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SEAWEED AS A SUPPLEMENT TO RUMINANTS WINTER DIET – LESSONS LEARNED

Håvard Steinshamn & Margarita Novoa-Garrido

4th International Seaweed Conference, 22-23 September 2015, Normandy, France

BACKGROUND

- In Norway, ruminants are fed indoors for a long period (6-8 months) with preserved forages, mainly grass silage
- Silages and other preserved forages may have low content of vitamin E and Selenium, and supplementation is regarded as necessary during indoor feeding
- In organic production, necessary supplements such as vitamins should be of natural sources, if possible (Council Regulation (EC) No 834/2007)

BACKGROUND

- Macro algae (seaweed) have traditionally been used as supplementary feed to ruminants in Norway
- Little research has been done – most on *Ascophyllum nodosum* a brown algae with common name such as “rockweed”, “knotted wrack”



Photo: Vigleik Stusdal



Photo: Celine Rebours

Jensen *et al.* 1968 found:

- 6% higher fat corrected milk yield by cows supplemented with fortified *A. nodosum* meal
- 6 times higher concentration of Iodine in milk from cows supplemented with fortified *A. nodosum* meal

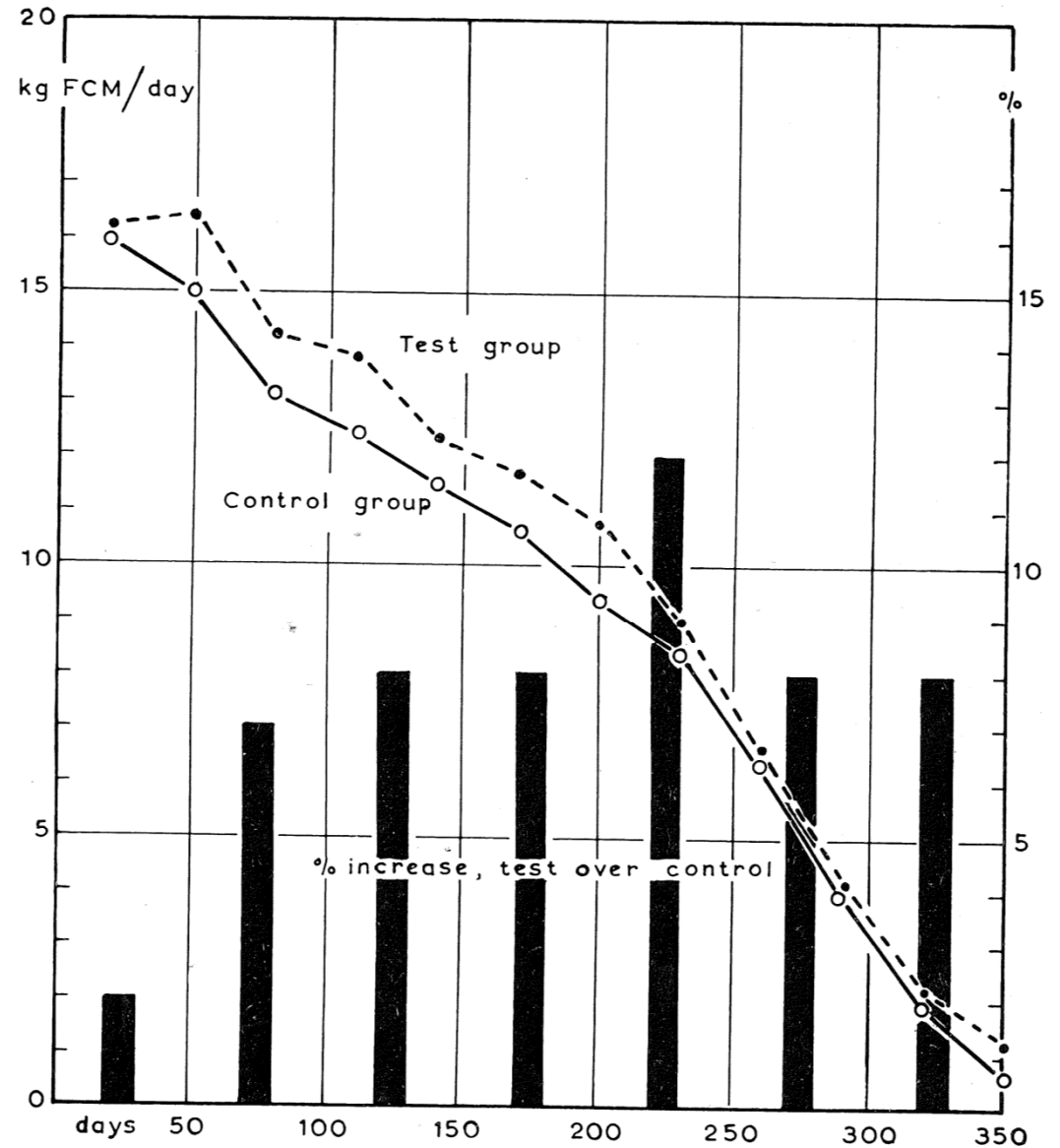


Fig. 5 Average lactation performance (23 lactations in each group) in the groups and difference in daily milk yield test-control throughout the lactation period (in per cent).

BACKGROUND

- Supplementation of pigs with *A. nodosum* have positive effect on:
 - Growth in young pigs (Turner *et al.* 2002)
 - Gut health (Dierick *et al.* 2009)
- Supplementation of ruminants with *A. nodosum* have positive effect on
 - Product quality (improved shelf-life) (Allen *et al.* 2001)
 - Stress tolerance (improved stress tolerance) (Saker *et al.* 2004)
 - Prevalence (less) of *E coli* O157:H7 in cattle feces (Braden *et al.* 2004)
- Alginate, specific poly mannuronic acid, act as non-specific immuno-stimulants in humans cells (Otterlei *et al.* 1991) and in fish (Rokstad *et al.* 1996; Skjermo & Bergh 2004)

BACKGROUND

Components in <i>A. nodosum</i> meal (Jensen <i>et al.</i> 1968)	%
Dry matter	85 – 88
Crude protein	5 - 10
Crude fat	2 – 4
Crude fibre	< 8
Ash	17 – 20
Alginate (mannuronic and guluronic acids)	20 – 26
Mannitol (a sugar alcohol)	5 – 10
Laminaran (a glucan, a polysaccharide)	2 – 5
Fuoidan (a sulfated polysaccharide)	10
