varieties are in good agreement with those for the Swedish varieties, except in the case of lysine, where our values are slightly lower than those reported by Eklund and Agren (1975).

Generally plant proteins are deficient in methionine, having less than 2 g/100 g of protein (Van Etten et al., 1967). However, poppy seeds have a higher content which is comparable with the FAO Reference Pattern for this essential amino acid. Thus poppy seed should be good adjunct to vegetable proteins to enhance their nutritive value.

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Glucosinolates in Crucifer Vegetables: Turnips and Rutabagas

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Twenty-nine cultivars of turnip [*Brassica campestris* L. ssp. *rapifera* (Metzg.) Sinsk.] and twelve of rutabaga [*Brassica napus* L. ssp. *rapifera* (Metzg.) Sinsk.] were analyzed for fourteen glucosinolates. Major glucosinolates in turnip roots are 2-hydroxy-3-butenyl, 2-phenylethyl, and 3-indolylmethyl glucosinolates; in rutabaga roots there are these three plus 4-(methylthio)butyl glucosinolate. Only a few small turnips show a negative correlation between glucosinolate concentration and root weight. Whereas the amounts of individual glucosinolates within a cultivar fluctuated from year to year, there was little change in the relative proportions of these glucosinolates. Both 4-(methylthio)butyl and 5-(methylthio)pentyl glucosinolates are lower in peelings and tops (above-ground parts) of turnips than in peeled roots, whereas 3-butenyl and total glucosinolates were higher. However, 2-phenylethyl and 3-indolylmethyl glucosinolates are concentrated in turnip peelings. Other glucosinolate distributions within the plant are also discussed.

A number of glucosinolates (GS's) that may be regarded as potential toxicants occur in small amounts in cruciferous vegetables. A product from one of these, 2-hydroxy-3-butenyl-GS, is thyrotoxic; others may be thyrotoxic or toxic to the liver or kidney (VanEtten & Tookey, 1979; Nishie & Daxenbichler, 1980; Gould et al., 1980). The toxicity of products from many of the GS's of vegetables is unknown but currently under study. The GS composition of existing cultivars needs to be established to evaluate whether new cultivars might pose health problems because of increased levels of GS's (Senti and Rizek, 1974), as well as to recognize new cultivars of lower GS content. Therefore, the present study of turnips [*Brassica campestris* L. ssp. *rapifera* (Metzg.) Sinsk.] and rutabagas [*Brassica napus* L. ssp. *rapifera* (Metzg.) Sinsk.] was undertaken as a part of a general survey of these crucifers (VanEtten et al., 1980; Daxenbichler et al., 1979, 1980). In addition to those commonly grown in the United States a number of cultivars from Japan and several European cultivars grown primarily as livestock feed were also included.

For a number of years GS's have been known to be present in turnip and rutabaga roots (VanEtten, 1969, and references cited therein). Limited quantitative data has been reported recently: Mullin et al. (1980) analyzed turnip and rutabaga cultivars from Canada and Europe for 5 GS's. We report here quantitative data on 14 GS's in peeled roots of 29 turnip and 12 rutabaga cultivars and indicate the distribution of GS's in tops (above-ground parts), peeled roots, and peelings.

EXPERIMENTAL SECTION

Sample Source and Preparation. Turnip and rutabaga cultivars were grown near Madison, Wi, in 1975, 1978, and 1979 as shown in Tables I and II. Plants were harvested in July or August and then refrigerated until extracted. Refrigeration time ranged from 3 weeks (1975

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Table I. Correlation[a] of Turnip Cultivars[b] by Similarity of Glucosinolate Patterns in Peeled Roots

	no. of roots analyzed for year grown			major market	
	1975	1978	1979	L[c]	H[c]
group I					
(1) Alander Cundy			2	X	
group II					
(2) Civasto			1	X	
(3) Cowhorn Long White	5				X
(4) Leielander			2	X	
(5) Polybra			2	X	
(6) Taronda			2	X	
group III					
(7) Purple Top Strap Leaf	5				X
group IV					
(8) Arca Cundy			2	X	
(9) Cyclon			2	X	
(10) Donda Zelder			2	X	
(11) Jobandi			2	X	
(12) Jobe			2	X	
(13) Labra			2	X	
(14) Marco Zelder			2	X	
(15) Dedra			2	X	
(16) Rekord			2	X	
(17) White Egg	5				X
group V					
(18) Croppa			2	X	
(19) Purple Top White Globe	3	3	2		X
group VI					
(20) Houtlander Labor			2	X	
group VII					
(21) Just Right[d]	3				X
(22) Presto			2		X
(23) Shogoin			2		X
(24) Tokyo Market	5				X
(25) Tokyo Market Second Early			2		X
(26) Tokyo Market Express[d]			2		X
(27) Tokyo Top[d]			2		X
group VIII					
(28) Tigra	3			X	

