

Yield and glucosinolate of mustard seeds and volatile oils of caraway seeds and coriander fruit.

II Yield and volatile oils of caraway seeds (*Carum carvi* L.)

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Abstract. Caraway was grown in Freising, West Germany and at three locations in Finland. The growth substrate was a fertilized peat of the same quality at each location. The total volatile oil contents of the seeds varied between 5.45 and 7.59 ml/100 g. There were no significant differences in total oil content or in carvone content between the seeds grown at different locations.

In addition, different varieties ('Hungarian', 'Kami', 'Caraway I and II' Sv) were tested in Helsinki. The average yield was 3200 kg/ha at the first harvest and 800 kg/ha in the second year. The Hungarian cultivar gave the largest yield and the growth period of this variety was approximately one week shorter than that of the Scandinavian varieties 'Kami' and 'Caraway I and II'. The volatile oil contents of the seeds ranged between 4.22 and 6.98 ml/100 g. There were no significant differences between the varieties in the total oil contents. The proportion of carvone varied between 48 and 56 % of the total oils.

Index words: caraway, carvone

Introduction

Caraway (*Carum carvi* L.) is grown on 30 hectares of land in Finland with a level of seed (botanically fruit) production corresponding

to approximately 40 % of the self-sufficiency (HÄLVÄ 1985). There is growing interest in increased cultivation of caraway as an alternative to the present over-production of most traditional agricultural crops. Caraway grows wild as far north as in Finnish Lapland.

At present the seeds are mostly sold without variety names. Winter-hardy varieties with

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high oil contents and larger yields are needed to enable large-scale caraway seed production. Previous studies on caraway cultivation in Finland were carried out almost 40 years ago (VAARAMA 1947) and basic research was therefore necessary to illuminate the present situation.

Certain caraway varieties and cultivars were grown both in Finland and in West Germany as part of a Herb Plant Research Project of the Finnish Academy of Sciences (1983—1985).

Materials and methods

Caraway was grown during 1983—84 in Freising, West Germany (48°24') and at three locations in Finland: Helsinki (60°14'), Saha-lahti (61°28') and Inari (69°04'). The cultivar grown was 'Caraway I' Sv. The purpose of the study was to test the effect of latitude on the volatile oils of caraway seeds (location test).

In addition, different varieties and cultivars were tested in Helsinki in 1983—85. The four cultivars grown were 'Hungarian', a common type in Hungary, 'Kami' LD from Denmark and 'Caraway I and II' Sv from Sweden. The two Swedish varieties were obviously of the same origin. Annual caraway (*Carum carvi f. annua*) was also grown in one year but the seeds did not ripen by the end of the growing season and thus were not included in the study.

The trials for the location tests were set up in beds filled with a peat layer of 20 centimeters. The peat was of the same quality (St 400 A2) at each location. The control sample was also grown in mineral soil in Freising. The size of the plots was 1.8 m² and the experiments were carried out with three replicates.

The field tests for variety testing were set up according to the method of randomized blocks, with plots of 10 m² on mineral soils. The seeds were sown at a density of 10 kg/ha. The row spacings were 12.5 centimeters (trials I and III) or 25 centimeters (trial II).

Caraway was cultivated using general farm-

ing practices and harvested at the end of the second growing season except at the northernmost location where the crop was harvested on the third year after sowing. In Helsinki one experiment (II) was continued for three years and thus harvested twice. The data on field trials was statistically analysed by the analysis of variance and the means were separated by Tukey's test (STEEL and TORRIE 1980).

After the harvest the seeds were dried and the content and composition of the oils were analysed.

Total volatile oil was assayed by steam distillation (WILLIAMS 1984). Approximately 100 grams of caraway seeds were ground rapidly in a Bamix spice mill and 25 grams of the ground seeds were steam distilled for four hours. After distillation the amount of the oil was measured from the scale of the side tube of the distillation apparatus to an accuracy of 0.01 ml. The results were expressed in ml/100 g. Oils were diluted with pentane for gas chromatographic determinations and the samples were sealed in vials under nitrogen. The most important volatile compounds of caraway seeds, limonene and carvone, were determined by gas chromatography (Micromat 412) using a fused silica capillary column (i.d. 0.3 mm, length 25 cm) coated with ov-351. The temperature was programmed from 60°C to 220°C at 6°C/min.