Phlorotannins (a tannin)	4 – 15

OBJECTIVES

- To compare the effects of supplementing dairy cows in mid-lactation with *A. nodosum* meal or vitamin E on immune response
- To compare the effects of supplementing pregnant ewes with *A. nodosum* meal or vitamin E on immune response and on transferred and adapted immunity by their offspring

HYPOTHESIS

Supplementing the diet with *A. nodosum* to lactating dairy cows and pregnant sheep would produce better adaptive immune response following immunization compared to no supplementation and similar to animals given extra vitamin E

MATERIAL AND METHODS - COW EXPERIMENT

- Feeding trial with 24 mid-lactating cows in a 4 × 4 Latin square design with six replicates. Each period lasted four weeks
- Feeding: Grass clover silage *ad libitum* + 3 kg/d of a concentrate mixture + Experimental feed
- Cows were immunized experimentally with four different albumins (human serum albumin, ovalbumin, equine serum albumin, canine serum albumin) 6 days before the start of the experiment

MATERIAL AND METHODS – SHEEP EXPERIMENT

- Continuous feeding trial from mating until onset of grazing season, total 200 days, with 40 ewes randomly assigned to 4 dietary groups in two blocks
- Feeding: grass silage as basal diet + concentrate mixture (during peripartum) + experimental feed



MATERIAL AND METHODS – SHEEP EXPERIMENT

- Ewes were immunized
 - Ovivac[®] P, 4 weeks before lambing, a standard immuno-prophylactic practice in Norwegian sheep production
 - experimentally with a vaccine against equine herpes and an influenza virus (EIV) 5 and 2 weeks before lambing
- Lambs (2 weeks old) were immunized experimentally
 - Diphtheria toxoid vaccine and human tuberculosis vaccine



MATERIAL AND METHODS – COW EXPERIMENT

Cow experiment	Dietary supplements			
	Control	Seaweed	NatvE	SyntvE
Ingredients, g/kg				
Barley	749	515	740	744
Seaweed meal ¹ , <i>A. nodosum</i>	0	305	0	0
Molasses	42	36	42	42
Vitamin E (3800 mg α -tocopheryl aceate)			12.6	7.6
Minerals and other vitamins	209	144	205	206

¹AlgeaFeed 3.5; Algea AS, Lødingen, Norway

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Molasses	42	36	42	42
Vitamin E (3800 mg α -tocopheryl aceate)			12.6	7.6
Minerals and other vitamins	209	144	205	206
Fed				
Supplementation per cow, kg DM/day	0.7	0.8	0.7	0.7
Seaweed, kg DM/day	0	0.2	0	0

