

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

III Yield and volatile oils of coriander fruit (*Coriandrum sativum* L.)

HÄLVÄ, S.¹, HIRVI, T.^{2*}, MÄKINEN, S.³ and HONKANEN, E.²

¹ Dept of Horticulture, University of Helsinki, SF-00710 HELSINKI, Finland

² VTT, Food Research Laboratory, SF-02150 ESPOO, Finland

³ Dept of Nutrition, University of Helsinki, SF-00710 HELSINKI, Finland

Abstract. Certain cultivars of coriander were tested during 1983—1985 at two locations in Finland, namely Helsinki and Kangasala. Only five cultivars were available for the trials: 'Kultive', 'Hungarian' I and II, 'Coriander' LD and 'Lucs'. The seeds germinated in 11—19 days and the vegetation reached a height of 36—115 centimeters by the end of the growing season. The growth period ranged from 108 to 132 days.

The fruit yields ranged from 790 to 1900 kg/ha in loamy soil in Helsinki, and from 120 to 390 kg/ha in crusted silt soil in Kangasala. There were no significant differences between the yields of different cultivars in any single trial, despite the considerable annual variation.

The amount of volatile oils in the fruit ranged from 0.34 to 1.49 ml/100 g and the proportion of the main compound, linalool, was 48.7—72.7 %. The small-fruited cultivars ('Hungarian' I and II, 'Lucs') had a higher oil content than those with larger fruits ('Kultive', 'Coriander' LD) but growth period of the small-fruited cultivars was too long for cultivation in the climatic conditions of the Nordic countries.

Index words: variety, oil yield, fruit yield

Introduction

Coriander (*Coriandrum sativum* L.) is not cultivated in the Nordic countries in significant amounts. Finland imports approximate-

ly 20 tonnes coriander seeds (botanically fruits) annually. There exists a growing interest in the cultivation of special crops such as coriander in Finland but few varieties are suitable for growing in the northern climate. In most cases, seeds of coriander are sold without a variety name. Variety studies have been car-

* Present address: Soil Analysis Service Ltd, Vellikellontie 4, SF-00410 HELSINKI, Finland

ried out for instance in the Soviet Union and India (JUKNEVICIENE 1977, KUMAR et al 1977, PENEVA and KRILOV 1977).

The only earlier studies on coriander production in Finland were carried out almost 30 years ago (RAUTAVAARA et al 1953) and the research in the other Nordic countries is also scarce. Knowledge on the current varieties and growing techniques was therefore needed. Certain coriander varieties were tested in 1983—1985 as part of a Herb Plant Research Project, the aim of which was to determine the feasibility of large-scale herb plant production in Finland.

Materials and methods

Coriander varieties were tested during 1983—1985 at two locations in Finland: Helsinki (60°14'N) and Kangasala (61°28'N). Only a limited number of varieties was available for the trials. In 1983 the variety 'Kultive' and two cultivars from Hungary named 'Hungarian' I and II were tested. In the following years 'Coriander' LD (Denmark) and 'Lucs' (Soviet Union) were also included.

The field experiments were set up according to the method of randomized blocks with plots of 8—10 m². The data was statistically analysed by the analysis of variance. The means were separated by the Tukey's test (STEEL and TORRIE 1980).

Coriander seeds were sown at a density of 20 kg/ha. Weeds were controlled by application of linuron (20 g/a) before the germination of coriander seeds. The volatile oil content of the dried fruit was assayed by steam

distillation (WILLIAMS 1984). The fruits were ground rapidly in a Bamix spice mill and 100 grams of ground fruit were steam distilled for four hours. After the distillation the amount of the oil was measured (to the nearest 0.01 ml) from the scale of the side tube of the distillation apparatus. The results were presented in ml/100 g. The oil concentrates were analysed as described previously (HÄLVÄ et al 1986).

Results and discussion

Fruit yield

The coriander seeds germinated in 11—19 days. Germination of the seeds was uneven in the crusted silt soil in Kangasala compared with germination in the humous loamy soil in Helsinki.

In the first year no plant diseases or insects were recorded whereas in the rainy summer of 1984 the fungus *Cladosporium* sp was identified in the vegetation. PURSEGLOVE et al (1981) also reported that this fungus may harm coriander. Other plant diseases or insects commonly found in Europe (HEEGER 1956, NEMETH et al 1969, MATHUR et al 1971, PURSEGLOVE et al 1981) were not found.