[a] Correlation coefficients = 0.74 or greater among all members of a group. The 29th cultivar, Tyfon, was not analyzed as peeled root. [b] All cultivars open pollinated unless otherwise indicated. [c] L = livestock (European stubble turnip); H = human consumption. [d] F_1 hybrid.

samples) up to 2 months (1979 samples). Samples of 100 g fresh weight were cut as longitudinal wedges from peeled and intact roots. Numbers of replicate samples are given in the tables. Also analyzed were 100-g samples of peelings approximately 1 mm thick and tops (above-ground parts). All samples were extracted with boiling, aqueous methanol as previously described (VanEtten et al., 1976). The methanol was removed and the extracts were frozen until analyzed.

Methods of Analysis. Total GS's in the sample extracts were estimated by measuring glucose released (VanEtten et al., 1974) by enzymatic hydrolysis of GS's as described by VanEtten and Daxenbichler (1977). The procedure was modified in 1978 and 1979 sufficiently to allow use of a similar but different glucose-specific reagent, Glucose Auto/Stat (Pierce Chemical Co., Rockford, Il). A calibration curve for the new Pierce reagent was determined daily by using 10, 20, and 30 μg/mL glucose standards. Furthermore, an improved thioglucosidase, EC 3.2.3.1 (myrosinase), was prepared from a cold water extract of *Sinapis alba* L. (*Brassica hirta*) defatted seed meal by collecting the protein precipitating between 30 and 75% ethanol–water (v/v). The recovered precipitate, after lyophilization, had an activity against epiprogoitrin of 0.15–0.20 μmol min^{-1} mg^{-1} at 25 °C, pH 6.

Table II. Correlation[a] of Rutabaga Cultivars Grouped by Similarity of Glucosinolate Patterns in Peeled Roots

	no. of root analyzed for year grown		
	1975	1978	1979
group I			
(1) Alta Sweet Top	3		
(2) American Purple Top	3		
(3) Bangholmes Dima			2
(4) Laurentian	3	3	2
(5) York			2
group II			
(6) American Purple Top		3	2
group III			
(7) Bangholm-Magres			2
(8) Marion			2
group IV			
(9) Macomber		3	2
group V			
(10) Wilhelmsburger-Sator			2
(11) Wilhelmsburger-Gartons			2
(12) York X Wilhelmsburger			2
group VI			
(13) Della			2

[a] Correlation coefficient = 0.74 or greater among all members of a group. All were open pollinated.

Individual GS's (except 3-indolylmethyl and 3-(*N*-methoxy)indolylmethyl] were estimated by gas–liquid chromatography of their isothiocyanates and oxazolidine-2-thiones formed by appropriate hydrolysis (Daxenbichler and VanEtten, 1977). Reproducibility of the analytical method has been reported (VanEtten et al., 1976). Identification of some aglucons was made by a GC–MS tandem system (Daxenbichler et al., 1979; Spencer and Daxenbichler, 1980). Both 3-indolylmethyl-GS's were hydrolyzed to form SCN ion that was measured by an adaptation of the method of Josefsson (1968). Sample extract representing 2.5 g of fresh plant material in 5.0 mL of water was added to 5.0 mL 0.05 M phosphate buffer, pH 7.0; then ~1 mg of mustard myrosinase (thioglucosidase) was added, and the buffered solution was incubated in a capped tube for 2 h at 37 °C. To 1 mL of the resultant solution were added 1 mL water and 2 mL 0.4 M $Fe(NO_3)_3$ in 1.0 HNO_3. After centrifugation at 8000 rpm for 30 min, the samples were measured colorimetrically at 460 nm both before and after adding 1 drop of 5% $HgCl_2$, and the difference was determined. Absorbance measurements were made with a Spectronic 20 Bausch & Lomb spectrophotometer.