¹AlgeaFeed 3.5; Algea AS, Lødingen, Norway

MATERIAL AND METHODS – SHEEP EXPERIMENT

Sheep experiment	Dietary supplements			
Ingredients, g/kg	Control	Seaweed	NatvE	SyntvE
Barley	881	409	880	879
Seaweed meal ¹ , <i>A. nodosum</i>	0	546	0	0
Molasses	40	31	40	40
Vitamin E (840 mg α -tocopheryl aceate)			2.25	1.68
Minerals and other vitamins	79	14	78	79

¹AlgeaFeed 3.5; Algea AS, Lødingen, Norway

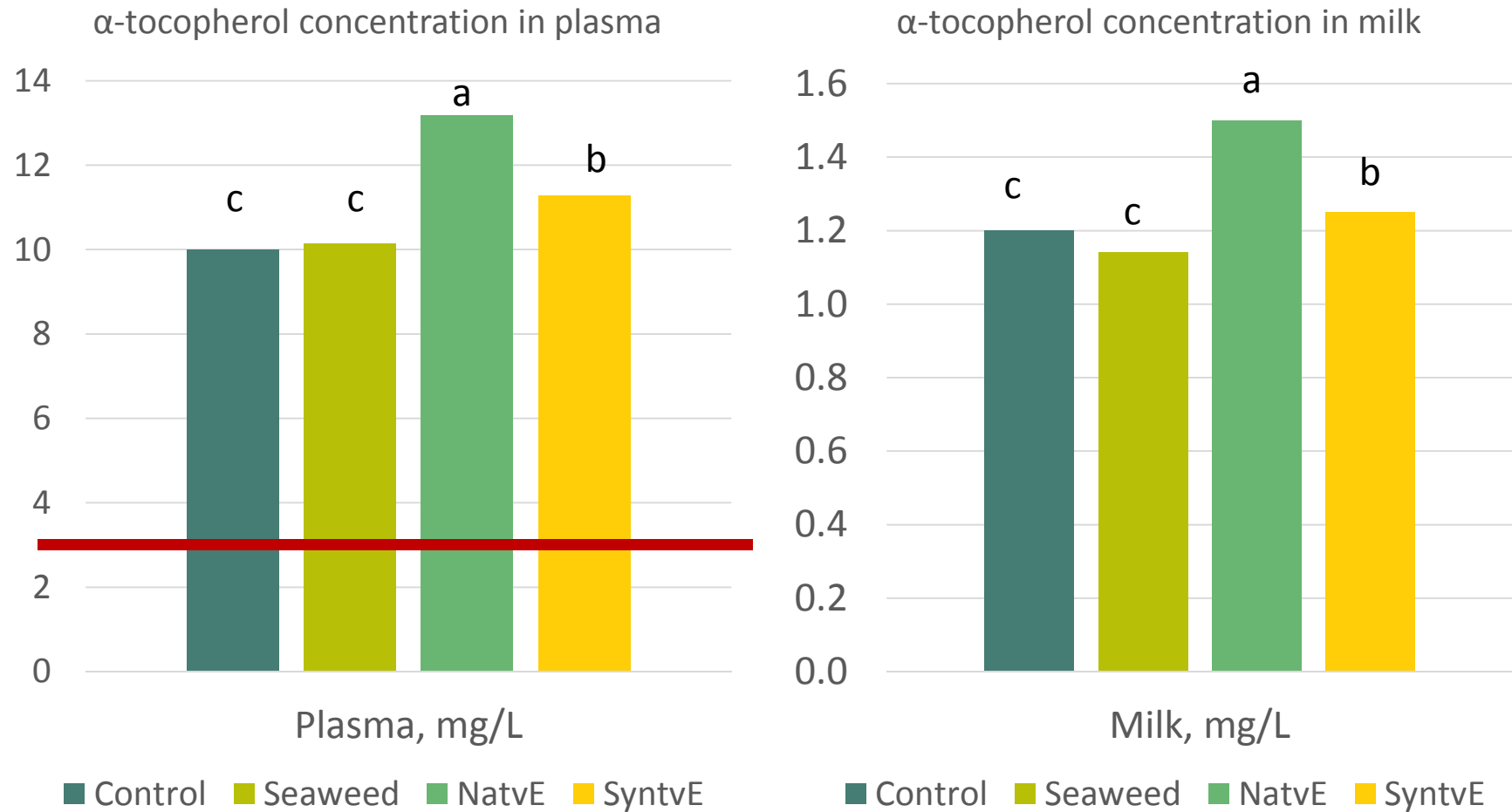
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Vitamin E (840 mg α -tocopheryl aceate)			2.25	1.68
Minerals and other vitamins	79	14	78	79
Fed				
Supplementation, g DM/d	110	144	110	110
Supplementation before lambing, g DM/d	175	215	175	175
Seaweed, g DM/day	0	80/116	0	0

