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# EQUOL AND ENTEROLACTONE

Two mammalian phytoestrogens  
with estrogenic potency  
found in organically produced milk

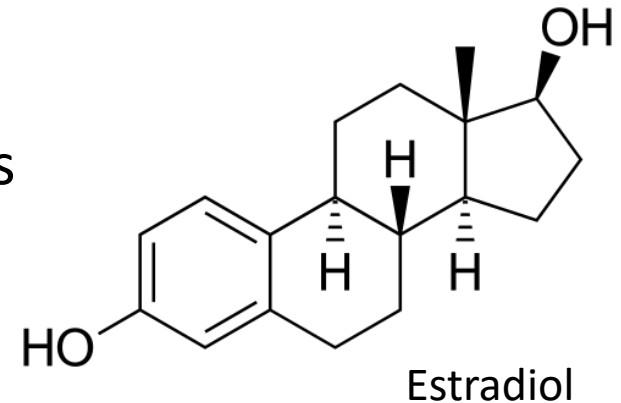
Steffen Adler & Håvard Steinshamn, Norwegian Institute of Bioeconomy Research

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# Phytoestrogens in organically produced milk

## Background

- Plant derived compounds similar to estradiol
- May induce or inhibit the response on hormone receptors in animals or humans
- May impair fertility in sheep
- In cattle effects not consistent
- In humans: Protect against cancers, prevent osteoporosis, function as antioxidant, negative side effects



# Phytoestrogens in organically produced milk

## Background

### Isoflavones

Biochanin A

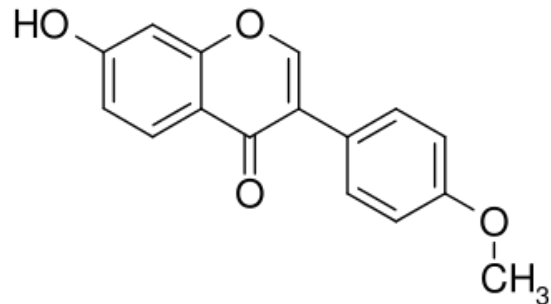
Genistein

Formononetin

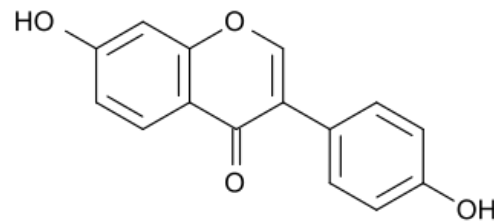
Daidzein

Prunetin

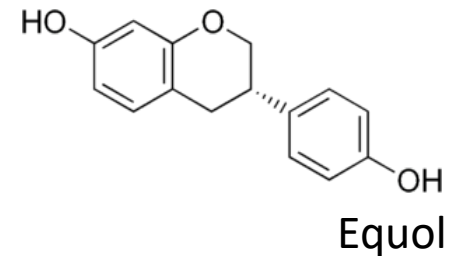
Equol



Formononetin



Daidzein



Equol

Protect against cancers, prevent osteoporosis, function as antioxidant, negative side effects.

# Phytoestrogens in organically produced milk

## Background

### Lignans

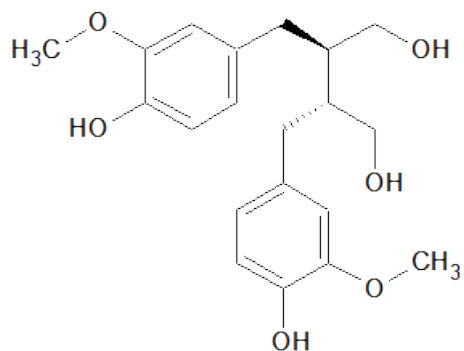
Secoisolariciresinol

Matairesinol

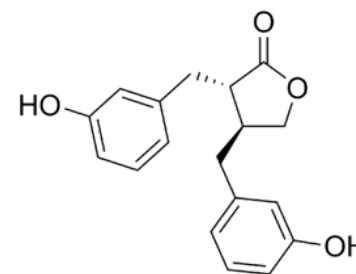
Enterodiol

Enterolactone

Sum lignans



Secoisolariciresinol



Enterolactone

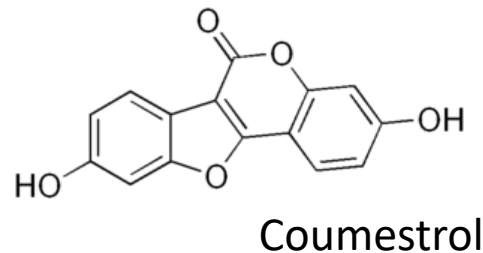
Enterolactone is anti-carcinogenic and lignans may be protective of cardiovascular disease (Adlercreutz, 2007; Peterson et al., 2010).

