The SMCO content of grazing radish compared with other brassicas in New Zealand

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Abstract

The S-methylcysteine-sulphoxide (SMCO) levels of a new multiple grazing radish cultivar, Ceres Graza, were compared with other radish cultivars, swedes, kales, bulb and leaf turnips as well as *Brassica juncea* and *B. carinata* over 3 years at Ceres Research Station near Christchurch. The results showed that radishes, turnips, *B. juncea* and *B. carinata* had a low SMCO content relative to the kale and swede which had the highest content of all the species tested. These results are in general agreement with those published previously for the radishes and commercial Brassica crop species and represent one of the few published data on *B. carinata* and *B. juncea* in New Zealand.

Additional key words: *S-methylcysteine-sulphoxide*

Introduction

Forage brassicas represent a valuable source of winter feed for livestock in that they provide large volumes of quality feed during periods when pasture is incapable of meeting demand. However, several compounds produced by brassicas have the ability to cause animal health problems in ruminants consuming diets with a high proportion of brassica. The role of S-methylcysteine-sulphoxide (SMCO) in causing haemolytic anaemia is well documented (Smith, 1974, 1978; Prache, 1994), although sheep appear less susceptible than cattle to this problem (Carlson and Breeze 1984).

The concentration of SMCO varies between the brassica species and cultivars and there is sufficient genetic variation within a species to breed varieties with lower concentrations of SMCO (Whittle *et al.,* 1976).

Recent advances in the breeding of radish (Stewart, 2004) have produced a late flowering and hairless plant, Ceres Graza (PG545) with the ability to regrow over many cycles of grazing (Stewart and Moorhead, 2004). This material is a result of crosses from diverse sets of genetics and the comparable concentration of SMCO with commercial species is currently unknown.

The aim of this study was to compare the SMCO content of Ceres Graza radish with that of other brassica crops grown in the same environment.

Methods

Replicated trials of a range of brassica and radish cultivars were sown annually in plots of $10m^2$ each year from 2001 to 2003 at Ceres Research Station near Christchurch. The trials contained a range of breeding lines in each species as well as a range of commercial cultivars. These included the kales (*cv.* Sovereign, Gruner, Kestral), swedes (*cv.* Dominion, Winton, Highlander, Major Plus), rapes (*cv.* Winfred, Rangi), turnip (*cv.* Yorkglobe, New York, Greenglobe, Rival), a breeding line of Ethiopian cabbage (*B. carinata*), a number of breeding lines of Chinese root mustard (*B. juncea spp napiformis*) as well as a number of breeding lines of radish including the multiple grazing type, Ceres Graza. The trials were sown in early summer (December, January) under irrigation and were allowed to develop until samples were taken in June.

Table 1. Mean SMCO content (g/kg DM) of leaf, bulb and inedible root from a variety of Cruciferae over 3 years

Crop	Plant Component	No. of samples & cultivars	SMCO content (g/kg DM) Year 1	Year 2	Year 3	Mean
kale	Leaf fodder	31 (18)	7.0 (6.6-7.4)	7.2 (4.1 -12.0)	8.0 (4.1-20.2)	7.4 (4.1-20.2)
swede	Leaf fodder	13 (10)	6.5 (4.6-7.5)	5.6 (4.5 -6.9)	5.5 (4.0-5.6)	5.9 (4.0-7.5)
rape	Leaf fodder	20 (11)	4.7 (3.8-5.3)	3.9 (2.7-6.9)	4.0 (2.2-5.7)	4.2 (2.7-5.7)
turnip	Leaf fodder	13 (8)	3.1 (1.6-4.5)	3.0 (2.2-3.8)	2.6 (2.2-2.9)	2.9 (1.6-4.5)
Ceres Graza radish	Leaf fodder	3 (1)	2.8	3.1	2.3	2.7 (2.3-3.1)
radish mean[1]	Leaf fodder	10 (6)	2.8	3.0 (2.4-3.7)	2.3	2.7 (2.3-3.7)
B. juncea	Leaf fodder	5 (3)	3.5	1.6 (1.6-1.7)	2.7 (2.3-3.1)	2.6 (1.6-3.1)
B. carinata	Leaf fodder	1 (1)	--	2.6	--	2.6
swede	Bulb fodder	8 (7)	6.9 (4.6-10.4)	3.2 (1-7-6.1)	--	5.0 (1.7-10.4)
turnip	Bulb fodder	12 (8)	6.4	4.4 (3.3-5.3)	2.8 (2.2-3.4)	4.5 (2.2-6.4)
B. juncea	Bulb fodder	4 (3)	3.0	4.8	4.5	4.1 (3.0-4.8)
Ceres Graza radish	Inedible root	2 (1)	--	6.1	4.3	5.2 (4.3-6.1)
radish mean	Inedible root	10 (5)	4.4	3.8 (2.8-3.5)	5.2	4.5 (2.8-5.2)
rape	Inedible root	10 (6)	--	4.4 (4.0-4.7)	2.5 (1.2-4.0)	3.5 (1.2-4.7)
kale	Inedible root	2	--	1.9 (1.7-2.0)	--	1.9 (1.7-2.0)
B. carinata	Inedible root	1	--	0.6	--	0.6