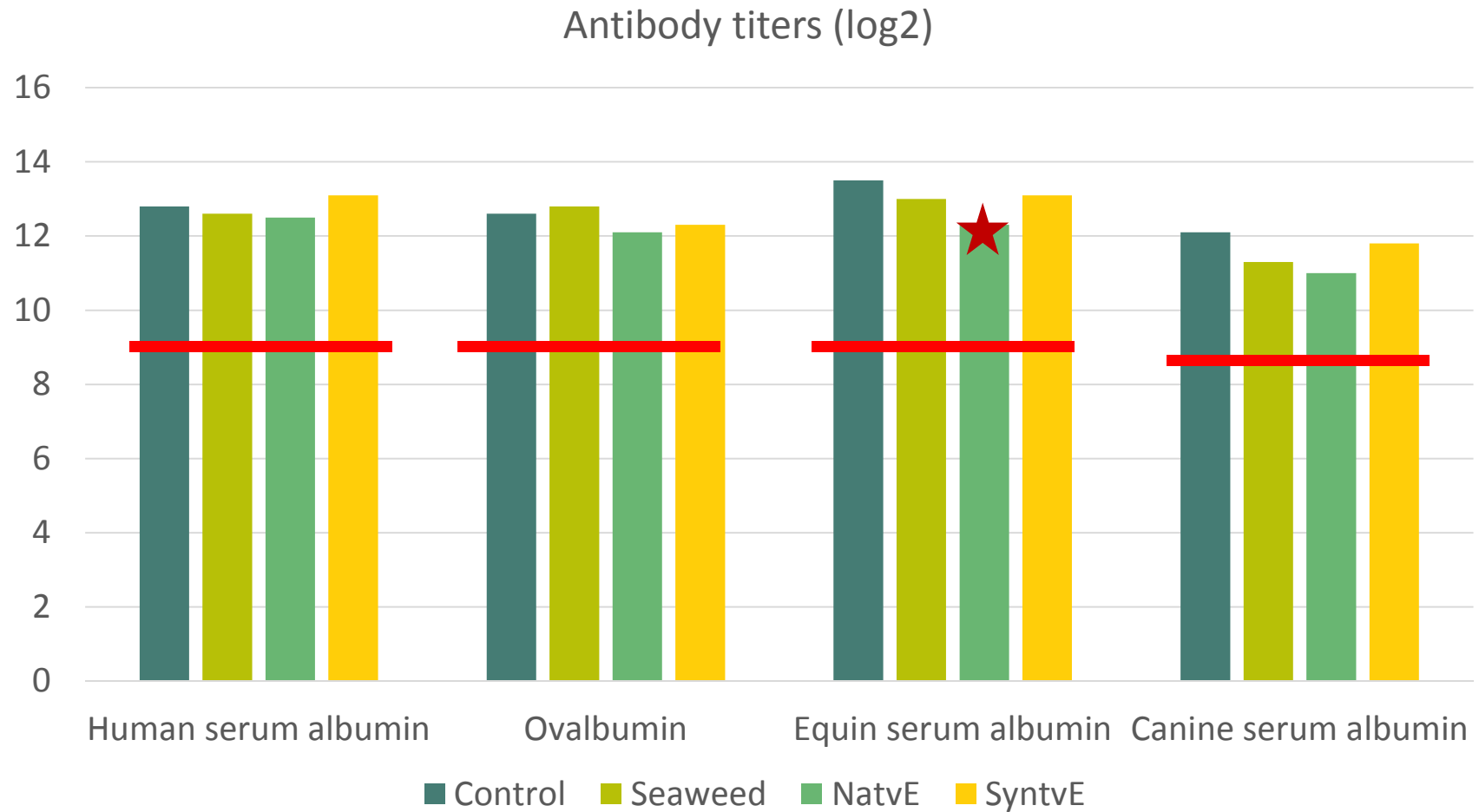
¹AlgeaFeed 3.5; Algea AS, Lødingen, Norway