# Phytoestrogens in organically produced milk

## Background

Coumestans

Coumestrol<sup>10</sup>



Maximum tolerable daily intake of in humans 22  $\mu\text{g}$  per kg of body mass (Shaw, 2009). Positive health effects not clear.

# Phytoestrogens in organically produced milk

## Objective

Study the relationship between intake of forage legumes and milk content of equol and enterolactone in organically managed dairy cows.

# Phytoestrogens in organically produced milk

## Material

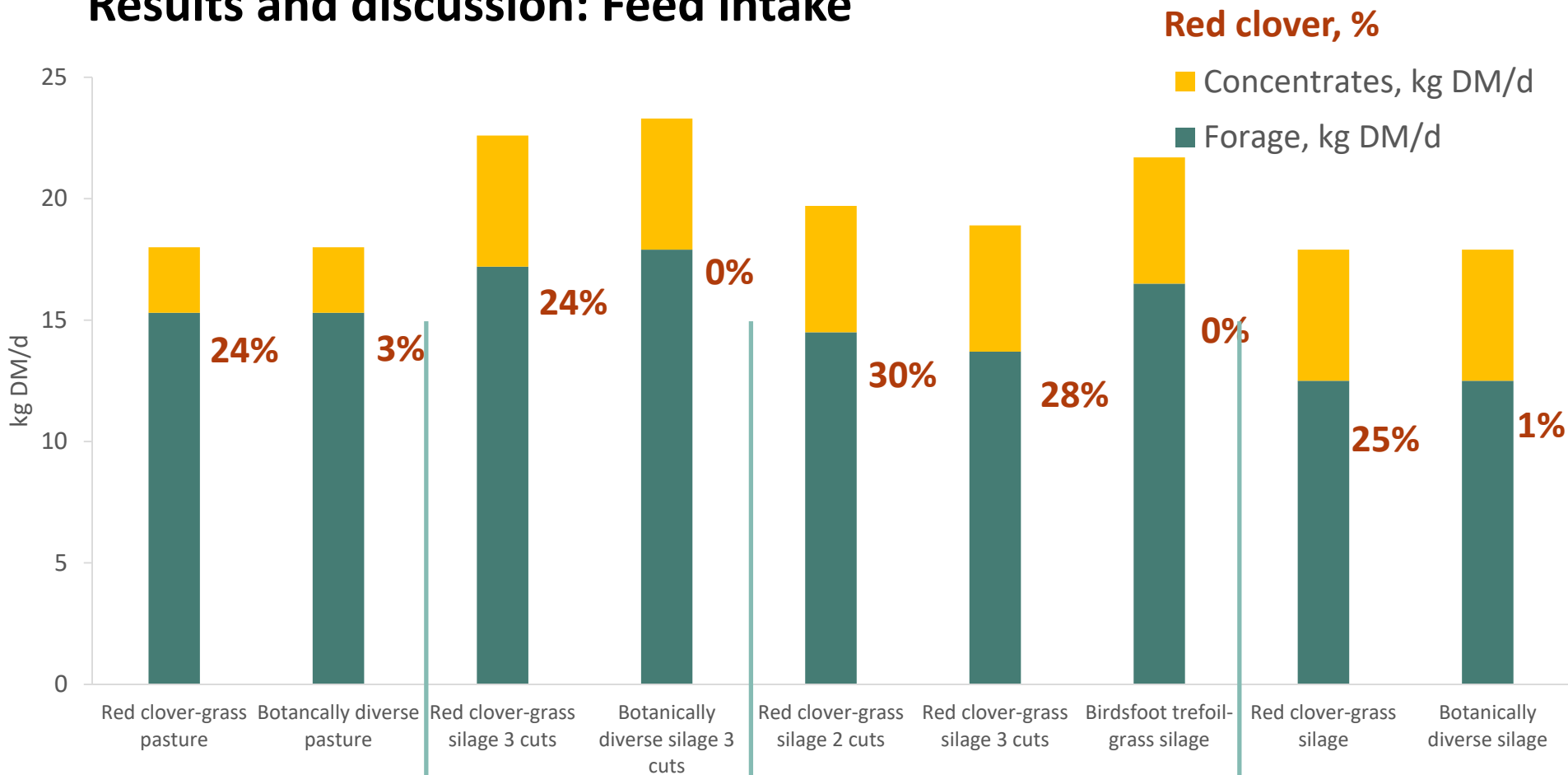
- Grazing experiment, Norway 2009
- Silage feeding experiment, Norway and Sweden 2008
- Metabolism study, silage, Norway 2007/2008
- Farm study, Norway 2007-2008