RESULTS AND DISCUSSION

Glucosinolate (GS) Patterns in Peeled Roots. The GS contents and composition of roots of 41 cultivars of turnip and rutabaga present a complex picture. For clarification, correlation coefficients were determined between all possible pairs of cultivars from the concentration of 11 GS's in each cultivar. Then turnip cultivars with similar patterns were grouped (Table I). Correlations within each group were 0.74 or higher ($P < 0.01$). Listed in Table III are 9 of the 11 GS's used to establish correlations for the groups. The remaining two GS's are 4-(methylsulfinyl)butyl-GS and 5-(methylsulfinyl)pentyl-GS that occur in smaller amounts. However, total GS contents calculated from released glucose were not used in determining the correlations because total GS does not reflect the relative proportion of individual GS's.

Turnip groups I–VII (Table I) form a sequence in which each group is successively less well correlated to I than its predecessor; i.e., correlation coefficients between groups

Table III. Turnip Root (without Peel): Content of Glucosinolates (GS's)[a] in Cultivar Groups[b]

glucosinolate		content, μmol/100 g fresh wt, in cultivar group								
		I (1)[c]	II (5)	III (1)	IV (10)	V (2)	VI (1)	VII (7)	VIII (1)	s^d
1-methylpropyl	mean:	31	13	35	22	38	20	1	6	7
	range:		3-31		7-40	34-43		0-3		
3-butenyl	mean:	16	3	69	7	5	3	77	2	35
	range:		1-6		3-14	2-9		39-122		
2-hydroxy-3-butenyl	mean:	53	38	100	83	48	46	15	48	20
	range:		31-53		66-105	40-66		0-78		
4-(methylthio)butyl	mean:	13	4	11	9	3	9	7	30	4
	range:		3-7		5-14	2-4		5-11		
4-pentenyl	mean:	6	17	48	25	44	36	24	20	19
	range:		1-31		5-51	19-47		11-58		
2-hydroxy-4-pentenyl	mean:	0	14	26	17	27	28	tr	16	9
	range:		6-30		5-42	23-31		0-0.01		
5-(methylthio)pentyl	mean:	8	14	31	19	19	27	9	46	10
	range:		5-25		5-46	18-21		8-14		
2-phenylethyl	mean:	52	25	40	42	71	94	64	45	26
	range:		6-42		13-68	45-120		39-102		
3-indolylmethyl[e]	mean:	62	77	64	56	56	12	32	40	42
	range:		47-112		28-97	49-71		23-41		
total GS[f]	mean:	279	227	505	305	336	227	216	287	91
GS from aglucon, % of total[g]	mean:	98	93	90	97	95	124	113	96	

[a] Other GS's present in small amounts but included in the calculation of correlation coefficients are 4-(methylsulfinyl)-butyl and 5-(methylsulfinyl)pentyl. Other minor GS's include allyl, isopropyl, 4-(methylsulfonyl)butyl, and benzyl. [b] Cultivars in each group are given in Table I. They are grouped by correlation between pairs; for details, see the text. Tyfon is not included since it was not analyzed as peeled roots. Data for individual cultivars are available on request: HSC Laboratory, Northern Regional Research Center, U.S. Department of Agriculture, 1815 N. University Street, Peoria, IL 61604. [c] Number of cultivars in the group. [d] Standard deviation between samples, pooled over all cultivars. [e] Includes 3-(*N*-methoxy)indolylmethyl-GS. [f] GS value calculated from glucose release by thioglucosidase. [g] Total of aglucons as a percent of total GS.

Table IV. Rutabaga Root (without Peel): Content of Glucosinolates (GS's)[a] in Cultivar Group[b]