RESULTS – COW EXPERIMENT

No effect of seaweed on plasma and milk concentration of α -tocopherol



No effect of seaweed on specific antibody titre values to immunization



RESULTS – SHEEP EXPERIMENT

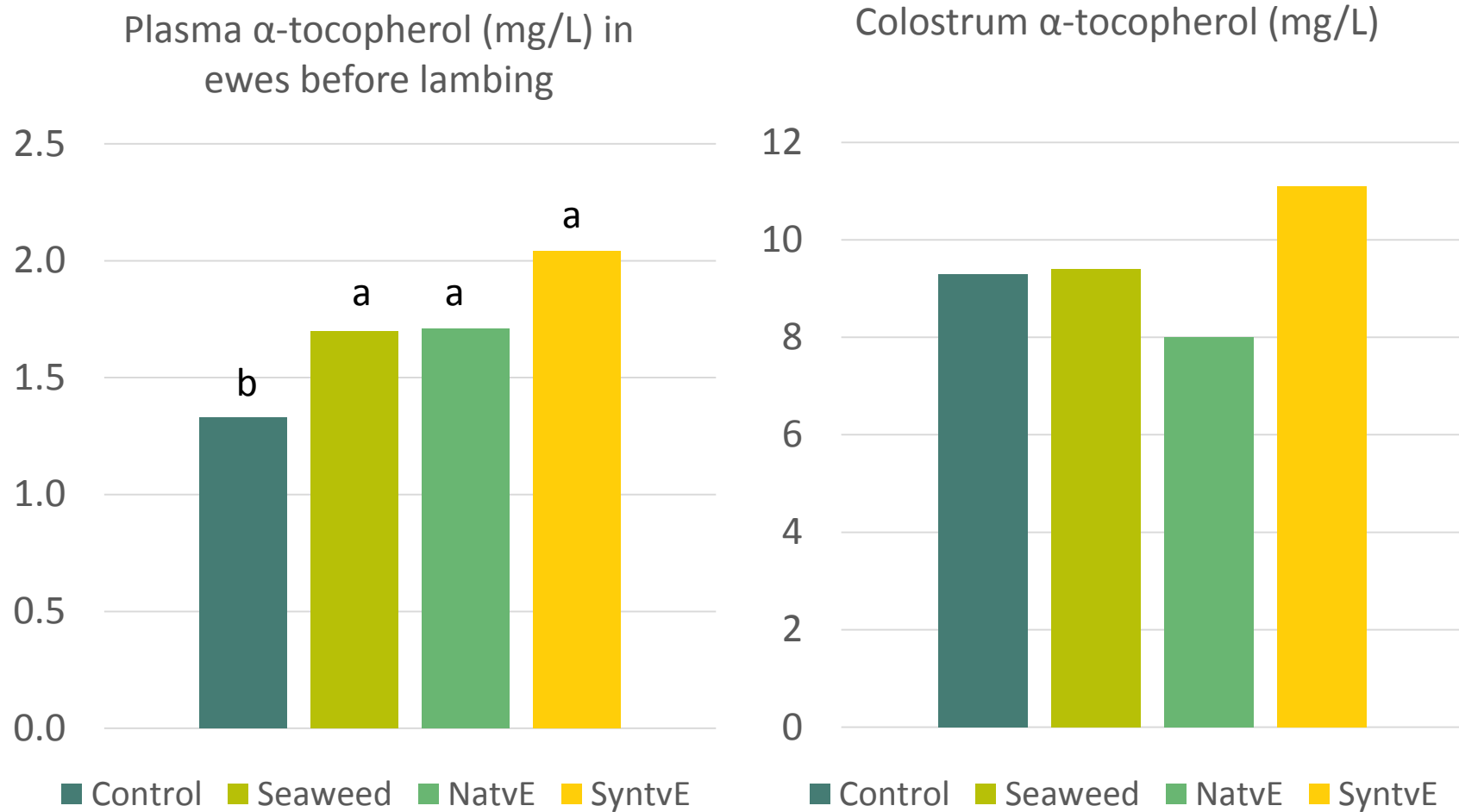
Higher lamb mortality rate after ewes fed seaweed

	Control	Seaweed	NatvE	SyntvE
Number of lambs born	19	20	18	17
Number of lambs dead	2	7	1	0
Mortality rate, %	10.5	35.0	5.6	0