## Analysis methods

- Liquid chromatography-tandem mass spectrometry technique (Micromass, Manchester, UK) with standard addition (Steinshamn et al., 2008)

# Phytoestrogens in organically produced milk

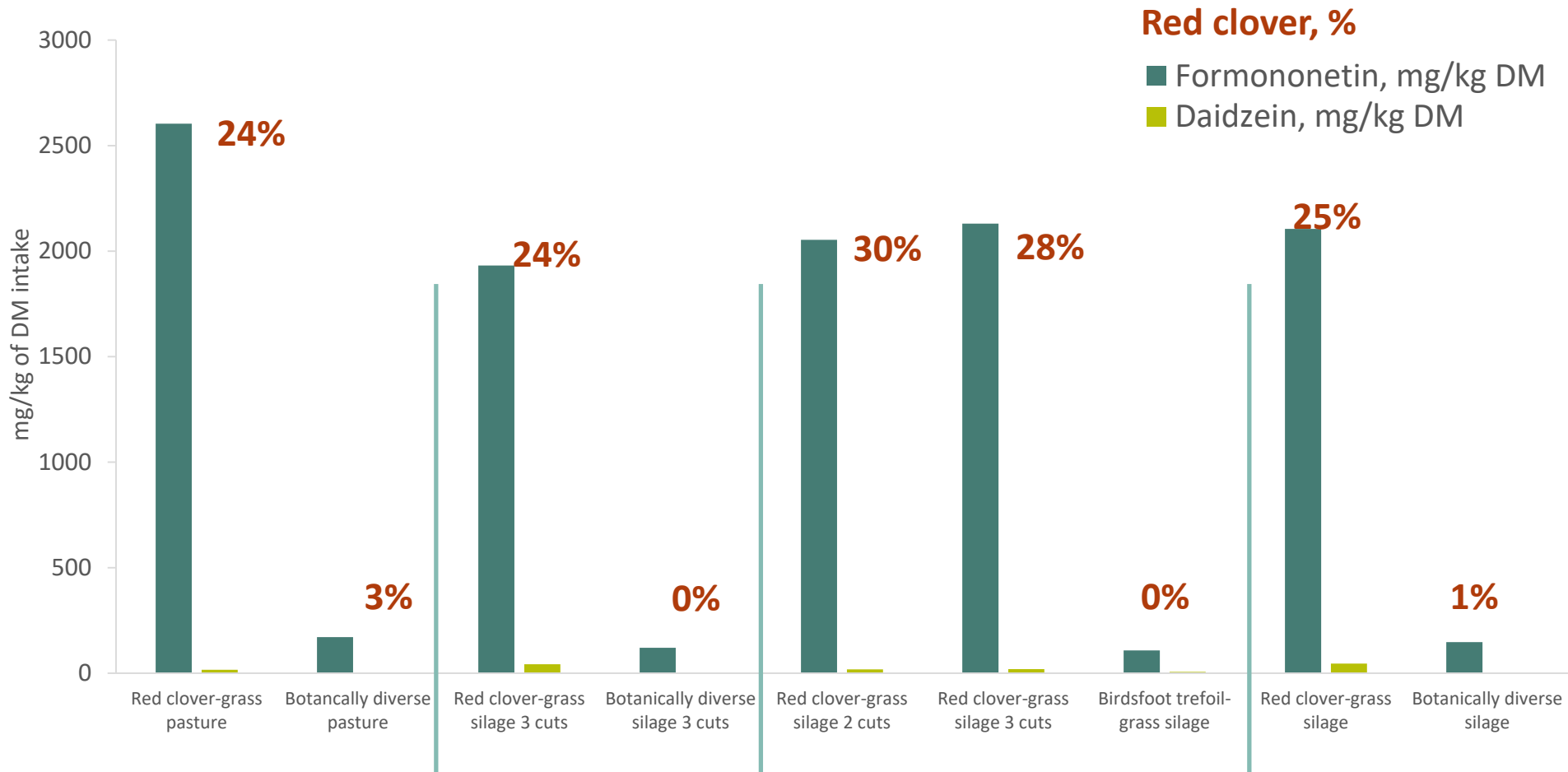
## Results and discussion: Feed intake





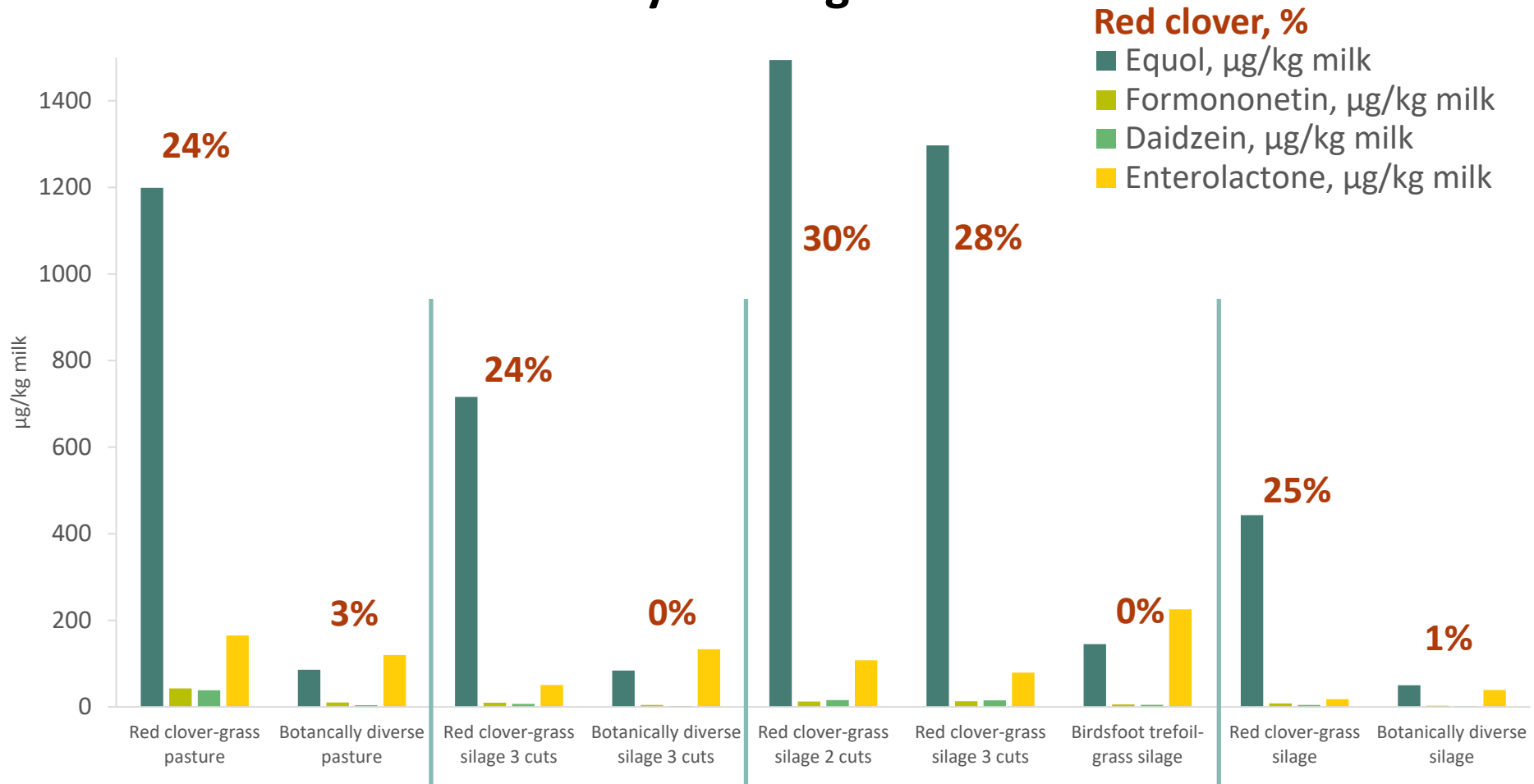
# Phytoestrogens in organically produced milk