glucosinolate		content, μmol/100 g fresh wt, in cultivar group						
		I (5)[c]	II[d] (1)[e]	III (2)	IV (1)[e]	V (3)	VI (1)	s^f
1-methylpropyl	mean:	27	14	41	0.5	41	56	7
	range:	0-58	14-14	37-45	0-1	38-47		
3-butenyl	mean:	4	6	10	8	17	65	9
	range:	tr[g]-8	5-7	1-19	1-15	1-35		
2-hydroxy-3-butenyl	mean:	107	97	66	57	53	77	23
	range:	68-156	91-103	51-81	54-61	52-55		
4-(methylthio)butyl	mean:	40	24	33	15	34	52	11
	range:	8-82	22-25	27-38	12-17	28-41		
2-hydroxy-4-pentenyl	mean:	0.2	11	3	8	0.4	0	3
	range:	0-1	11-12	0-7	7-9	0-1		
5-(methylthio)pentyl	mean:	4	59	45	21	53	5	10
	range:	1-21	50-69	33-57	16-26	49-56		
5-(methylsulfinyl)pentyl	mean:	2	17	10	5	16	0	4
	range:	0-14	11-22	10-11	4-5	15-18		
2-phenylethyl	mean:	37	25	40	52	51	44	10
	range:	10-102	20-31	32-48	44-59	31-67		
3-indolylmethyl[h]	mean:	31	37	23	44	92	79	10
	range:	23-53	34-40	14-32	40-48	72-114		
total GS[i]	mean:	314	438	301	251	415	514	69
GS from aglucon, % of total[j]	mean:	82	73	94	85	90	74	

[a] Other GS's were present in small amounts, but included in the calculations of correlation coefficients are 4-(methylsulfinyl)butyl and 4-pentenyl. Other minor GS's include allyl, isopropyl, and 4-(methylsulfonyl)butyl. [b] Cultivars of each group are given in Table II. They are grouped by correlation between pairs; for details, see the text. Data for individual cultivars are available on request: HSC Laboratory, NRRC, Northern Regional Research Center, U.S. Department of Agriculture, 1815 N. University Street, Peoria, IL 61604. [c] Number of cultivars in the group. [d] Group II contains 18 μmol/100 g 4-pentenyl-GS and other groups, 0.5-4. [e] One cultivar, but grown in 2 crop years. [f] Standard deviation between samples, pooled over all cultivars. [g] tr = less than 0.1. [h] Includes 3-(*N*-methoxy)indolylmethyl-GS. [i] GS value from glucose released by thioglucosidase. [j] Total of aglucons as a percent of total GS.

I and VII are only 0.16–0.55. However, group VIII is reasonably correlated to I (0.62) but poorly to VII (–0.14 to 0.26).

Concentrations of a few GS's are conspicuous (Table III): group I is low in both 4-pentenyl and 2-hydroxy-4-pentenyl, whereas groups II and V are low in 4-(methylthio)-butyl; groups III and IV are high in 2-hydroxy-3-butenyl (progoitrin); group VI is high in 2-phenylethyl and low in 3-indolylmethyl; group VIII is high in both sulfur-containing 4-(methylthio)butyl and 5-(methylthio)pentyl; group VII is high in 3-butenyl but very low in 2-hydroxy-3-butenyl. The two group VII cultivars that do contain some 2-hydroxy-3-butenyl have large butenyl/2-hydroxy-3-butenyl ratios (>1.6), whereas all cultivars except the ones in this group have these ratios much less than 1.0. Surprisingly, 2-hydroxy-3-butenyl-GS, a major component in most turnips, is absent in Tokyo Market, Tokyo Market Second Early, Tokyo Market Express, Tokyo Top,

Table V. Year to Year Variation, Glucosinolates in Peeled Rutabaga Roots

	content, μmol/100 g fresh wt					
	American Purple Top			Laurentian		
glucosinolate[a]	1975	1978	1979	1975	1978	1979
1-methylpropyl	7	14	14	7[b]	33[c]	47[d]
2-hydroxy-3-butenyl	68	103	91	78[b]	99[b,c]	156[c]
4-(methylthio)butyl	9	25	22	10[b]	49[c]	60[c]
4-pentenyl	tr[b]	15[c]	20[c]	tr	0.2	0
2-hydroxy-4-pentenyl	tr[b]	12[c]	11[c]	0	1	0
5-(methylthio)pentyl	1[b]	69[c]	50[c]	1	2	2
5-(methylsulfinyl)pentyl	0[b]	11[c]	22[d]	0	0	0
2-phenylethyl	10	31	20	14[b]	29[b,c]	44[c]
3-indolylmethyl[e]	23	34	40	15[b]	33[b,c]	42[c]
total GS[f]	144[b]	480[c]	397[c]	161[b]	385[c]	429[c]

[a] GS's that were significantly different across the three years. Means of three values for 1975 and 1978 and of two values for 1979. [b-d] Numbers within the same line and cultivar bearing different superscript letters differ significantly ($P < 0.05$). [e] Includes 3-(*N*-methoxy)indolylmethyl-GS. [f] Measured as glucose released.

