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DAIRY CATTLE REPRODUCTION COUNCIL

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DCRC Webinar 2021

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Importance of Dietary Methionine and Selenomethionine on Health and Reproduction

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Answers to Questions Asked, Courtesy of:

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Q1: I missed what was said about the continuing education (CE) credit. What do we need to do?

DCRC: To obtain continuing education credit as a Professional Animal Scientist (PAS) with the American Registry of Professional Animal Scientist (ARPAS), sign in at https://www.arpas.org/Membership/CEUs/Report-CEUs.

To obtain continuing education credit with the Registry of Approved Continuing Education (RACE) from the American Association of Veterinary State Boards (AAVSB), share your name, state, and veterinary license number with Kristy Mach (kristym@dcrcouncil.org), executive director of the Dairy Cattle Reproduction Council (DCRC).

Q2: Why did MUN only affect the first AI but not subsequent AIs?

Phil: Most likely due to increased milk yield at the point of the first breeding.

Q3: How much methionine should be given in feed to protect from bad inflammation?

Phil: See the recommendation suggested on the last slide of my presentation.

Q4: According to your results, PUFAS are essential for early embryo development?

Phil: Yes. Not only PUFAs but all fatty acids.

Q5: Do higher PUFAS content in the uterine environment promote better embryo development?

Phil: There are indications that vegetable oils rich in PUFA supplementation slightly improved some reproductive parameters in dairy cows subjected to the fixed-time artificial insemination (TAI) protocol.

Q6: Phil, on the embryo loses and the embryo size data, what is the mode of action of methionine and why is there no effect in primiparous cows?

Phil: Protein synthesis (embryo growth) is enhanced with the addition of methionine. The lower output of methionine in milk in primiparous cows compared to multiparous cows may be the reasoning.

Q7: Do you have any evidence whether methionine supplement could be beneficial to rule out the negative impact of heat stress on fertility?

Phil: Not directly. Check our paper coming out in the *Journal of Animal Science* that talks about alveoli growth and apoptosis. The title is "Immune and metabolic effects of rumen-protected methionine during a heat stress challenge in lactating Holstein cows."

Q8: The levels of methionine and lysine that you presented, relative to ME or as a ratio...has been developed/derived to optimize milk response i.e., work based on Rulquin et al., etc. What are the levels to optimize repro?

Phil: At this point, we use the same numbers for milk yield, and no optimization for repro has been developed.

Q9: Phil, you showed some interesting data on the change in uterine fatty acid profile with methionine supplementation. Does fatty acid supplementation influence uterine fatty acid profile and what is the ideal fat/fatty acid to supplement with methionine?

Phil: Yes. Check the answer to question #3.

Q10: With the higher level of methionine, you can get more glutathione synthesis. How would this affect embryogenesis and overall oxidative stress of the dam, mammary gland, and offspring?

Phil: Improved oxidative stress status could be reflected in the higher liver functionality index for cows receiving rumen protected methionine (RPM). We reported that lesser mRNA expression of genes involved in inflammatory processes such as *IL6, IL8, IL-1b, PTGES3, TSPO, SOD1,* and *MUC1* are indications that cows that are fed RPM throughout the transition period had a less inflammatory uterine environment after 15 days in milk, likely reflecting an improvement in their uterine resilience mechanism and capacity to prevent uterine diseases from happening. Furthermore, the greater mRNA expression of *FGF7, MAT1A, LCAT,* and *SAAH* demonstrate that RPM can also be involved in the cells' nutrient metabolism and proliferation processes that are crucial for uterine regeneration and preparation for conception.

Q11: Phil, you showed an increase in the gene expression of lipoproteins. Was this due to a higher amino acid requirement or what do you think is the mode of action?

Phil: Most likely, cell proliferation and lipid transport, needed at that moment, is the driver for the higher expression of apoliprotein.

Q12: What would be a good or "normal" level/amount of selenium? And what would be considered too low/little?

Darren: This would vary much depending on whether you are asking what dietary levels are good or what indicators you are using to determine selenium status. Are you also asking whether the amount of selenium offered is to prevent clinical disease or maximise selenoprotein expression? You would also need to consider the species of animal, some animals (particularly horses) are much less tolerant of dietary selenium than others. What is the purpose of the animal? Is it subject to metabolic demands? To prevent clinical manifestations of a selenium deficiency does not necessarily require particularly high selenium doses, however, it is likely that problems that go unseen (subclinical deficiency) are more of an issue. In general, selenium inclusion into animal diets is limited by legislation, and those limits are certainly sufficient to prevent clinical manifestations of a deficiency. However, there is emerging research that shows that selenoprotein expression continues to increase as dietary inclusion moves beyond those permitted by current

legislation. It should not be forgotten that legislation limiting inclusion in animal diets is probably intended to protect high consumers of animal products.