## Results and discussion: Isoflavone intake



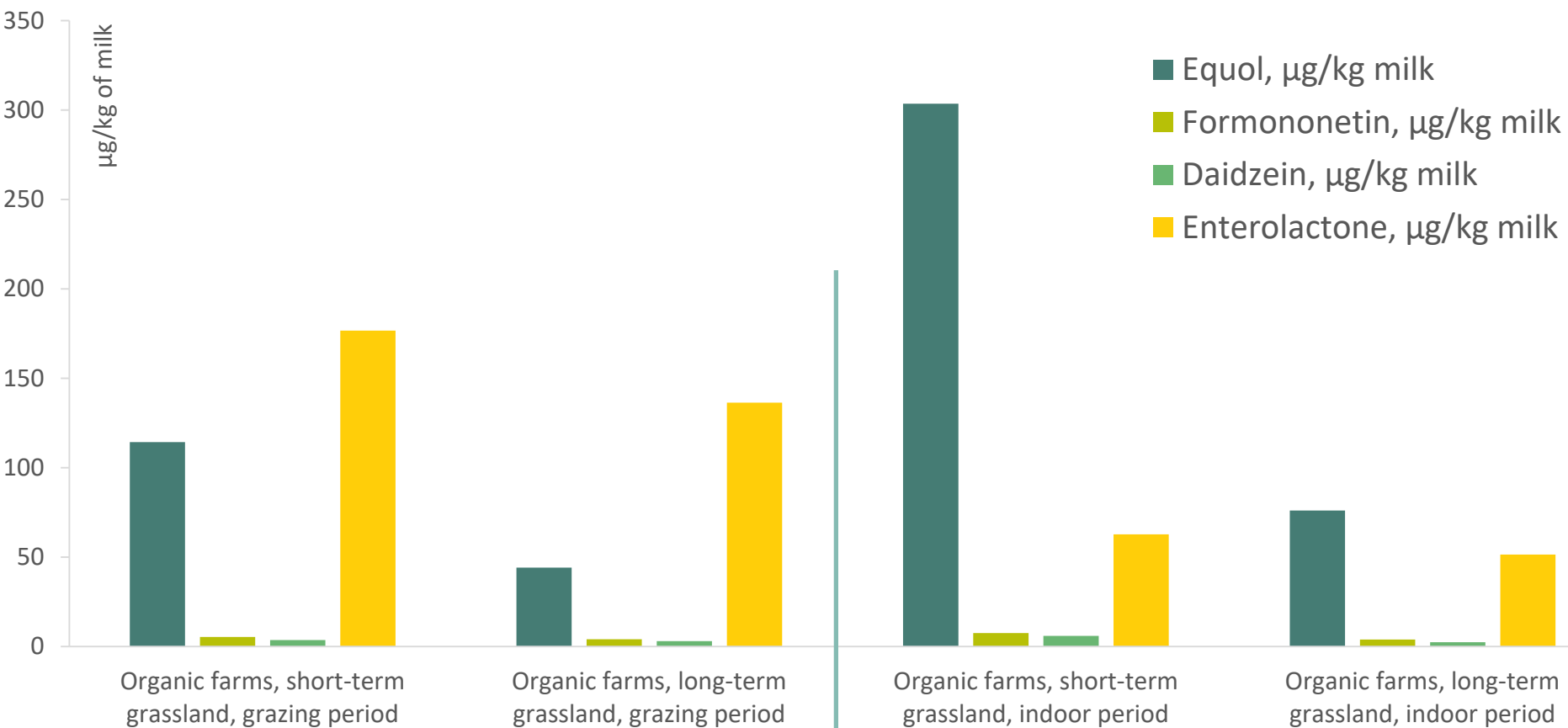
# Phytoestrogens in organically produced milk