Results and discussion

Seed yield

The caraway seeds germinated in 19—43 days. The rosettes reached a height of 37—41 centimeters during the first growing season in the south and approximately 10 centimeters in the north. Larvae of *Depressaria daucella* were observed in the caraway florescences in the second growing season and by the end of seed ripening also *Erysiphe heraclei*-disease was found. Both these species have previously been reported to harm caraway cultivations, the former also in Finland (VAPPULA 1962, ONDREJ 1983).

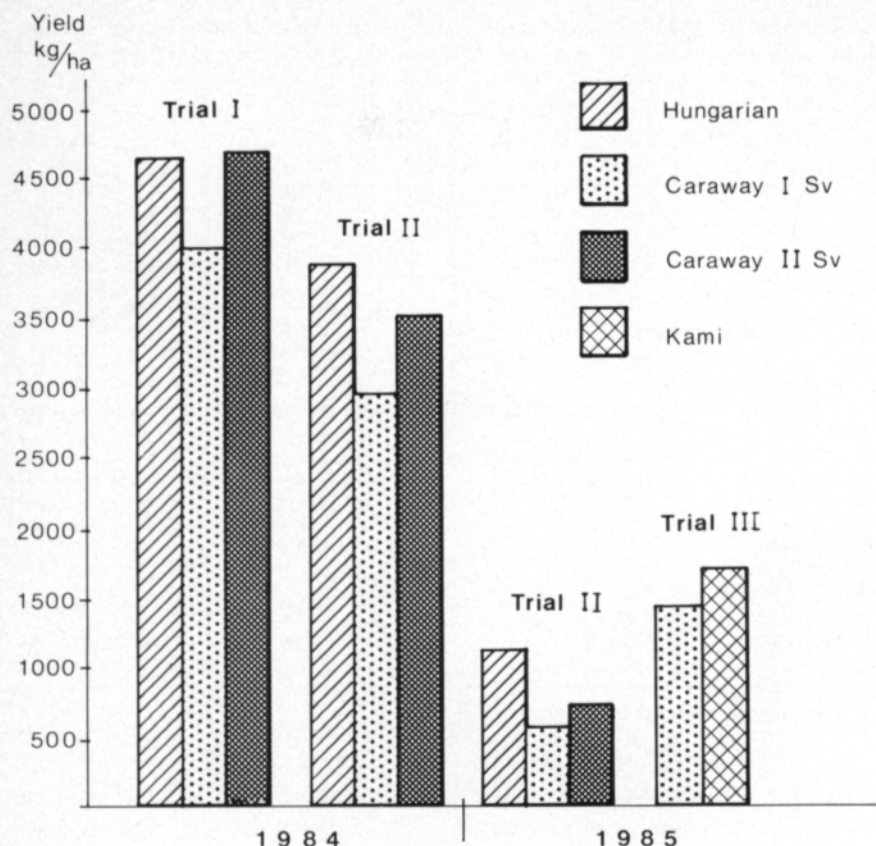


Fig. 1. Seed yields of caraway varieties during 1984—85 in Helsinki.

Table 1. The growth periods of caraway varieties during 1983—85.

Variety	Growth periods (days)			
	Trial I 1983—84	Trial II		Trial III 1984—85
		1983—84	1983—85	
'Hungarian'	435	405	803	—
'Caraway I' Sv	442	411	808	451
'Caraway II' Sv	442	413	810	—
'Kami'	—	—	—	449
Mean	440	410	807	450

At the time of harvesting the vegetation had a height of 77—91 centimeters and none of the cultivars showed particular tendency to be flattened down. The vegetation of the cultivar 'Hungarian' was highest.

The average yield of caraway seeds was 3200 kg/ha at the first harvest. In the following year, however, the yield was only 25 % of the figure (Fig. 1). The yield was smallest

in the trial with the wider row spacing (25 cm). The 'Hungarian' cultivar had largest yield, the difference being significant ($p < 0.05$) in all trials except one. The yields were at least equal to the mean figures reported by RAUTAVAARA et al 1953, ANON 1980 and HÄLVÄ 1985.

The growth period for caraway ranged from 405 to 442 days (Table 1), that of the cultivar 'Hungarian' being shortest, approximately

Table 2. Volatile oil contents (ml/100 g) and the proportion of carvone in caraway seeds grown in three peat plots and at four locations and in a control sample grown in mineral soil in Germany (1984).

Plots	Freising		Helsinki		Sahalahti		Inari	
	Vol. oil	Carvone %	Vol. oil	Carvone %	Vol. oil	Carvone %	Vol. oil	Carvone %
1	5.88	54	6.13	53	6.20	48	6.46	51
2	5.45	52	7.36	51	6.14	49	6.24	50
3	5.63	55	7.59	52	6.02	51	6.65	49
Control	5.60	51						

The sum of carvone and limonene is assumed to be 100.