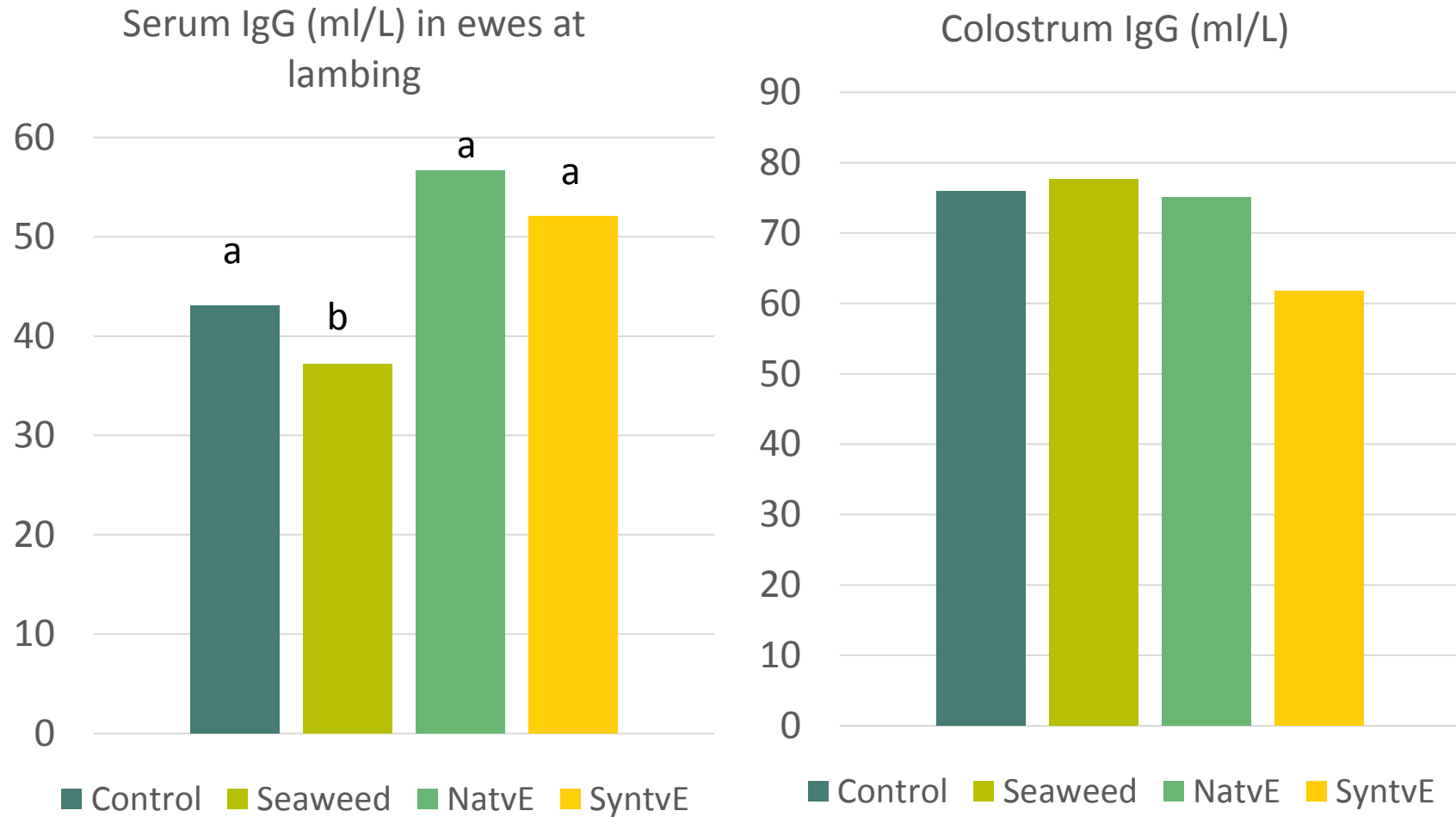
Autopsy of three dead lambs:

- pneumonia, septicemia, and enteritis
- *M. haemolytica* isolated from lungs and livers

