Water Quality for Dairy Animals

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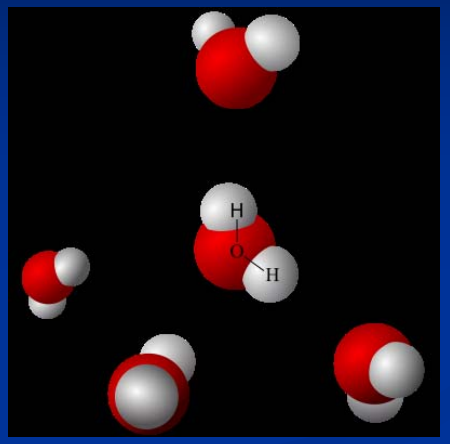
What is Water?

Chemistry (very simple)



Physiology (very complex)

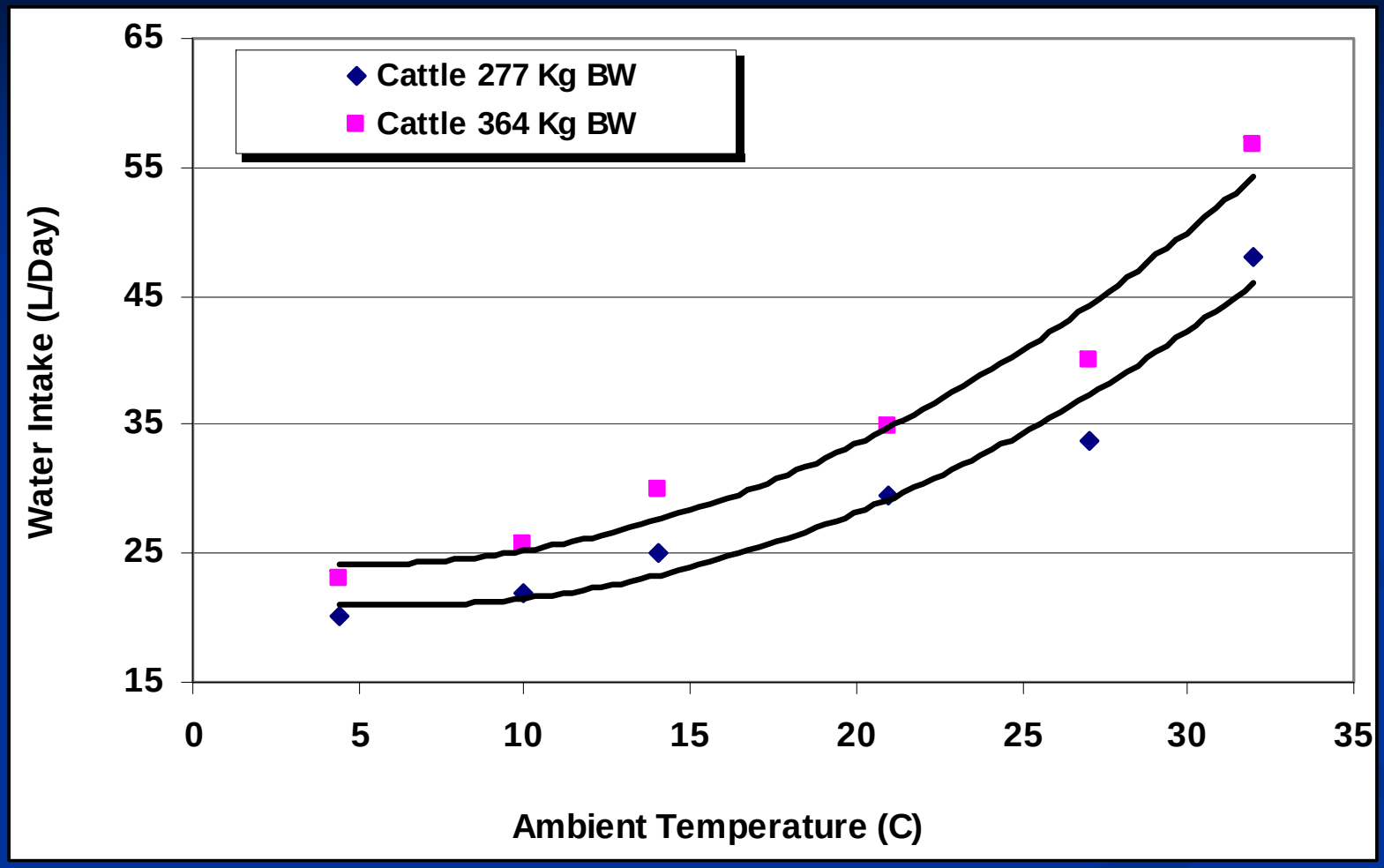
Water is an Essential Nutrient

- ***unreservedly required for all basic physiological and metabolic functions of the body***

How Much Water is Required by Animals?