## Results and discussion: Phytoestrogens in milk



# Phytoestrogens in organically produced milk

## Results and discussion: Farm study



# Phytoestrogens in organically produced milk

## Key results and discussion: Individual differences

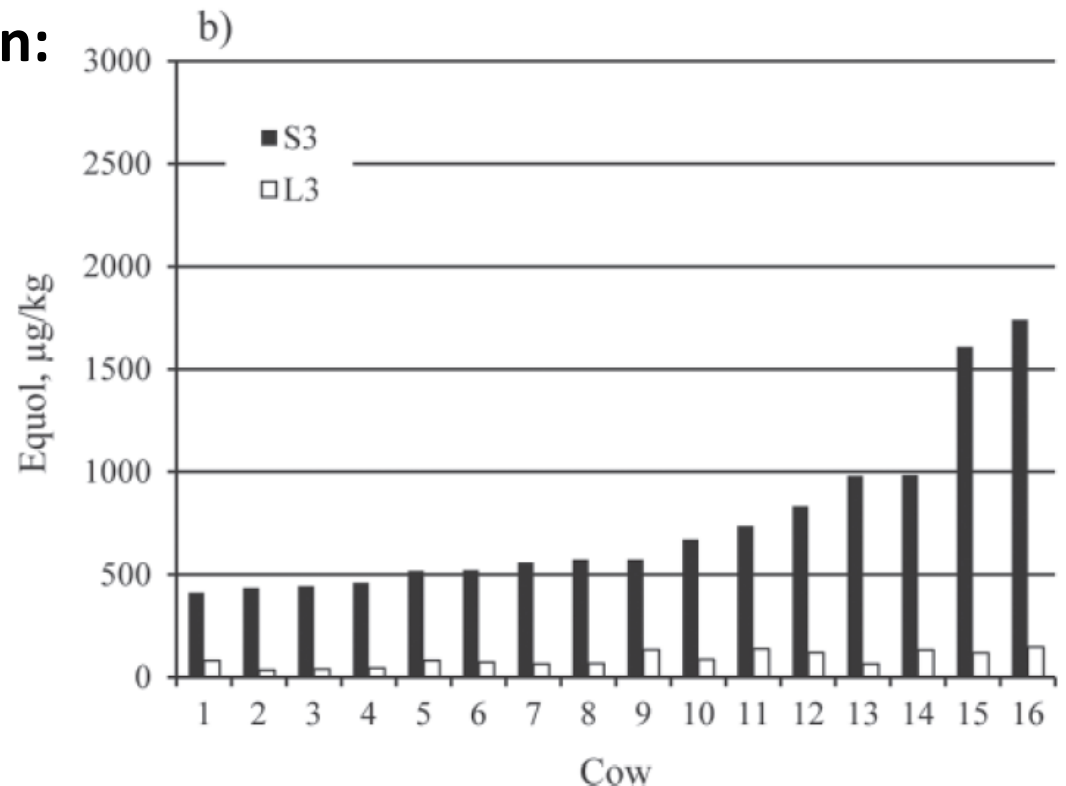


Figure 1. Variation in equol concentration ( $\mu\text{g}/\text{kg}$ ) in milk among cows fed: (a) 2-cut birdsfoot trefoil-grass silage (B2), 2-cut red clover-grass silage (R2), or 3-cut red clover-grass silage (R3), and (b) short-term ley silage (S3) or long-term ley silage (L3).

# Phytoestrogens in organically produced milk

## Results and discussion: Metabolism

- Isoflavones and lignans were extensively metabolized in the rumen on all diets
- 11% of dietary formononetin and daidzein recovered in omasum, mainly as equol
- Intestinal metabolism was less severe
- Main route of excretion was through feces and urine
- Unknown enterolactone precursors other than matairesinol and secoisolariciresinol in forages

# Phytoestrogens in organically produced milk

## Conclusions

- High concentrations of equol in “red clover milk” (organic milk) (Antignac et al., 2003; Mustonen et al. (2009))
- More enterolactone in pasture milk
- Unknown enterolactone precursors
- Small amounts of coumestrol
- Humans consuming soy products have a higher isoflavone intake than humans consuming red clover milk
- But not all humans can produce equol
- Equol has higher estrogen potency than isoflavones
- Red clover milk may be a functional food, but negative side effects possible

# Phytoestrogens in organically produced milk

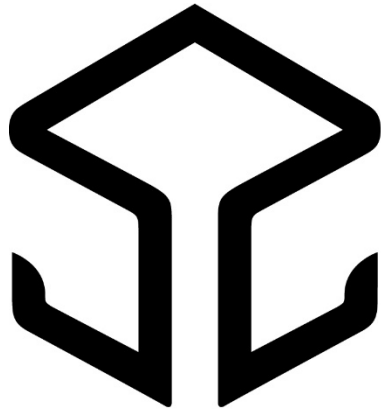
## Implications

- Plant derived phytoestrogens can cause estrogenic and anti-estrogenic effects in animals and humans
- Red clover milk has high concentration of equol and may be considered a functional food, but possible health effects may depend on many factors
- Organically produced milk is not necessarily based on red clover feed



Thank you for listening!





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