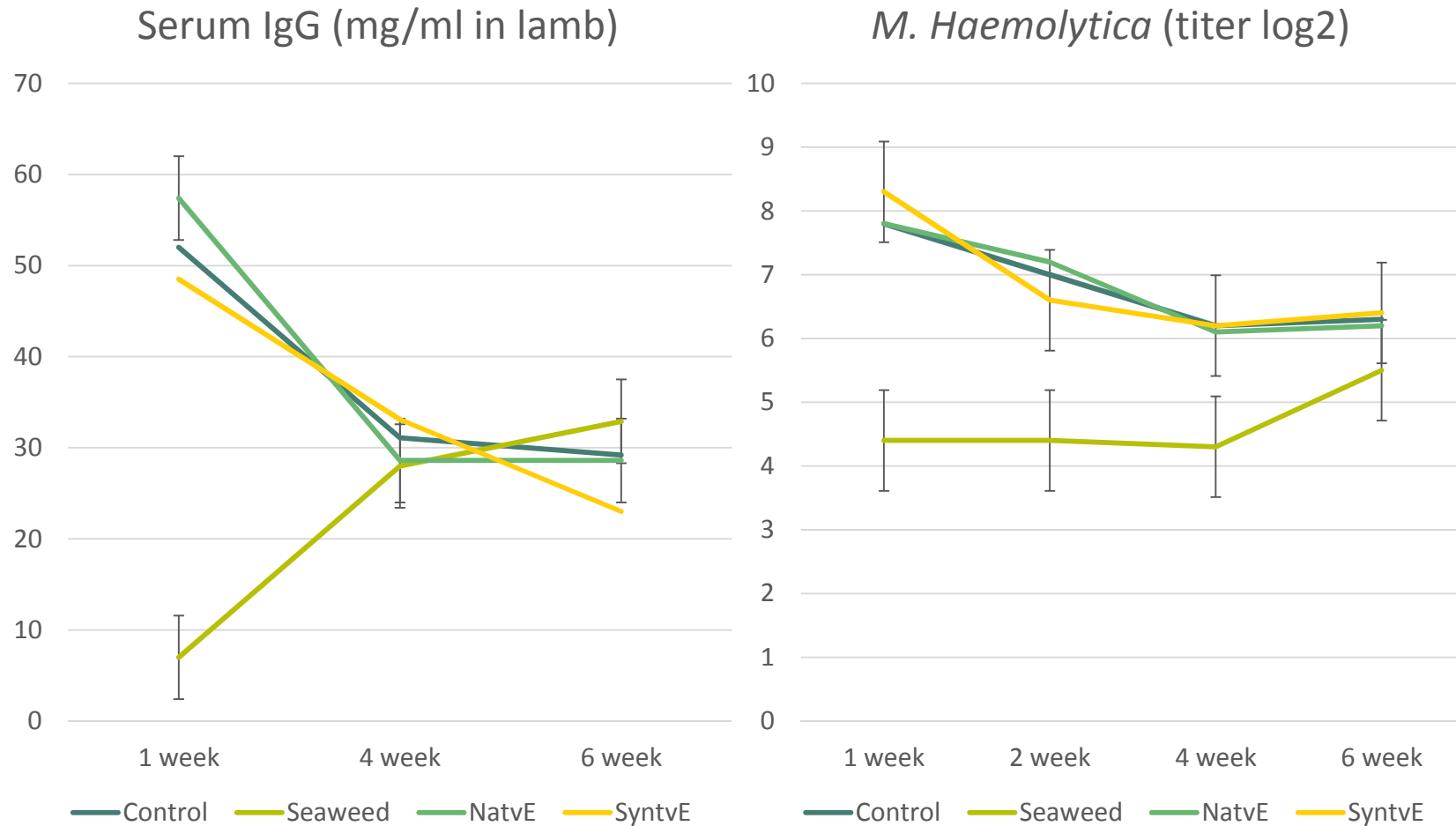
Higher plasma concentration of α -tocopherol in ewes fed seaweed, but not in colostrum



Lower serum IgG concentration in ewes fed seaweed at lambing, but no difference in colostrum

