Effect of total solid contents in drinking water and milk yield per cow on milk mineral concentrations from California dairy farms

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INTRODUCTION

In order to comply with nutrient management plans, accurate estimates of manure and nutrient excretion are needed. So, adequate manure storage facilities can be designed for effective nutrient management plans (Nennich, et al. 2005).

Different authors (Van Horn, et al., 1994, Beede and Davison, 1999, Weiss and Wyatt, 2004) have suggested estimating mineral excretion in dairy cows by subtracting the amount secreted in milk from the total daily intake.

The concentration of minerals in milk are assumed constant and book values are used rather than assayed values (e.g., NRC, 2001).

In many cases, drinking water total solid contents (**TS**) are ignored to estimate mineral requirements and/or mineral excretion.

Our hypothesis is that drinking water TS contents and milk yield per cow (**MY**) may affect milk mineral contents.

OBJECTIVE

The objective was to evaluate the association of water **TS** contents and **MY** on milk mineral contents.

METHODS

Dairies Surveyed

Number of dairies: 40
Location: Merced County, CA
Means (ranges) of:
- Herd size: 787 lactating cows (210 to 2435)
- Milk yield: 31.8 kg 3.5%FCM/cow per day (20.6 to 43.5)
- Total Solids (TS) in drinking water: 550 mg/L (100 to 1700)

Samples

Drinking water samples were collected from water troughs

Milk samples (am + pm) were collected from bulk tanks

All samples were collected in duplicate on two non-consecutive days with no more than one week in between each sample and its duplicate

Chemical Analysis & variables studies

Water was analyzed to estimate TS content by oven drying (105ºC, 24 h)

Bulk tank milk samples were analyzed for milk mineral composition by wet chemistry: calcium, phosphorus, magnesium, chloride, potassium, sodium, sulfur, copper, iron, manganese, selenium, and zinc, at the UC Davis, ANR Analytical Lab.

Data analysis

Forty dairies divided in four groups (10 dairies/group) were selected according to drinking water TS content and MY: high (H) and low (L) water TS (HTS > 500 mg/L and LTS < 500 mg/L), and high and low MY (HMY > 32 kg/d and LMY < 32 kg/cow per day); and analyzed as 2 x 2 factorial design. The model included effects of water TS, MY, and its interactions: LTSLMY, LTSHMY, HTSLMY, and HTSHMY.

RESULTS

Means (ranges) of drinking water TS (**mg/L**) were: 809 (535 to 1683) and 307 (100 to 515) for HTS and LTS; and MY (**kg 3.5%FCM/cow per day**) were: 36.0 (31.6 to 43.5) and 27.6 (20.6 to 31.6) for HMY and LMY, respectively.

Milk mineral concentration (**mg/L**) means (ranges) were: **Ca** 1008 (930 to 1114); **P** 906 (845 to 1019); **Mg** 100 (88 to 109); **K** 1534 (1405 to 1670); **Na** 397 (327 to 459); **Cl** 1045 (925 to 1305); **S** 308 (288 to 338); **Cu** 0.036 (0.018 to 0.063); **Fe** 0.159 (0.136 to 0.233); **Mn** 0.016 (0.011 to 0.024); **Zn** 3.28 (2.8 to 3.8); **Se** 0.033 (0.013 to 0.049).

The associations between water TS and MY are presented in **Table 1**. Milk mineral composition from dairies with HTS water had lower ($P < 0.1$) percentage of the following minerals: K (-2), S (-2), and higher Mn (+15). Milk from dairies with HMY had significantly lower percentage of: Ca (-2.3), P (-3.1), Na (-5), S (-3), and Cu (-14). The Ca and Mg milk contents were higher on LTSLMY interaction, 4% and 3% respectively, respect to the other interactions.

Except P and K (similar milk contents to the NRC), lower milk contents of Ca, Mg, Cl, Na, Cu, Fe, Mn, and Zn were obtained when compared to the NRC 2001 values (Table 1). The milk contents of S and Se in the NRC are not used for requirement calculations.

Table 1. Effect of drinking water total solids contents and milk yield per cow on milk mineral composition.

Milk minerals	Water effects (W)		Milk effects (M)			W	M	W*M	NRC[4]
(mg/L)	LTS[1]	HTS	LMY	HMY	SE[2]	*P*-values[3]			2001
Calcium	1016	1001	1021	998	6.9		**	**	1220
Phosphorus	914	898	920	893	6.9		**		900
Magnesium	101	100	101	100	1.2			*	150
Chloride	1057	1033	1065	1025	17.7				1150
Potasium	1549	1519	1538	1531	11.0	*			1500
Sodium	392	401	407	386	6.0		**		630
Sulfur	311	305	313	303	2.2	*	**		---
Copper	0.039	0.036	0.040	0.035	0.002		*		0.15
Iron	0.159	0.162	0.165	0.156	0.005				1
Manganese	0.016	0.019	0.018	0.017	0.001	*			0.03
Selenium	0.033	0.034	0.033	0.034	0.002				---
Zinc	3.301	3.266	3.232	3.245	0.047				4

(1) LTS/HTS : low & high total solids in water, LMY/HMY: low & high milk yield per cow
(2) SE: standar error of the mean
(3) P-values: ** $P<0.05$; * $P<0.10$
(4) NRC (2001) mineral milk contents for requirement calculations

CONCLUSIONS & REFERENCES

The results indicate that milk mineral contents might be affected by drinking water TS contents and MY.

High MY (36.0 kg/d) affected milk Ca, P, Na, S, and Cu contents respect low MY (27.6 kg/d). This response was likely associated with dilution effect. More research is needed to evaluate the observed water TS effects on the milk mineral contents.

The milk mineral differences with the NRC 2001 indicates that milk mineral contents should be adjusted to every local conditions for requirement and mineral excretion estimations.

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