Table VI. Glucosinolates[a] of Peelings and Intact Roots vs. Peeled Roots

	content, μmol/100 g fresh wt			
	paired root and peelings, 1975, 1978		unpaired samples, 1979	
glucosinolate	peelings	peeled roots	intact roots	peeled roots[b]
turnips[c]				
3-butenyl	36*[d]	18*	28	22
4-(methylthio)butyl	5*	7*	8	8
5-(methylthio)pentyl	15*	22*	13	16
2-phenylethyl	203*	56*	43**[d]	52**
3-indolylmethyl[e]	249*	65*	122**	51**
total GS[f]	665*	303*	320**	266**
rutabagas[g]				
2-phenylethyl	46	22	77**	49**
3-indolylmethyl[e]	182*	30*	102**	55**
total GS[f]	470*	249*	472**	391**

[a] Means for GS's (μmol/100 g fresh weight). [b] Mean for two roots. [c] Paired samples: 1975 and 1978 cultivars 3, 7, 17, 19, 21, 24, and 28 of Table I. Unpaired samples: 1979 cultivars 1, 4, 6, 8-16, 18-20, 22, 23, and 25-27 of Table I. [d] Shows a significant difference ($P < 0.05$) from corresponding paired (*) or unpaired (**) sample. [e] Includes 3-(*N*-methoxy)indolylmethyl-GS. [f] Measured as glucose released. [g] Paired samples: 1975 and 1978 cultivars 1, 2, 4, 6, and 9 of Table II. Unpaired samples: 1979 cultivars 3-13 of Table II.

and Presto cultivars (group VII). Moreover, 2-hydroxy-4-pentenyl-GS is also absent from these same cultivars. Plant breeders may find these cultivars, all grown for human food, useful in their studies.

Rutabaga cultivars are similarly grouped (Table II) by correlations calculated between cultivars in the same manner as turnips from 11 GS's shown in Table IV and its footnote *a*. The rutabaga groups (Table IV) are not so variable as are the turnips. Groups I and VI are low in 2-hydroxy-4-pentenyl-, 5-(methylthio)pentyl-, and 5-(methylsulfinyl)pentyl-GS's; group IV is low in 1-methylpropyl-GS and group VI is relatively high in 3-butenyl-GS.

Major components of both turnips and rutabagas are 2-hydroxy-3-butenyl-, 2-phenylethyl-, and 3-indolylmethyl-GS's. 4-Pentenyl is a major component of turnips but not of rutabagas; 4-(methylthio)butyl is high in rutagabas but low in turnips. The level of 2-hydroxy-4-pentenyl is somewhat higher in turnips while 5-(methylthio)pentyl is higher in rutabagas.

The values of both 2-hydroxy-GS's and 3-indolylmethyl-GS's of turnip and rutabaga reported earlier (Mullin and Sahasrabudhe, 1977, 1978) fall within the range reported here. Our measurement of 40 μmol/100 g for 2-phenylethyl-GS in peeled roots in Purple Top Strap Leaf turnip agrees with the 35–42 μmol/100 g calculated from an estimate by Lichtenstein et al. (1962) based on a bioassay. Cole and Phelps (1979) data cannot be compared because of a different basis of reporting. Mullin et al. (1980) reported the presence of five GS's in several cultivars that we also analyzed. Their data was generally lower; e.g., in Macomber (our group IV) we found 57 μmol/100 g progoitrin where Mullin et al. found 9, and for indolyl-GS's (SCN ion precursors) we found 44 μmol/100 g where they found 26. We cannot explain such differences

Table VII. Turnip Tops vs. Peeled Roots: Glucosinolates

	content, μmol/100 g fresh wt					
	Just Right[b]		Tigra[b]		Tyfon[c]	
glucosinolate[a]	top	peeled root	top	peeled root	top	unpeeled root
1-methylpropyl	2	tr[d]	14	6	46	31
3-butenyl	294	83	25	2	15	9
2-hydroxy-3-butenyl	2	27	39	48	22	26
4-(methylthio)butyl	tr	7	10	30	0.4	6
4-pentenyl	151	58	45	20	59	49
5-(methylthio)pentyl	1	14	18	46	9	29
2-phenylethyl	3	102	6	45	12	112
3-indolylmethyl[e]	75[f]	35[f]	78[f]	40[f]	41	160
total GS[g]	586	337	306	287	221	429