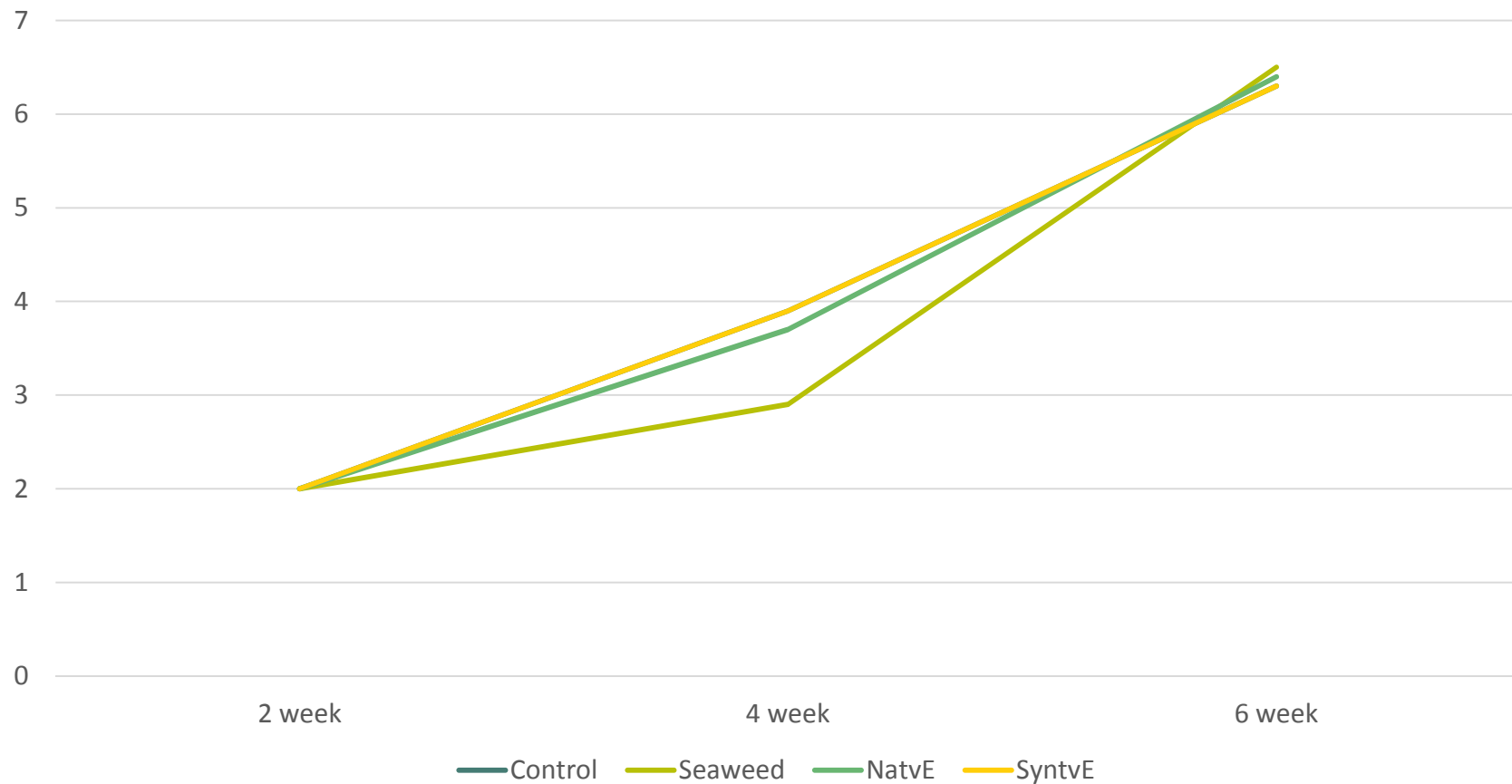


Transfer of maternal immunity was strongly impaired in lambs after ewes fed seaweed



The adaptive immune system of the lambs was not affected by their mothers diet

Corynebacterium diphtheriae toxoid (titer log₂)



SUMMARY – DAIRY COW EXPERIMENT

- The lack of vitamin E supplementation effects on adaptive immune response against immunizations was most likely due to adequate intake of vitamin E from the basal diets
- Therefore, it was not likely that seaweed should have any effect either

SUMMARY - SHEEP EXPERIMENT

- Seaweed had no effect on the concentration of antibodies (IgG and IgM) in the colostrum, but impaired severely the transfer of maternal immunity from the ewes to the lamb as indicated by the low levels in new-born lambs
- The lambs must have had problems to absorb the antibodies from the colostrum, which we do not know the mechanism for. But:
 - Polyphenols, abundant in seaweed, have high affinity for proteins and may have bound antibodies and made them difficult to absorb
 - Seaweed are rich in minerals, particularly Iodine, and studies have shown that supplementing ewes with Iodine and other minerals in the final weeks before parturition reduces the absorption of antibodies by lambs
 - Do alginates bind Antibodies?

CONCLUSIONS

- Supplementation of ewes with *A. nodosum* decreased the serum antibody concentrations in the ewes and impaired the passive (maternal) immunity of their lambs during their first week of life
- More research is needed on the identification of bioactive components in seaweed, their effects in animal health, the mechanisms related to their effects on the animal health and testing before seaweed should be used as it is as feed supplement to ruminants

LESSONS LEARNED

Supplementing ruminants with *A. nodosum* meal should be avoided during late gestation and early lactation

ANIMAL RESEARCH PAPER

Effects of supplementing mid-lactation dairy cows with seaweed and vitamin E on plasma and milk α -tocopherol and antibody response to immunization

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Immunological effects of feeding macroalgae and various vitamin E supplements in Norwegian white sheep-ewes and their offspring



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THANK YOU FOR YOUR ATTENTION!