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Annual grain crops for forage production 1994 update on essential oils in Saskatchewan spice crops

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1994 UPDATE ON ESSENTIAL OILS IN SASKATCHEWAN SPICE CROPS

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Introduction

About this time last year, a 3-year project on Development of a Spice Industry For Saskatchewan was approved for funding by the Saskatchewan Agricultural Development Fund. The general objectives of the program were to:

1. License cultivars of fenugreek and three Umbelliferae crops.
2. Develop a field production package for each.
3. Evaluate seed quality and potential end uses.

The project is designed to provide financial support for the plant breeding program already underway by Dr. A.E. Slinkard and Dr. A. (Bert) Vandenberg and to fund the necessary agronomic studies and off-station testing being conducted by Professor Rick Holm, Dr. Lawrence Townley-Smith at the Agriculture Canada Research Station, Melfort, and Dr. Jazeem Wahab at the Saskatchewan Irrigation Development Centre, Outlook. Initial funding was directed toward employing technical help for the 1994 field testing program, but a half-time technician is conducting analyses of essential oils in seed from the 1992 and 1993 crops and, recently, the excellent 1994 crop.

The specific objectives of the project are to develop one superior line of fenugreek, caraway, cumin and coriander by the end of the 3-year period plus evaluate production practices such as date and depth of seeding, fertilization practices and weed control. Also other Umbelliferae crops will move into cultivar testing, such as anise and dill, when enough lines become available. The first objective of the program, the release of a fenugreek cultivar, PI 143504, has just been achieved, following a recent announcement by Dr. Slinkard.

Background

Spices, such as those from Umbelliferae seeds and fruits, are utilized as whole spice, ground spice, essential oil and oleoresin. The quality standards for the whole spice market emphasize seed size and visual characteristics as well as rigorous sanitation standards for imported seed. The volatile constituents are steam distilled from spices to provide an 'essential oil' which is a highly flavored and aromatic liquid concentrate for use in prepared and processed foods and toiletries. The constituents of essential oils are low molecular weight organic compounds, especially derivatives of the benzene ring such as carvone (MW=150), which show volatility at room temperature. These essential oils are called 'oils' because of their insolubility in and lower density than water. Spice seeds also contain fixed oils or vegetable oils with the same insolubility in and lower density than water. However, these vegetable oils have molecular weights of about 800 and boiling points of over 200°C. Thus, only the essential oils are steam volatile.

To prepare an oleoresin, organic solvents are used to extract the essential and vegetable oil or to extract the vegetable oil from the steam-distilled spice residue and, after desolventizing the solvent/oil mixture, the two oils are blended. A typical oleoresin would contain 90% fixed oil, 5% essential oil and 5% of other solubles from the seed. Oleoresins have 10 to 20% of the potency of

an essential oil and are easier to use in standardizing the flavor and aroma of a prepared food or non-food product.

Spice Markets

Reports in the literature indicate that the markets and prices for essential oils in the United States are increasing at 5-6% per year and the total value is projected to reach 400 million dollars (US) in 1995 (Table 1). Baked goods are the major market for essential oils, with processed foods, beverages and non-food uses being other major uses. The major essential oil crops in the USA are citrus (grapefruit, lemon, lime, orange) and mint (peppermint, spearmint).

Table 1 Annual Sales of Essential Oils in USA

Food and Non-food uses	Million Dollars		
	1980	1990	1995
Baked goods	91	132	168
Processed foods	25	69	93
Beverages	33	40	52
Non-food uses	56	67	87
Total	205	308	400

Among seed spices, coriander is one of the major sources of essential oil, and world production of the oil of coriander is over 700 tonnes (Table 2). Recently, the imports of coriander seed in to the United States has decreased, but demand for cumin and caraway have increased proportionately. So substantial markets for these spices in the United States are available to Canadian producers.

Table 2 US Imports of Dried Spices in 1988 and 1993*

Spice	1988		1993	
	Imports tonnes	Price \$/kg	Imports tonnes	Price \$/kg
Cumin	3700	1.22	5200	1.75
Caraway	2838	0.85	4000	1.00
Coriander	5938	0.56	2200	0.73

USDA/FAS

Cumin Seed Quality

Cumin seed intended for processing should contain 4 to 6% (v/w) of essential oil and analyses of the best cultivar in the yield tests conducted at Saskatoon gave mean values of 5.3% in 1992 and 3.8% in 1993 (Table 3). In both years, the earliest date of seeding, late April, gave the highest essential oil content. The total extractables also varied between seeding dates and years. The highest yields of hexane-soluble material were 20% for the mid-May date in 1992 and 25% in early May in 1993.

Table 3 Essential Oils and Extractables in Cumin, % (v/w)

Year and Constituent	Seeding Date			
	Late April	Early May	Mid-May	Late May
1992 -Weed Control Test	5.9			
Essential Oil	9.7	5.4	5.0	5.0
Extractables		14.2	19.8	16.5
1993- Seeding Date Test	4.0		3.7	
Essential Oil	20.6	3.6	20.3	4.0
Extractables		25.2		19.5

The constituents in the essential oils of cumin averaged 26% cymene, 22% cuminaldehyde, 18% terpinene, 16% myrcene and 14% myrtenol in 1993 samples. According to the literature, cumin essential oil should contain 40-65% cuminaldehyde, which is much higher than was found in the Saskatchewan samples to-date. Therefore, the results of the analyses of the 1994 cumin samples are of considerable importance in establishing the quality of cumin from Saskatchewan.