Water Requirement Varies Depending on Several Variables

- **feed characteristics**
- **environment**
- **animal physiological status**
- **production mode**


Cattle 277 Kg BW
Cattle 364 Kg BW
Water Intake (L/Day)
65
55
45
35
25
15
0
5
10
15
20
25
30
35
Ambient Temperature (C)

Lactating Cows (600 kg) Milk yield:	Water Intake at Temp 10oC	Water Intake at Temp 32oC
15 kg/day	59	89
30 kg/day	92	146
45 kg/day	124	203

Relative to other nutrients, water is consumed in considerably larger quantities

but, in most situations “water” that we use for drinking is not just water, but rather a solvent for many contaminants

Because water is consumed in large quantities, intake of water contaminants can reach level that may be detrimental

Water availability and quality are <u>extremely</u> important for animal health and productivity

- ***limiting water availability to animals will depress production rapidly and severely***
- ***poor quality drinking water is often a major factor limiting water intake***

Understanding Water Quality Problems

The key factors that must be taken into consideration while assessing water quality for dairy include:

- sensory attributes such as odor and taste
- physiochemical properties
- chemical composition
- biological contaminants (protozoa, bacteria, algae, viruses)

Water quality can be affected by many factors

- organic contaminants
  - living organisms, decaying organic matter, sewage, industrial waste contaminants
- mineral contaminants
- dissolved gases such as hydrogen sulfide, which may give a rotten-egg odour
- water treatment and disinfection chemicals, as well as disinfection by-products

On average, 35% of SK farm water sources exceeded acceptable concentrations of health related parameters listed in the *Guidelines for Canadian Drinking Water Quality*

(Sketchell and Shaheen, 2001)

Understanding Water Quality Problems

While assessing the risk of adverse effects that may be associated with water quality at least two major factors must be considered

- water intake
- concentration of the contaminant

Water As Toxicological Hazard: Risk Assessment

It is a common practice that water contaminants are evaluated as a "stand alone" problem, but in reality, while assessing potential hazards associated with water contaminants, total intake from all sources (water, feed, supplements etc.) must be considered

- feed or feed ingredients may contain high levels of the same contaminants that are present in water (cumulative effect)
  - levels of contaminants in feedstuffs are strongly influenced by environmental variables

Water As Toxicological Hazard

- Naturally Occurring Contaminants
- Agricultural Contaminants
  - fertilizers, pesticides, herbicides, waste, nutrients, pathogens, oil, gas, paint, and wood preservatives
- Industrial Contaminants
  - PCB, dioxins, organic compounds, minerals, etc
- Biological Contaminants
- Biologically Active Contaminants

Biologically Active Contaminants

Pollutants, Natural metabolites, Pharmaceuticals

- pollutant with known endocrine effects
  - some organochlorine pesticides, polychlorinated biphenyls, various phenolic compounds
- hormones excreted by humans and animals
  - natural and used in human and veterinary medicine
  - growing environmental concern
  - may be of significance in areas where large number of animals are raised

Hormonally active chemicals/pharmaceuticals may stimulate a physiological response

- *e.g. potential problems with fertility*

Water borne endocrine disruptors are being increasingly recognized as a growing environmental concern

In livestock industry this aspect of water borne contaminants is poorly understood, and probably grossly underappreciated problem

Biological Contaminants

Direct hazard associated with water born microorganizms is a real and present concern:

- ***protozoa, bacteria, algae, viruses***
- ***many surface water sources are contaminated***

In modern dairy agriculture, strict management of water supplies must take into consideration contamination with water-borne microbial pathogens

Table 2.2 Total Coliform Bacteria and *E.coli* Bacteria Counts in Saskatchewan Groundwater Sources.

	Coliform Bacteria		E.coli Bacteria	
Bacteria Counts (CFU* per 100 mL)	No. of Samples	Percent of Total	No. of Samples	Percent of Total
≤1	2164	74.7	321	99.1
1 to 10	278	9.6	2	0.6
10 to 100	271	9.3	1	0.3
>100	185	6.4	0	0.0

Source: Saskatchewan Watershed Authority Rural Water Quality Data Base

The data presented above would suggest that in Saskatchewan the bacteria contamination of groundwater may not be a major problem,

but, a low count of bacteria at the source of water does not mean that there is no problem in the barn!!!

Note: A contamination of water at the level of watering bowl may introduce high numbers of organisms into a group of animals, and this scenario may create a significant 'multiplier' effect.

The actual risk of waterborne pathogens in dairies may higher then we think.