[a] All GS's listed show a significant difference ($P < 0.05$) between tops and peeled roots (except for 3-indolymethyl-GS, $P < 0.10$) for Just Right and Tigra. Tyfon was not statistically analyzed. [b] Mean of three paired root and peeling samples per cultivar. [c] Mean of three top samples; three roots composited as one sample. This is a stubble turnip for livestock. [d] tr = less than 0.1. [e] Includes 3-(*N*-methoxy)indolylmethyl-GS. [f] Difference between tops and peeled roots significant at $P < 0.10$. [g] Calculated from glucose released.

because of the numerous variables involved. However, a partial explanation may be that these authors could not quantify butenyl- and pentenyl-GS's (Mullin et al., 1980) and do not report several GS's that we found in significant amounts in a number of cultivars, i.e., 1-methylpropyl-GS (secondary butyl) and 5-(methylsulfinyl)pentyl-GS.

Root Size vs. Glucosinolate Content. Cabbage head size tends to be inversely proportional to both GS (VanEtten et al., 1976) and SCN ion content (Bible et al., 1980). However, in the present study, total GS correlated inversely ($P < 0.05$) only to fresh weights of 1975 turnip roots based on 20 roots (5 replicates of cultivars, 3, 7, 17, and 24 of Table I, pooled). Mean root weights for 1975, 1978, and 1979 turnips were 0.4, 1.5, and 0.9 kg, respectively, and for rutabagas were 0.9, 1.7, and 0.8 kg. Since only the lightest weight roots had this correlation, perhaps after the roots reach a certain size, the GS level no longer relates to the root weight.

Yearly Variation. One turnip and three rutabaga cultivars were grown in more than 1 crop year. Purple Top White Globe turnip, grown in 3 years, showed a significant difference only in 2-phenylethyl-GS: 45 μmol/100 g in 1975 and 120 μmol/100 g in 1979. Macomber rutabaga, grown in 1978 and 1979, showed a significant difference only in 3-butenyl-GS: 1 μmol/100 g (1978) and 15 μmol/100 g (1979). Analyses of two rutabaga cultivars that were grown in 3 years are shown in Table V. In general, the wide differences reflect lower values in the 1975 crop. Although individual and total GS's varied from year to year, the GS pattern remained relatively stable over these growing seasons: correlations between years for 11 GS's within a given cultivar ranged from 0.79 to 0.99. Increases in 5-(methylthio)pentyl- and 5-(methylsulfinyl)pentyl-GS's were, however, sufficient to exclude 1978 and 1979 American Purple Top from group I of the rutabagas (see Table II).

Distribution within the Plant. The GS contents of root peelings were analyzed in two ways: in 1975 and 1979, peeled root and associated peelings were compared for 8 turnip and 4 rutabaga cultivars, and in 1979, intact root was compared with two peeled roots of 20 turnip and 11 rutabaga cultivars.

Only those GS's that showed significant differences are included in Table VI. Some of the GS's that have significantly different levels in turnip peeling vs. peeled roots (1975 and 1978) lost their respective differences in the unpaired (1979) comparisons because of the large proportion of root to peel in the intact roots. For rutabagas, the unpaired samples are significantly different in 2-phenylethyl-GS; the paired samples reflect the same trend. The 3-indolylmethyl-GS's are more concentrated in the peelings than in the peeled roots, which may account for the higher total GS measurement in both peelings and intact roots. Peelings of Tokyo Market Second Early, Tokyo Top, and Presto turnip contain large amounts of an unidentified material that is distributed through many of the turnip and rutabaga cultivars. Work to identify this component is under way.

A limited comparison was made of tops of Just Right and Tigra turnips with the corresponding peeled roots (Table VII). Both 4-(methylthio)butyl- and 5-(methylthio)pentyl-GS's are lower in tops, whereas 3-butenyl- and 3-indolylmethyl-GS's, and total GS are higher. Similar relationships are apparent in the comparison of peelings to peeled roots (Table VI). The analogy of tops and peelings does not apply to 2-hydroxy-3-butenyl- and 4-pentenyl-GS. Peelings are richest in 2-phenylethyl-GS, the peeled roots contained less, and the tops have the least amount. Tyfon turnip was not compared statistically with these other two cultivars, but analyses demonstrated trends similar to those of the other two cultivars, except for 3-indolylmethyl-GS's and the total GS reflects high 3-indolylmethyl in the peeling.

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