natural vitamin and antioxidant sources. The supplementation of seaweed meal is especially interesting, since seaweed is an abundant and easy accessible raw material on the coastline and has traditionally been used as a winter supplement to sheep in Norway.

The hypothesis was that supplementation with natural vitamin sources improves the immunologic status in ewes and their offspring. A feeding trial was performed to study the effects of supplementing ewes‘ diets with seaweed meal, and natural or synthetic vitamin E on different immunological parameters.

Material and methodology

Forty Norwegian White breed ewes were divided into four treatments. Within each treatment the ewes received an iso-energetic diet that included a daily ration of concentrate supplemented with

seaweed meal (SW), natural vitamin E (natE), synthetic vitamin E (syntE) or without any supplementation (C). In the SW concentrate the seaweed meal added up to 4.4 % of the total DM intake. The trial lasted the entire eight month indoor feeding period.

The concentrates were analysed for α-tocopherol (Jensen and Nielsen, 1996) and the nutrient elements Na, Se, As and I.

Production of specific antibodies and cell mediated immunity following immunization, production of antibodies against environmental microbes and the immunoglobulin concentration in the mothers and the lambs were registered, as well as the mitogen and antigen induced lymphocyte proliferation (Table 1).

Table 1: Overview of immunological parameters measured in the feed trial

Ewes	Lambs
Specific antibodies after vaccination (Tetanus toxoid, *Mannheimia haemolytica*, equine herpes- and influenza virus)	Specific antibodies after vaccination (Diphtheria toxoid)
Antibodies against environmental bacteria (*M. haemolytica*)	Antibodies against environmental bacteria (M. haemolytica)
Immunoglobulin concentration in blood and colostrum (IgG, IgM)	Cell mediated immunity after vaccination with *Mycobacterium bovis* (IFNγ)
	Transfer of maternal immunity (equine herpes- and influenza virus, tetanus toxoid, IgG, IgM)
	Production of immunoglobulin (IgG, IgM)
	Mitogen and antigen induced lymphocyte proliferation

Results

The ewes consuming the SW and C concentrates had lowest daily intake of α-tocopherol and SW highest intake of As and I (Table 2).

Table 2: Weighted mean daily intake of α-tocopherol, Na, Se, As and I

	SW	syntE	natE	C
α-tocopherol (mg/day)	28	138	72	21
Na (g/day)	44	42	40	38
Se (mg/day)	0.55	0.45	0.43	0.38
As (mg/day)	3.30	0.57	0.56	0.56
I (mg/day)	51.3	2.74	2.52	2.25

The serum IgG concentration in the ewes in the SW group was 37 mg/ml. This concentration was significantly lower ($P<0.05$) than in the ewes on other treatments, which had serum IgG concentrations ranging from 43 mg/ml to 57 mg/ml. There was no effect of dietary treatment for the other immunological parameters measured in the ewes.

The lambs in the natE feeding group showed significantly stronger cell mediated immunity to *M. bovis* following immunization than the other treatments (Table 3).

The transfer of maternal immunity in one week old lambs in the SW group was severely impaired both regarding serum IgG and IgM concentrations, and specific maternal antibodies against tetanus toxoid, equine herpes- and influenza virus (EIV) and *M. haemolytica* (MH) (Table 4). There was no difference between the feeding groups in the antibody levels after vaccination against *Diphtheria* toxoid (data not shown).

Table 3: Mean values of IFNγ (ng/ml) four weeks after vaccination with M. bovis

	SW	syntE	natE	C	P
IFNγ	2.4	5.1	8.0	2.6	*

* significant at P<0.05

Table 4: Levels of maternal immunological parameters transferred to the offspring during the first weeks after lambing in the different feeding groups

	SW			syntE			natE		C		P		
Age (week)	1	4	6	1	4	6	1	4	6	1	4	6	
IgG (mg/ml)	7	28	32	49	33	23	57	29	29	52	31	29	**
IgM(mg/ml)	0.4	1.3	1.5	2.0	1.1	1.3	1.8	1.1	1.6	2.3	1.6	1.7	**
Tetanus (titre log_2)	6.9	5.6	4.8	10.5	9.9	8.5	11.7	9.8	9.1	11.6	10.2	9.7	**
EIV (titre log_2)	3.5	3.2	2.7	5.7	4.1	3.9	6.0	4.0	3.3	5.9	3.9	3.8	**
MH (titre log_2)	4.4	4.3	5.5	8.3	6.1	6.4	7.8	6.1	6.2	7.8	6.2	6.3	**

** significant at P<0.01

Discussion

The cell mediated response to *M. bovis* suggests that supplementation with high levels of natural vitamin E could be an effective support to the immune mechanisms involved in the disease resistance to virus infections, fungal infections, cancer and infections with intracellular bacteria such as *Mycobacterium sp*.

The consumption of seaweed meal by the ewes at the concentration and the duration applied in this study left the newborn lambs unprotected against infection during their first week of life. However, the adaptive immunity was not affected by the seaweed meal intake. These results indicate that whole seaweed meal has one or more components that interfere with the intestinal uptake of the maternal immunity in the lambs.

As a product of marine origin, the seaweed meal has a high iodine (I) concentration. Low levels of immunoglobulin G has been observed in lambs where their mothers have been fed high amounts of minerals, including iodine, the last week of gestation (Boland et al 2006). This is an aspect to take into consideration when formulating diets including whole seaweed products.

Our immunological results indicate that on milligram basis half the amount of natural vitamin E equalize the effect of synthetic vitamin E. Seaweeds are definitely an interesting organic renewable resource that can be can exploited in agriculture due to their properties (Allen et al., 2001; Kuda et al., 2005; Devi et al., 2008). However, seaweeds have a very complex composition, and it is not yet understood how the different components influence the animal physiology. Fractionation of seaweeds and studies of the separate fractions should be the future approach in order to find new natural supplements to be used in organic farming. Seaweed should however not be fed to ewes in late gestation and early lactation as it may suppress maternal transfer of antibodies.

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Suggestions to tackle the future challenges of organic animal husbandry

There is a need to provide mineral supplements based on organically bound selenium and vitamin E, and knowledge of their bioavailability and distribution in the animal body to improve the ani-

mals' antioxidant defence system in organic farming. However, the current study showed that good animal health may be achieved without supplementation.

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