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Variation of S-Methyl-L-Cysteine Sulfoxide Content in Fresh Plants of 0- and 00-Rape Varieties

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Abstract

To get information on S-methyl cysteine sulfoxide (SMCO) contents in winter rape, two 0- and four 00-rape varieties, grown at 670 m above sea level, were sampled six times from October 1987 to July 1988. SMCO was measured, after extraction and ion exchange chromatography, by amino acid analysis. The SMCO content of rape plants ranged from 0.3 to 5.7 g/kg organic matter, and it was below 0.1 g/kg in rapeseeds. SMCO differences between 0- and 00-varieties were not statistically significant. Typically, the SMCO content of the plants increased during the winter season, often reaching highest levels in April. Glucosinolate contents of rape plants varied with rape type, and were not consistent with SMCO-patterns. Cases of deer losses, therefore, cannot be explained simply on the basis of concentration differences, between SMCO and glucosinolates, in 0- and 00-rape plants.

Introduction

Rape plants and their seeds contain several toxic substances, which, if absorbed in sufficient amounts, are responsible for various disorders in domestic and wild animals. In ruminants, the non-protein bound amino acid S-methyl-L-cysteine sulfoxide (SMCO) can cause hemolytic anemia, and other problems, leading to reduced feed intake, altered ruminal digestion, and decreased performance, after being metabolized to dimethyl disulfide by rumen microorganisms (1-3). Dimethyl disulfide inactivates proteins by blocking SH-groups. It binds to reduced GSH, which lowers the reducing environment in erythrocytes, leading to precipitation of hemoglobin and Heinz body formation. This affection has been shown to occur in cattle and sheep fed kale, which contains high amounts of SMCO (1-2), and it was observed as well in roe deer consuming rape plants, which also carry SMCO (5).

This study was designed to compare SMCO-levels and chemical composition of plants from 0- and 00-winter rape varieties during the course of growth, but particularly during the winter and spring season.

Experimental

Materials. All rape samples were cultivated in a field trial in Arconciel (Gruyère area), at 670 m. above sea level, by the Federal Agricultural Research Station Changins. The winter rape varieties tested were, 1: BIENVENU, 2: JET-NEUF, 3: LIBRAVO, 4: SABRINA, 5: SERASEM B-002, and 6: SERASEM S-002, the first two varieties being 0- and the latter four being 00-rape. Samples were obtained at dates 1: 27.10., 2: 01.12.1987, 3: 08.02., 4: 11.04, 5: 24.05., and 6: 11.07.1988.

Methods. 1. SMCO-analysis. S-methyl-L-cysteine sulfoxide was extracted from 40 g of finely chopped, fresh, whole plant material with a mixture of 160 ml ethanol, 96 %, and 40 ml hydrochloric acid, 0.5 N, during 6 hours. The filtered extract was directly injected into a BECKMAN, Mod. 119 CL Amino Acid Analyzer.

Analysis validation and the determination of SMCO in rapeseeds were also done by reversed phase HPLC. It included automatic pre-column derivatisation with orthophthalaldehyde (OPA) and fluorimetric detection on a HEWLET PACKARD, Mod. AminoQuant, amino acid analyzer.

2. Chemical composition. All analyses were carried out on lyophilized samples. Dry matter and ash were obtained from weight loss analysis. Crude protein was determined by the KJEL-FOSS procedure. Crude fat was directly extracted with petroleum benzine, boiling range 40-60 °C, using TWISSELMANN-extractors. A FIBERTEC SYSTEM I, Tecator AB, Sweden, served to determine crude fiber.

3. Glucosinolates. The determination of glucosinolates in rape plant and seed samples were carried out by the "Landwirtschaftliche Untersuchungs- und Forschungsanstalt", D-2300 Kiel 1. It involved reversed phase HPLC analysis, according to a procedure, presently submitted for approval to the Commission of European Communities. The results take into account the sum of the contents of progoitrin, gluconapoleiferin, gluconapin, 4-hydroxy-glucobrassicin, glucobrassicanapin, and glucobrassicin.

Results and discussion

The results of the rape plant analyses are presented in table 1. Except for crude protein, which tends to increase, the nutrient composition remains quite constant from winter to spring. The samples collected in May and July indicate the transition, from immature to mature plants, with an associated build-up of oil seeds and cell wall constituents in stem and leaves.