Q13: Do you know if selenomethionine and methionine would affect other animal's health and reproduction similarly (for example, horses instead of dairy cattle)?

Darren: There has been significant research on a range of food producing animal species that have reported benefits of supplying Selenomethionine based supplements over inorganic mineral salts. The degree and type of response will be affected by species, age of animal, purpose of the animal, duration of supplementation, and the particular variable of interest; some biochemistry and haematology parameters are unaffected by selenium.

Q14: Can inorganic Se satisfy the Se status and permit sufficient in de novo synthesis of Selenoprotein? Some data suggested that up to 40% of the selenoproteins end up in the milk.

Darren: Inorganic selenium sources were used successfully to alleviate problems with clinical selenium deficiency long before the advent of manufactured organic selenium sources, so in essence it could be argued that inorganic selenium would permit sufficient de novo synthesis of selenoproteins. However, as mentioned in my talk there are a number of issues with inorganic sources. Firstly, they are much less available to the animal, particularly ruminants, as a significant proportion is reduced in the rumen environment making it unavailable to the animal. Secondly, inorganic forms need to be in constant supply since that which is not utilised for selenoprotein synthesis enters a methylation pathway and is excreted from the body. Selenomethionine is not subjected to the same degree of ruminal degradation and is therefore more available to the animal. Selenomethionine can be stored non-specifically into body tissue and forms an endogenous selenium pool that can provide benefits during times of reduced selenium intake or increased metabolic stress. Selenomethionine is markedly less toxic than selenium salts. More recent evidence has shown that selenocysteine in tissues is elevated when hydroxyselenomethionine is used as a selenium source, elevated selenocysteine is thought to be indicative of increased selenoprotein expression.

Q15: Could organic Se-methionine supplement have a beneficial effect on embryo survival in ewes? And increase embryo numbers?

Darren: An interesting question. Research conducted about 25 years ago on the effects of supplemental Se on embryo survival in sheep used inorganic forms and reported that supplemental (inorganic) Se had a detrimental effect on embryo survival (although no reported biochemical indication of selenosis). More recent studies are more variable in their findings. Some studies suggest that Selenomethionine based Se sources can have beneficial effects on colostrum Se and subsequent IgG uptake (similar to that reported in cattle), as well as foetal mass which may have been mediated by selenium induced changes to the placenta. Equally, there are a number of studies that report no effect of supplemental selenium to embryo number/foetal outcome. This would suggest that the effects of the maternal selenium supply are not just simple selenium supply but potentially influenced by a number of other contributing factors (nutrition [adequacy and exposure to other trace elements], environmental, etc.).

Q16: Do you know what the relative safety/ toxicity is for the different Se sources (inorganic vs. SeY vs. SeMet/ OH-SeMet)?

Darren: The LD50 of selenite has values ranging between 1 and 5 mg/kg bodyweight depending on laboratory species. The opinion of EFSA (European food safety) is that Selenomethionine is significantly more tolerable than selenium salts, and based on generally available data the difference between toxic levels of Selenomethionine and selenium salts can be three to four times higher (simply because of the way in which the body deals with the different forms of selenium). What needs to be considered is the proportion of any selenium supplement that comprises Selenomethionine (Not all Selenomethionine based supplements are totally Selenomethionine. They may contain a proportion of other selenium containing fractions that may have similar toxicity to that of selenium salts). That said, there are strict limits on the inclusion rates of selenium supplements which are significantly lower than doses associated with toxicity.

Q17: We know that SeMet can improve the selenoprotein status of the animal, and thus there is an improvement in ALA and EPA and DHA concentrations. How will this affect immunological responses and the productive/reproductive performance in male and female cattle?

Darren: There are reported changes to fatty acid profiles in monogastric species to selenium dose and source, but I am not particularly familiar with selenium induced changes to ALA, EPA and DHA in cattle, although it is acknowledged that selenium has been reported as one cofactor in the conversion pathway of ALA to DHA and EPA. That said, longer chain PUFAs have been shown to have anti-inflammatory properties in high-yielding dairy cattle, and there is evidence to suggest that supplementing cattle diets with PUFAs increases calving rate.

Q18: Does the new NASEM change calculated selenium requirements/allowances? Does it state a requirement for organic selenium?

Darren: I have tried to find further information on this with little success. From details that I have been able to find, it appears that nine trace elements were considered (for adequate intake), seven were revised (albeit not dramatically) but iron and selenium were left unchanged. Furthermore, NASEM recommends approximately 0.3 mg total Se/kg intake for dairy cattle, which is the legal limit in the US hence why it remained unchanged?

The answers to these questions are provided in good faith
and are the scientific opinions uniquely of Phil Cardoso,
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and Darren T. Juniper, retired, former Associate Professor of Animal Science,
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