Table 3. Volatile oil contents (ml/100 g) and the proportion of carvone in the seeds of different caraway varieties during 1984—85.

Variety	Trial I -84		Trial II -84		Trial II -85		Trial III -85	
	Vol. oil	Carvone %	Vol. oil	Carvone %	Vol. oil	Carvone %	Vol. oil	Carvone %
'Hungarian'	4.51	54	4.22	56	6.67	49	—	—
'Caraway I'	4.43	53	4.64	54	6.57	50	4.24	53
'Caraway II'	5.02	48	5.24	51	6.98	50	—	—
'Kami'							4.51	50

The sum of carvone and limonene is assumed to be 100.

one week shorter than for the Scandinavian cultivars. The vegetative growth was slow in the north: the seeds did not ripen fully until the end of the third growing season.

Volatile oils

In the location test the content of volatile oils in the caraway seeds ranged from 5.45 to 7.59 ml/100 g (Table 2). There were no significant differences in the total volatile oils or carvone contents in the seeds grown at different locations. The oil content of caraway seeds grown in peat was higher than that of seeds grown in mineral soil.

In the variety test the total amount of volatile oils ranged between 4.22 and 6.98 ml/100 g (Table 3). No significant differences were recorded between the varieties. The proportion of carvone varied in all samples between 48 and 56 %. The amounts of compounds present in small quantities, such as α -pinene, β -pinene, myrcene, p-symene, carveol and dihydro carveol, were approximately equal in

the different samples. The figure of carvone content is rather lower than the mean of 50—76 % quoted in the literature (OSVALD 1959, FURIA and BELLANCA 1975), but in better agreement with an earlier study by KUUSI et al (1981). According to KUUSI et al (1981), the volatile oil content in caraway seeds grown wild in Finland is higher (6.71—8.03 ml/100 g) than that in the seeds of certain varieties.

The carvone content was slightly higher in the seeds of the variety 'Hungarian' than in the seeds of the other varieties. The caraway seeds grown in Inari contained more oil than the seeds grown at the other locations (Table 2). The results in the variety test may partly be affected by the fact that the seeds were not fully ripe at the time of harvest. The weather factors may also have had an effect on the oil.

According to the results of this study there exists a need for breeding of caraway to produce specific varieties with abundant seed yields and improved volatile oil contents.

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SELOSTUS

Kuminan siemensato ja haihtuva öljy

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Maustekasvitutkimus on ollut maassamme toistaiseksi vähäistä. Edelliset kuminatutkimukset ovat 1940-luvulta, joten perustiedon saaminen muun muassa nykyisistä lajikkeista on tarpeen. Saatavilla on muutamia viljelymuotoja, varsinaisia lajikkeita on vähän. Kuminaa viljellään Suomessa noin 30 hehtaarin alalla mikä merkitsee tuotantoa, joka vastaa noin 40 % omavaraisuutta. Kuminan sadon tuottoa ja aromia tutkittiin Maustekasvien tutkimusprojektin (SA 01/813) yhteydessä vuosina 1983—1985.

Kuminan aromipitoisuutta tutkittiin siemenistä, jotka tuotettiin kolmella paikkakunnalla Suomessa (Helsinki, Sahalahti, Inari) ja Freisingissa, Länsi-Saksassa. Kokonaisöljypitoisuus oli 5.45—7.59 ml/100 g. Öljyn koko-

naisäärässä eikä karvonin määrässä ollut eroja eri paikkakuntien välillä. Lisäksi Suomessa tutkittiin kuminalajikkeita ja viljelymuotoja 'Unkarilainen', 'Kami' ja 'Kumina I' Sv ja 'Kumina II' Sv. Näistä kaksi jälkimmäistä on todennäköisesti samaa alkuperää.

Keskimääräinen kuminan siemensato oli ensimmäisenä satovuonna 3200 kg/ha. Toisena vuonna samalta alueelta saatiin siementä 800 kg/ha. 'Unkarilainen' viljelymuoto oli satoisin. Siementen haihtuvan öljyn pitoisuus oli 4.22—6.98 ml/100 g. Karvonipitoisuus oli suhteellisen alhainen, 45—56 %. Eri lajikkeet tai viljelymuodot eivät eronneet toisistaan öljypitoisuutensa perusteella.

Kuminasta tarvittaisiin jalostettuja lajikkeita, joista saataisiin runsaan siemensadon lisäksi hyvälaatuista öljyä.