1. Mean of all radish breeding lines except Ceres Graza

Leaf and root samples were taken during winter for SMCO analysis. Ten leaves (laminae and petiole) were sampled from each plot while 5 roots were removed and sliced thinly prior to freezing at -20°C. These frozen samples were later freeze dried and ground through a 1mm sieve. A sub-sample (2.75g DM) was extracted in heated methanol and the extract filtered using a 0.45uM syringe filter prior to analysis.

SMCO content was measured using the high performance liquid chromatography (HPLC) method based on Gustine (1985). Differences include the use of a Prodogy column - (Phenomenex Ltd) 5u ODS, (250 x 46 mm) and use of a column heater at 40°C.

Results and Discussion

The mean SMCO content (g/kg DM) of each species is presented in Table 1.

Relative to common brassica crops such as kale (7.4 g/kg DM), swedes (5.9 g/kg DM), rape (4.2 g/kg DM) and turnip (2.9 g/kg DM), radish (2.7 g/kg DM) contained smaller amounts of SMCO in leaf. The SMCO concentration in bulbs and roots were comparable between swedes, turnips, radish and rape but lower in kale when grown in the same environment. This is in general agreement with previous comparisons of fodder radish which indicated the SMCO content of leaf and root were low (2.4 – 3.8 g/kg DM) when compared to other Brassica crops (Whittle *et al.,* 1976). The Ceres Graza radish was typical of other radishes in leaf SMCO contents although it was slightly higher in the inedible root in one of the 3 years.

Of all crops sampled kale had the highest content of SMCO in the leaf. The SMCO content of kale reported here is very similar to those reported by Barry *et al.*, (1980 & 1983) where kale had between 5.0 g/kg DM for leaves and 8.0-11.5 g/kg DM SMCO for entire plants in winter. Similarly, Whittle *et al.,* (1976) reported concentrations of SMCO in whole kale plants to be between 3.0 and 14.0 g/kg DM.

The leaf SMCO concentration in *B. carinata* and *B. juncea* (2.6 g/kg DM) and the root concentration in B *carinata* (0.6 g/kg DM) were low relative to other brassicas, although B. *juncea* SMCO concentrations within the root (4.1 g/kg DM) were comparable to other brassicas. These species may represent breeding opportunities for low SMCO varieties.

Currently, the most common technique for minimising the risk of SMCO-precipitated anaemia is to manipulate the intake of SMCO by controlling the proportion of brassica in the diet at any one time and by avoiding the use of excessive rates of sulphur and nitrogen fertiliser (Garret *et al.*, 2000). These data suggest radish is a lower risk crop in terms of SMCO poisoning relative to brassicas such as kale and swedes.

In brassicas, SMCO concentrations generally rise as the plants mature and large increases in concentration are usually seen in response to secondary growth and during the flowering phase (Whittle *et al.*, 1976). Soil fertility and nitrogen and sulphur fertiliser use during the growing season also have an influence on the SMCO concentration of forage (MacDonald *et al.,* 1981). These data compared different brassica species during the winter only and further work is required to determine the relative concentrations of SMCO in radish relative to other brassicas during regrowth after grazing and as the plant enters its reproductive phase with and without the use of nitrogen and sulphur fertilisers.

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