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Mineral content of chicory (*Cichorium intybus*) and narrow leaf plantain (*Plantago lanceolata*) in grass-white clover mixtures

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ABSTRACT

Organic dairy farmers in The Netherlands seek for system solutions to reduce the dependence on external minerals for supplementation of their dairy cows. In general herbs are known for a higher mineral content than grass. The objective of this study is to investigate the mineral content of chicory (*Cichorium intybus*) and narrow leaf plantain (*Plantago lanceolata*) in grass-white clover (*Trifolium repens*) mixtures. On five organic dairy farms on sandy soil and three farms on clayey soil, a mixture of grass (*Lolium perenne*), white clover, chicory and narrow leaf plantain were established in each of three years. From each mixture one fresh sample was taken at cutting stage in three following years. From the fresh samples the different plant species in the mixtures were separated and analysed on mineral content. Chicory had higher mineral content than grass and white clover. Most significant differences in mineral content between chicory and grass and white clover were for sulphur, copper and zinc. However, before chicory is recommended for increasing the mineral status, possible negative aspects of this herb such as lower DM intake by the animal, bitter milk taste and reduced absorption of copper through interaction with sulphur should be taken into account.

INTRODUCTION

Herbs can be included in grass clover mixtures for different reasons. For example a group of Danish dairy farmers, who are delivering their milk to a certain factory, grow a mixture of grass-clover with herbs for sector image purposes. Another reason for including herbs is enhancing functional biodiversity. For example, through the deep rooting system, chicory is able to utilize sub-soil N which is not used by ryegrass (Høgh-Jensen *et al.* 2006). Another form of functional biodiversity is the better production from narrow leaf plantain under drought conditions (Van Eekeren, unpublished results). On the other side it is also important that the dry matter production of the mixtures with herbs is not negatively influenced. The same goes for animal intake. For a lot of herbs it is known that they are very palatable for livestock. However, in the Netherlands it is the experience that goats avoid chicory when they are given a choice. Looking at milk production, Eriksen *et al.* (2006) could not find significant differences between cows grazing on grass clover with or without chicory. However, they found a barny and bitter taste of the milk from cows grazing on chicory. The presence of plants secondary metabolites (e.g. aucubin, a natural antibiotic in plantain, and condensed tannins and sesquiterpene lactones in chicory) may have positive effects on livestock health. In addition to the above benefits, herbs are known for a higher mineral content than grass. In the literature chicory and narrow leaf plantain are mentioned as potential herbs for inclusion in grass clover mixtures with a higher content of potassium, sodium, calcium, sulphur, boron, manganese,

zinc, copper cobalt and selenium (Crush and Evans 1990, Younie *et al.* 2001). Organic dairy farmers in The Netherlands seek for system solutions to reduce the dependence on external minerals for supplementation of their dairy cows. The objective of this study is to investigate the mineral content of chicory and narrow leaf plantain in grass white clover mixtures on two soil types in the Netherlands.

MATERIAL AND METHODS

On five organic dairy farms on sandy soil and three farms on clayey soil, a mixture of grass (*Lolium perenne*), white clover (*Trifolium repens*, cv. 'Alice' or 'Riesling'), chichory (*Cichorium intybus* cv. 'Forage Feast') and narrow leaf plantain (*Plantago lanceolata*, local cultivar) were sown over the years 2002 to 2004. From each mixture one fresh sample was taken at the time of harvesting. From the fresh samples the different plant species in the mixtures were separated and analysed for mineral content with the AES-ICP method (Atomic Emission Spectrometry-Inductive Coupling Plasma technique). Only selenium was analysed with the AFS method (Atomic Fluorescent Spectrometry technique). Data for sandy and clayey soils were statistically analysed separately with a one way ANOVA, in which farms were treated as randomised blocks.

RESULTS

White clover, chicory and plantain had higher calcium content than grass on both soil types (*Table 1*). On sandy soils, chicory had significant higher contents of sodium, potassium, sulphur, copper and zinc, compared to grass and white clover. On clayey soils the mineral con-

Table 1: Mineral contents of the different crops on sandy and clayey soils

	Sand (5 farms)				Clay (3 farms)		
	Grass	White clover	Chicory	Plantain	Grass	White clover	Chicory
g kg^{-1} DM							
Crude protein	161.6ab	244.9c	179.2b	136.2a	141	235	158
Crude fibre	271	229	239	206	281	276	306
Ash	102.1a	102.6a	153.6b	113.8a	124.7	106.0	130
Calcium	4.67a	11.93b	13.30b	13.24b	6.87a	17.80b	15.10b
Sodium	0.94a	1.94ab	3.78b	1.04a	4.0	4.6	9.1
Phosphorous	4.91b	3.76a	5.76b	4.78ab	5.13b	3.43a	4.60ab
Potassium	36.9a	34.5a	54.6b	39.2a	34.6	25.4	30.6
Sulphur	3.53b	2.38a	5.32c	4.04b	3.97b	2.13a	4.33b
Magnesium	2.45a	3.53b	3.70b	3.20ab	2.42	3.20	3.80
mg kg^{-1} DM							
Iron	177.6c	140.1bc	131.6b	75.2a	148	113	178
Copper	8.85a	7.62a	19.76b	9.74a	8.97a	9.00a	11.97b
Zinc	52.4a	40.2a	229.2b	74.0a	29.7a	22.3a	47.0b
Manganese	101.4ab	77.1ab	117.0b	66.6a	34.8	26.7	29.7
µg kg^{-1} DM							
Cobalt	102	55	114	81	43.3	48.3	82.7
Selenium	43.3	28.9	33.4	42	123	126	220

Note: Values denoted with the same letter on the same line are not significantly different ($P < 0.05$).

ten of chicory was only significantly different from grass and white clover for sulphur, copper and zinc.

DISCUSSION AND CONCLUSIONS

Chicory had significantly higher contents of sulphur, copper and zinc than grass and white clover on both soil types. Therefore, it can be concluded that chicory has potential to be used on farms with a mineral deficiency and more specific a copper or zinc deficiency. Here, the question arises how much the intake of chicory has to be for covering a mineral requirement. For example, on an organic dairy goat farm no external minerals for supplementation were used, and Smolders *et al.* (2005) reported a copper deficiency. Using the daily ration of this farm of 1,5 kg DM grass clover and 1,0 kg DM grain per lactating goat, 40% chicory in the grass clover herbage DM would be necessary to meet the recommended requirement (10 g copper kg DM^{-1}). In this calculation it is assumed that 100% of the copper in the chicory is absorbed. Results of Youni *et al.* (2001) showed that part of the extra copper in chicory is absorbed. In their research the mineral status, including copper, of lambs grazed on 100% chicory was increased in comparison to grass. At the other side Jongbloed *et al.* (2005) argue that copper in the rumen can be bound to sulphur. Since the content if sulphur is also increased with chicory it is not expected that all copper in chicory is absorbed. All together this means that before chicory is used in practice for increasing the mineral status, possible negative aspects of this herb such as lower DM intake by the animal, bitter milk taste and reduced absorption of copper through an interaction with sulphur should be taken into account.

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