The content of SMCO follows the trend of crude protein (correlation coefficient $r=0.93$). Interestingly, the content of SMCO in the organic plant fraction tends to increase from fall to spring, mainly reaching peak values in April. No significant differences are detected between 0- and 00-rape varieties ($P<0.05$). The amounts found, agree well with values reported for rape plants in the literature (4, 5).

The glucosinolate levels in rape plant do not follow the SMCO pattern. The glucosinolate contents of the 00-rape varieties tend to be slightly lower, particularly in winter.

In 0-rape varieties (but not in 00-rape) the glucosinolate content of rapeseed is considerably higher than in plants, as indicated in table 2. On the other hand, SMCO levels in rapeseeds are very low in all varieties tested. Thus, toxic SMCO effects are only expected to occur in ruminants, after ingesting large amounts of whole rape plants.

Particularly during winter time, when feed is scarce, rape plants of 00-rape varieties may be consumed by wild animals in greater amounts than those of 0-rape varieties. According to Onderschenka et al.(6), intake of rape plants may be sufficiently high in roe deer to cause hemolytic anemia and possibly other health problems.

Table 1. Comparison of 0- and 00-rape varieties: Variation of chemical composition and contents of S-methyl cysteine sulfoxide (SMCO) and glucosinolates in whole rape plants during growth

			contents in organic matter				
Variety	Sampling date	Dry matter g/kg	Crude fat g/kg	Crude fiber g/kg	Crude protein g/kg	SMCO g/kg	Glucosinolates mmol/kg
Bienvenu [0]	1	112	35	125	220	3.7	15
	2	141	36	110	200	4.1	15
	3	138	36	101	225	4.2	19
	4	108	32	113	235	4.4	17
	5	166	21	331	105	0.9	n.d.[1]
	6	339	168	388	93	0.3	11
Jet-Neuf [0]	1	129	38	111	218	4.2	23
	2	156	34	95	206	5.4	25
	3	172	31	86	233	5.2	34
	4	101	31	127	268	5.2	18
	5	159	22	341	110	1.1	n.d.
	6	308	164	383	92	0.5	11
Libravo [00]	1	125	35	115	184	3.7	n.d.
	2	140	28	108	185	4.7	8
	3	149	32	121	199	4.9	6
	4	114	32	109	261	5.1	27
	5	156	21	348	108	0.8	n.d.
	6	407	137	363	85	0.4	9
Sabrina [00]	1	125	37	111	198	3.3	14
	2	147	26	105	192	4.1	23
	3	147	35	103	210	4.5	23
	4	106	32	116	274	5.7	20
	5	144	25	343	128	0.9	n.d.
	6	316	145	402	87	0.5	9
Serasem B002 [00]	1	125	40	114	237	3.2	6
	2	154	31	112	223	3.8	8
	3	161	32	99	242	3.7	6
	4	110	33	114	263	4.8	21
	5	158	20	345	111	0.5	n.d.
	6	403	136	420	74	0.3	12
Serasem S002 [00]	1	145	35	100	193	2.8	4
	2	146	35	101	213	4.1	7
	3	151	31	90	236	4.9	6
	4	102	38	125	247	5.3	18
	5	143	25	340	151	1.0	n.d.
	6	269	126	424	110	0.9	9

1.) n.d.: not done

Table 2. Variation of composition, SMCO- and glucosinolate content in rapeseed

Variety	Dry matter g/kg	Crude fat g/kg	Crude protein g/kg	SMCO g/kg	Glucosinolates mmol/kg
		Contents in Organic Matter			
Bienvenu [0]	946	354	207	0.07	86
Jet-Neuf [0]	927	325	217	0.09	87
Libravo [00]	931	336	199	0.07	13
Sabrina [00]	925	331	204	0.08	25
Serasem B002 [00]	948	356	220	0.07	5
Serasem S002 [00]	940	363	204	0.06	9

In conclusion, considering the SMCO and glucosinolate levels detected, it is not clear, whether increased losses of roe deer, reported in some recent years after the introduction of 00-rape varieties in Europe, are actually caused by SMCO, at high intakes of 00-rape plants, or are due to another factor. Nevertheless, the SMCO present in immature 0- and 00-rape plants may affect the health of wild ruminants.

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