The vegetation reached a height of 36—115 cm by the harvest in Helsinki and 79—111 cm in Kangasala. The only variety which showed a slight tendency to be flattened down was 'Kultive'.

The growth period varied between 108 and 133 days, with degree-days between 1210 and 1228 (Table 1). The varieties 'Hungarian' I

Table 1. The growth periods of different coriander varieties compared with 'Kultive' during 1983—1985 at two locations. (The 'Hungarian' varieties I and II (1983) did not reach full fruit ripening in Finnish conditions.)

Variety	Helsinki				Kangasala		
	-83	-84	-85	Mean	-84	-85	Mean
'Kultive'	108	130	110	116	118	128	123
'Coriander' LD	—	130	110	+ 4	119	128	+ 1
'Lucs'	—	133	131	+ 16	132	—	+ 9
Mean				123			126

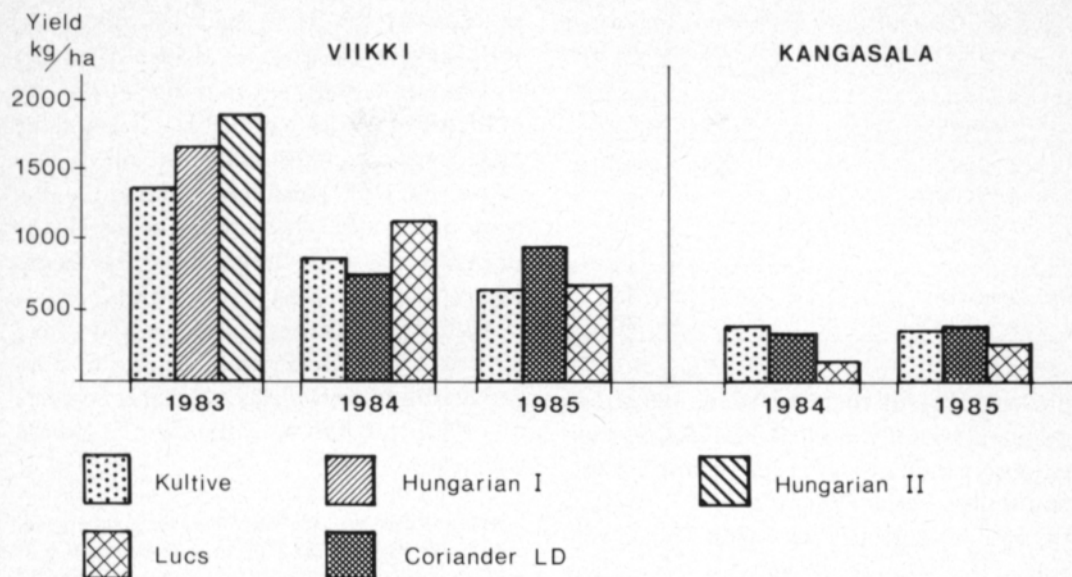


Figure 1. Fruit yields of coriander varieties during 1983–85 at two locations.

Table 2. The amount of volatile oils (ml/100 g) in coriander fruit in 1983–85 at two locations.

Variety	Volatile oils ml/100 g				
	1983 Helsinki	1984		1985	
		Helsinki	Kangasala	Helsinki	Kangasala
'Hungarian' I	1.33				
'Hungarian' II	1.48				
'Kultive'	0.34				
'Coriander' LD		0.43	0.52	0.46	0.54
'Lucs'		0.42	0.46	0.53	0.55

and II, and 'Lucs' had small fruits, the weight of one thousand seeds being 2.3–3.4 g. The growth period required by these varieties was too long for cultivation in the Nordic countries: the fruit of the 'Hungarian' cultivars did not reach full ripeness, and the growth period of 'Lucs' was more than 130 days (Table 1). 'Kultive' and 'Coriander' LD had larger fruits: the weight of one thousand seeds was 4.6–8.1 g. The growth period of these varieties was 108–130 days.

The coriander fruit yield was 790–1900 kg/ha in Helsinki but only 120–390 kg/ha in Kangasala (Fig. 1). These figures are smaller than or as large as those reported earlier (RAUTAVAARA et al 1953, MAGHAMI 1979, ANON 1980). The yields varied annually al-

though there were no significant differences between the varieties in any single trial.