Example: Most Recent Study by Toth et al., 2013. J. Dairy Sci. 96 :5756–5761

A survey was conducted on 13 dairies in the USA to determine the occurrence of animal-borne pathogens (Salmonella enterica, Escherichia coli O157:H7, Campylobacter jejuni, Mycobacterium avium ssp. paratuberculosis, and Cryptosporidium parvum) and their distributions across farm elements (feces, bedding, milk filters, stored manure, field soil, and stream water).

Of note, in this study, all but one farm were positive for at least one pathogen species, and 5 farms were positive for 3 species.

In this study, the highest occurrence of pathogens (73%) was in stored manure followed by feces (50%), milk filters, bedding, and water (range from 23 to 31%).

Escherichia coli O157:H7 was detected on 6 farms and in all farm elements, including milk filters.

Note: Cattle that carry E. coli O157 are asymptomatic, but in humans this pathogen may cause severe disease, and in many cases is the cause of death.

Mere presence of E. coli O157 in water sources may increase the risk of product (milk, meat) cross-contamination, which may have far reaching consequences on consumer confidence. Thus, water quality programs should be among the key control points in dairy farm pathogen reduction strategies.

Mineral Contaminants

- elements such as Ca, Fe, Mg, Mn, Se, S, may occur in some water sources at concentration that may be of toxicological significance
- heavy metals Cd, Hg, Pb, As
  - occur naturally in some water sources
  - associated with industrial pollution
- nitrites and nitrates

Major Problems Associated with Water Quality In Saskatchewan

Water is a significant contributor to the overall load of dietary **SULFUR** in Saskatchewan

- Conservative Estimates (based on limited studies)
  - 25 to 30% of farms involved in cattle business use water with sulphate levels between 1000-1500 ppm
  - 5 to 10% of cases the sulfate level in drinking water may exceed 3000 ppm
  - on some farms drinking water contained as much as 5000 to 7800 ppm of sulfate

The Significance of Water Sulfur In Saskatchewan Livestock Industry

An even moderately high content of S in the water may significantly affect overall S intake

- For instance, the consumption of water containing 1000 ppm of sulfate can contribute up to 0.27 % of dietary sulfur

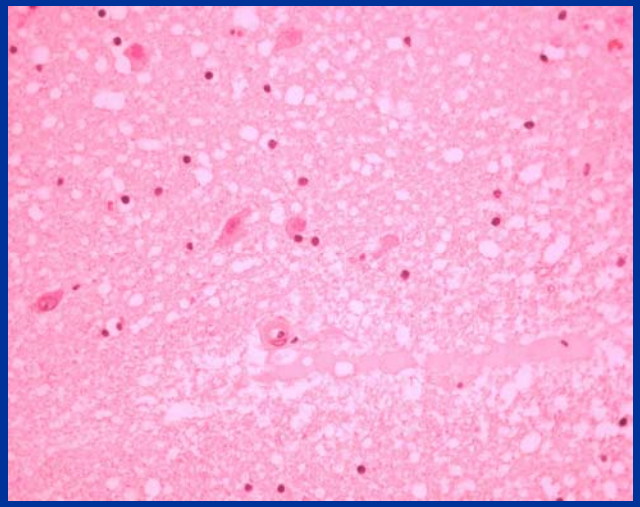
Dietary S above 0.3 - 0.4% is generally considered excessive and may cause significant health and metabolic effects

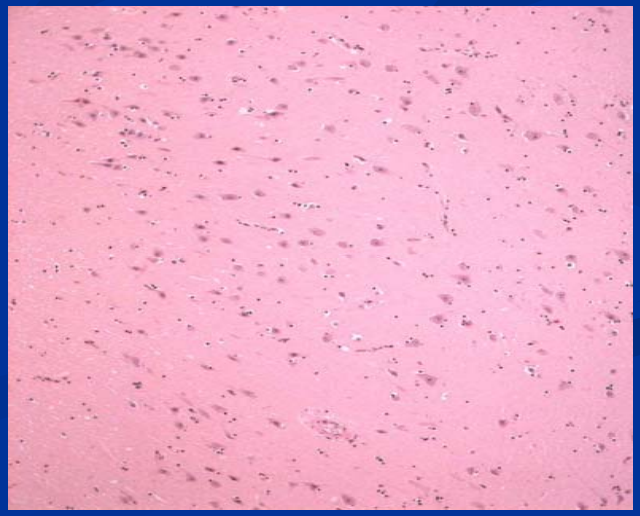
Excess Dietary Sulfur has been shown to cause a wide range of metabolic disturbances, significant adverse health effects, and death of animals

Sulfur Toxicity

In cattle, excess intake of sulfur may cause severe lesions in the brain, and death of the affected animal

Brain Lesions are characteristic of Bovine Spongiform Encephalopathy (BSE)