Caraway Seed Quality

Biennial caraway biotypes are the common sources of essential oils of caraway in world markets; the volatile oil contents vary typically between 3.0 and 7.5% of the seed. Carvone contributes the typical aroma of caraway seed and the carvone to limonene ratio in the essential oil should be 60:40. Caraway seeds also contain 15% vegetable oil of which oleic, linoleic and petroselinic acids are the principal fatty acids in the triglycerides. Petroselinic acid is an uncommon fatty acid that is found widely in Umbelliferae species including coriander.

A line of annual caraway was evaluated in 1993-1994 for its agronomic performance in comparison with biennial caraway. Seed samples of both biotypes were analysed for quality in 1993 (Table 4) and another set is available for analysis from the 1994 field experiments..

Studies on the original seed lots showed that the annual caraway contains much less essential oil than the biennial type with the annual being well below international standards (Table 4). The yields of extractables were also low at 15-17%, and the concentration of carvone was only 52-55%. Frozen annual caraway (1993 crop) showed similar characteristics to the mature annual sample except for a low carvone content.

Table 4 Composition of Essential Oil in Original Seed Lots of Caraway, 1993

Caraway Biotype	Essential Oil	Extractables	Oil Composition %	
	% (v/w)	% (w/w)	Carvone	Limonene
Biennial (Original Seed)	3.72	17.4	54.8	44.6
Annual (Original Seed)	2.42	15.0	52.5	46.5
Annual, Frozen	3.00	16.9	46.8	52.3

The results with annual caraway (original seed) are compared to data obtained on annual caraway from the 1994 crop (Table 5). In 1993 the essential oil and percent carvone were somewhat higher than in the original seed, and the yield of extractables was 17%. In 1994, the essential oil yields averaged much higher at 4.2% although carvone content was reduced relative to limonene percentage. One caraway sample from a commercial farm, grown in 1994, had only 2.1% essential oil and 5.1% carvone.

Table 5 Essential Oils in Annual Caraway %

Year	Essential Oil	Extractables	Oil Composition %	
	% (v/w)	% (w/w)	Carvone	Limonene
Original Seed	2.4	15.0	52.5	46.5
1993	2.8	-----	55.0	44.0
	2.7	17.1	55.1	44.0
1994	4.3	17.0	-----	-----
	4.1	-----	50.1	48.8

Coriander Fruit Quality

The coriander fruit contains two seeds but both the fruit coat and seed contain essential oils. The fruit should have 0.8 to 1.4% essential oil that is composed of 60-70% linalool. There is also 16 to 28% of vegetable oil in the fruit that contains primarily oleic and petroselinic fatty acids. Small seed size is associated with superior essential oil content. This was evident in the 1992 cultivar trial where only the small seeded lines, averaging 7-8 g/1000 fruit weight, yielded 0.9-1.0% essential oils and 65% linalool (Table 6).

Table 6 Essential Oils in Coriander Seed, 1992

Cultivar	1000-Seed	Essential Oil	Linalool
	wt., g	% (v/w)	% of oil
Suzanne, Lisa, Indian	15	0.4	68
PGR 8580	11	0.4	---
Autumn	8	0.9	64
12 Lines, ave.		1.0	65

In 1993, Autumn and PGR-10058 were grown in a replicated seeding date trial. All samples had nearly 1% essential oil and the linalool values were 70% in the early seeded plots (Table 7). This paralleled the yield data that favored early seeding. Other studies have shown that linalool content increases with maturity up to the stage that the fruit turns grey-brown, so early seeding would favor linalool concentration.

Table 7 Essential Oils in Coriander, 1993*

Seeding Date	Essential Oil % (v/w)	Linalool % of oil(v/v)
April - 4th week	1.0	70
May - 1st week	0.9	67
May - 3rd week	1.0	65
June - 1st week	0.9	63

* Average of Autumn and PGR-10058.

Analysis of farmer samples from the 1994 crop indicated that only large-seeded cultivars were grown (Table 8). Thus, the essential oil levels were low, and even linalool contents were quite low. These were the only samples for which enough seed was available for total extract analysis, and the 15-17% levels were similar to total extractable values for samples of coriander submitted to commercial spice houses in previous years that ranged from 15 to 18.5%. Apparently coriander seed from Morocco gives total extractables of 21 to 25% of the ground fruit so the Saskatchewan samples appear low in this property.

Table 8 Composition of 1994 Commercial Samples of Coriander

Seed Characteristic	Sask. Agric.	Moosomin Sample	Prairie Essential oils
1000 Kernel Wt., g	14.6	15.8	17.7
Essential Oils, % (v/w)	0.58	0.52	0.46
Linalool (% of total)	55.4	56.1	58.3
Extractables, % (w/w)	15.0	17.1	16.8

Conclusions

Cumin seed samples grown in field experiments in 1992 and 1993 were adequate in essential oil content and yield of total extractables. However, the low cuminaldehyde levels in the essential oils from the 1993 crop are of concern, but this defect needs to be confirmed in analyses of 1994 samples.

The biennial caraway grown at Saskatoon appeared satisfactory in essential oil and carvone contents. Variable results with an annual biotype indicate that further testing is necessary before a recommendation can be made on its quality.

Small-seeded lines of coriander contain up to 1.0% essential oil and 65-70% linalool in the essential oil which meets world standards. Large-seeds lines from field experiments and commercial fields were low in essential oil contents and yield of extractables.

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