Volatile oils

The amount of volatile oils in coriander fruit ranged from 0.34 to 1.49 ml/100 g (Table 2). The proportion of the main component, linalool, was 48.7–76.6 % (Table 3). The amount of volatile oils is within the figures reported earlier. The contents of limonene and linalool proved to be lower, and that of γ -terpinene, camphor, terpineol, geranyl acetate and geraniol higher than the figures cited in literature (FURIA 1975, FORMACEK & KUBECKA 1982). There is, however, prominent variation in the values. The small-fruited varie-

Table 3. The variation in the proportional amounts of the major compounds of the volatile oils in coriander fruit in 1983–85.

Compound	%
Linalool	48.7–76.6
γ -terpinene	7.2–16.5
Geranyl acetate	1.1–14.8
Camphor	2.9–12.3
Geraniol	1.9–4.8
Limonene	1.2–3.9
α -terpineol	0.0–2.1

ties had higher oil contents (1.2 ml/100 g) than those with larger fruits (0.4 ml/100 g). A similar observation has also been reported in several studies earlier (VARENZOV 1927, ALTHAUSEN et al 1940, KOLACHOV 1940). The oil content of the 'Hungarian' cultivars was particularly high and their smell and taste were sig-

nificantly ($p < 0.01$) stronger in comparison with 'Kultive' (MÄKINEN et al 1986). The fact that the fruits were not fully ripe at the end of the growing season probably influenced the quantity and composition of the oil. PURSEGLOVE et al (1981) also reported that the raw fruits of coriander are more aromatic than the ripe ones. However, the oil of raw fruit is not highly valued in Western countries.

According to the results of this study there is a need to breed and introduce new coriander varieties with larger yields and higher contents of volatile oils for cultivation in the Nordic countries.

Acknowledgements. We would like to express our gratitude to the Academy of Finland and the Ministry of Agriculture and Forestry and the TIURA-foundation for financial support.

References

- ALTHAUSEN, D., BORUFF, C.S., CAMLIN, E.R., KOENIG, C.J. & LANDES, K.H. 1940. Coriander. *The Spice Mill* 63: 8: 32–33. (Ref. PURSEGLOVE, J.W. et al. 1981).
- FORMACEK, V. & KUBECZKA, K.-H. 1982. Essential oils analysis of capillary gas chromatography and carbon-13 NMR spectroscopy. 372 p. Bristol.
- FURIA, T.E. & BELLANCA, N. (ed). 1975. *Fenaroli's handbook of flavor ingredients* 1. 551 p. Ohio.
- HEEGER, E.F. 1956. *Handbuch des Arznei- und Gewürzpflanzenbaues, Drogenwinning*. 776 p. Leipzig.
- HÄLVÄ, S., HIRVI, T., MÄKINEN, S. & HONKANEN, E. 1986. Yield and glucocinolate of mustard seeds and volatile oils of caraway seeds and coriander fruit. II Yield and volatile oils in caraway seeds (*Carum carvi* L.). *J. Agr. Sci. Finl.* 58: 163–167.
- JUKNEVICIENE, G., DAGYTE, S. & STANKEVICIENE, N. 1977. Biological properties and ethereality of some spice plants grown up at the Kaunas Botanical Garden. *Lietuvos TSR Mokslu Akademijos Darbai* C: 3: 9–16.
- KOLACHOV, P. 1940. Domestic cultivation of coriander. *The Spice Mill* 63: 11: 34/35. (Ref. PURSEGLOVE, J.W. et al. 1981).
- KUMAR, C.R., SARWAR, M. & DIMRI, B.P. 1977. Bulgarian coriander in India and its future prospects in export trade. *Ind Perfumer* 21: 11: 34–35. (Ref. PURSEGLOVE, J.W. et al. 1981).
- NEMETH, J., PAIZS, L. & KLEMENT, Z. 1969. The flower-stand blight and seed decay of coriander. *Acta Phytopath. Acad. Sci. Hungaricae* 4: 57–62.
- MAGHAMI, P. 1979. *Culture et cueillette des plantes medicinales*. 222 p. Hachette.
- MATHUR, S.C., ANWER, M. & CHANDOLA, R.P. 1971. Note on screening coriander (*Coriandrum sativum* L.) varieties against Aphid *Hyadaphis coriandri* (Das) Vagrants. *Sci. Culture* 37: 3: 162–163.
- MÄKINEN, S., HÄLVÄ, S., PÄÄKKÖNEN, K., HUOPALAHTI, R., HIRVI, T., OLLILA, P., NYKÄNEN, I. & NYKÄNEN, L. 1986. Maustekasvitutkimus (SA 01/813). Loppuraportti. Sadon käsittely ja aistinvarainen laatu [Report on the Herb Plant Research project crop processing and sensory tested quality.]: 40–65.
- PURSEGLOVE, J.W., BROWN, E.G., GREEN, C.L. & RUBBINS, S.R.J. 1981. Coriander. *Spices* 2: 736–813. London.
- RAUTAVAARA, T., VAARAMA, A. & VALLE, O. 1953. *Maustekasvien viljely Puutarhavilj.* Liiton opassarja 2. 56 p. Helsinki.
- STEEL, R.G.D. & TORRIE, J.H. 1980. *Principles and procedures of statistics, a biometrical approach*. 633 p. New York.
- VARENZOV, V.I. 1927. The mutual relation between the size of the seed and the yield of essential oil from coriander. *Trans. Sci. Chem. Inst. Moscow* 17: 183–1986. (Ref. PURSEGLOVE, J.W. et al. 1981).
- WILLIAMS, S. (ed) 1984. *Official method of analysis of the association of official analytical chemists. method no 30 021. Volatile oil in spices*. 1141 p. Arlington.