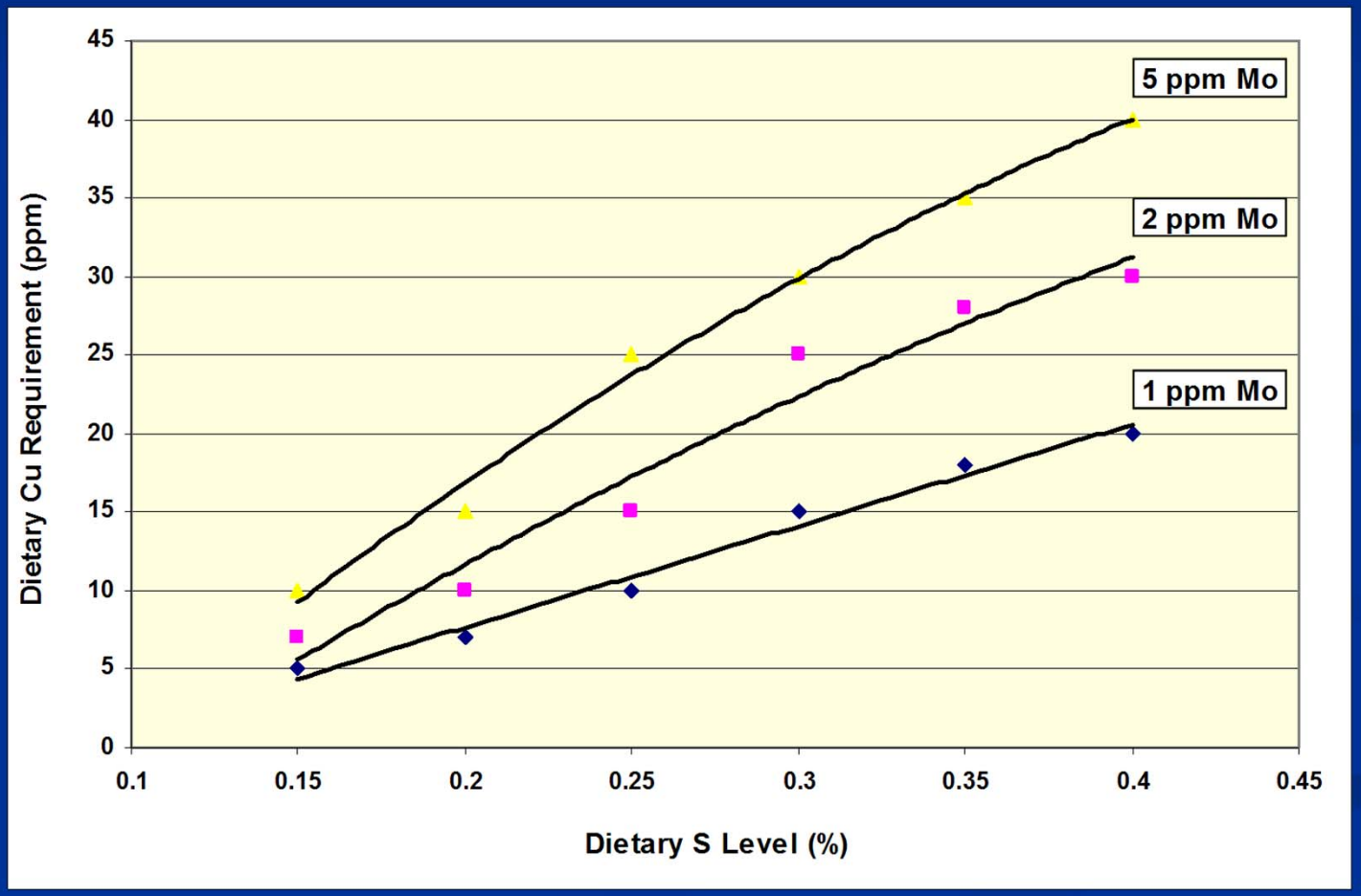


Metabolic Interactions:
Sulfur and Molybdenum Induced Copper Deficiency

Molybdenum is an important factor aggravating metabolic effects of excess dietary sulfur

- Mo concentration in water and feed varies considerably, depending on the environmental and industrial factors
- major synergistic effects of sulfur and Mo in ruminants
  - molybdenum-sulfur-copper interaction
  - even marginally excessive intake can result in serious metabolic disturbances in ruminant animals

Three Way Metabolic Interactions: Sulfur and Molybdenum Induced Copper Deficiency



The Significance Of Water Quality In Dairy Industry

Economic success of the dairy industry in Canada, is based on three fundamental parameters

- reproductive success
- milk yield
- product quality

Any of these parameters can be affected by water contaminants at a very subtle, sub-clinical, metabolic level resulting in significant production losses

Knowledge and ability to recognize the complex issues associated with water contaminants is essential for the rapid detection of problems and effective management of the adverse effects.

The End