Ms received October 29, 1986

Korianterin sato ja haihtuva öljy

Hälvä, S.¹, Hirvi, T.^{2*}, Mäkinen, S.³,
Honkanen, E.²

¹ Helsingin yliopisto, puutarhatieteen laitos,
00710 Helsinki

² VTT, elintarvikelaboratorio, Biologinkuja 1,
02150 Espoo

³ Helsingin yliopisto, ravitsemustieteen laitos,
00710 Helsinki

* Nykyinen osoite: Viljavuuspalvelu, Vellikellontie 4,
00410 Helsinki

Kun uusia tuotantovaihtoehtoja etsittäessä on kiinnostuttu useiden vähän viljeltyjen kasvilajien tuottamisesta, on yhtenä vaihtoehtona nähty myös maustekasvien viljely. Yksi maustekasvilajeista on laajamittaiseen peltoviljelyyn sopiva korianteri, jonka viljely on ollut vähäistä Pohjoismaissa. Lajikkeita on saatavilla vain muutamia, mikä osoittaa korianterin jalostuksen vähyyttä. Korianterin viljelyä on selvitetty edellisen kerran Suomessa yli 30 vuotta sitten (RAUTAVAARA ym. 1953).

Nykyisten lajikkeiden viljelykelpoisuutta ja öljypitoisuutta pohjoisissa oloissa tutkittiin Maustekasvien tutkimusprojektin (SA 01/813) yhteydessä vuosina 1983—1985. Hankkeen tarkoituksena oli selvittää laajamittaisen maustetuotannon mahdollisuuksia Suomessa.

Kokeessa vertailtiin viittä korianterilajiketta tai viljelymuotoa kahdella koepaikalla, Helsingissä ja Kangasalla. Siemeniä kylvettiin 20 kiloa hehtaarille. Helsingissä kasvualusta oli multavaa hietaa ja Kangasalla hiesumaata. Keskimääräinen korianterisato oli Helsingissä 790—1900

kg/ha ja Kangasalla 120—390 kg/ha. Sadot vaihtelivat huomattavasti vuosittain, eri lajikkeiden välillä ei kuitenkaan ollut merkittäviä eroja missään yksittäisessä kokeessa. Tutkituista lajikkeista neuvostoliittolainen 'Lucs' ja 'Unkarilainen' I ja II ovat pienisiemenisiä (kasvitieteellisesti hedelmiä) lajikkeita, jotka eivät ehtineet tuleentua täysin meidän oloissamme. Suurisiemenisten lajikkeiden ('Korianteri' LD ja 'Kultive') kasvuaika oli 108—130 vuorokautta.

Siementen eteerisen öljyn kokonaismäärä oli 0.34—1.49 ml/100 g. Tärkeimmän yhdisteen, linalolin, pitoisuus vaihteli 48.7 ja 76.6 prosentin välillä. Pienisiemenisten lajikkeiden ja viljelymuotojen öljypitoisuus oli korkeampi kuin suurisiemenisten.

Korianterilajikkeiden jalostustarve on edellisen perusteella ilmeinen. Mikäli pohjoisilla alueilla, kuten Suomessa halutaan viljellä korianteria tarvitaan satoisia lajikkeita, joilla on runsas ja hyvälaatuinen öljy sekä lyhyt kasvuaika.