Canadian Grain Commission
Commission canadienne des grains

ISSN 1498-9905

Quality of western Canadian mustard 2005

Douglas R. DeClercq
Program Manager, Oilseeds Services

Contact: Douglas R. DeClercq
Program Manager, Oilseeds Services
Tel: 204 983-3354
Email: ddeclercq@grainscanada.gc.ca
Fax: 204 983-0724

Grain Research Laboratory
Canadian Grain Commission
1404-303 Main Street
Winnipeg MB R3C 3G8
www.grainscanada.gc.ca

Canada

Quality Innovation Service

Table of contents

Tables

Acknowledgements

The CGC acknowledges the cooperation of mustard producers, grain handling offices, and seed handling plants in western Canada for supplying the samples of mustard harvested in 2005, and the Weather and Crop Surveillance department of the Canadian Wheat Board for providing the review of the 2005 growing season. The CGC recognizes Industry Services grain inspectors for grading the mustard harvest survey samples and GRL staff for conducting the analyses and preparing the report.

Introduction

This report presents information on the oil, protein and glucosinolate contents and the fatty acid composition of oriental *(Brassica juncea)*, brown *(Brassica juncea)* and yellow *(Sinapis alba)* mustard grown in western Canada in 2005. The data were obtained from analyses of harvest survey samples collected by the Canadian Grain Commission (CGC).

Summary

Compared to the ten-year means, all three types of mustard seed were higher in average fixed oil content and lower in protein content. However, both the oriental and brown mustard 2005 survey samples had lower average fixed oils and higher protein contents compared to the 2004 values. Top grade oriental mustard had a fixed oil content of 42.7%, a decrease of 1.7% from the 2004 value of 44.4%. Top grade brown mustard samples had a fixed oil content of 40.6%, a 1.0% decrease from the 2004 value of 41.6%. Oriental and brown mustard samples increased in protein content to 26.2% and 25.7% respectively in 2005. Compared to 2004 values, the average glucosinolate content of the 2005 oriental mustard samples increased while the 2005 brown mustard samples contained similar levels of glucosinolates. Compared to 2004, the yellow mustard survey samples were 0.8% lower in fixed oil at 30.8% and 0.4% higher in protein content at 31.4%.

Weather and production review

Weather review

Temperature and precipitation patterns for the 2005 western Canadian growing season can be found on the PFRA web site (http://www.agr.gc.ca/pfra/drought/drmaps_e.htm). Of particular note this growing season were the heavy rainfalls during the spring followed by moderate temperatures throughout the growing season. In Saskatchewan, June 2005 is tied with June 1953 for the wettest month on record in the last 90 years. The Weather and Crop Surveillance department of the Canadian Wheat Board provided the majority of the detailed weather review for the 2005 crop year.

Seeding

Precipitation from the beginning of April to the end of May 2005 was normal to above-normal in the Prairie region. Planting progress during the spring was dependent on location; the general trend saw western regions planted more rapidly than the eastern growing areas. The overall planting pace in western Canada was two to five days ahead of normal during the first three weeks of May, but rains slowed progress in the latter half of the month. Heavy rains in June delayed the completion of oilseed crop planting and caused some crop area to be left unseeded.

Growing conditions

Persistent heavy rains throughout the southern Prairies in June caused flooding losses in Alberta and southern Manitoba. Manitoba was hardest hit by the wet conditions, with unseeded and drowned-out areas exceeding two million total crop acres. The rest of the Prairies received normal to above-normal amounts of precipitation during the June period, which helped increase crop yield potential. Precipitation during July was mostly normal across the Prairie region, with temperatures slightly below normal in western regions and above normal in the east. The moderate temperatures boosted crop growth, without causing stress to the crop. Crop development was significantly ahead of last year in most regions, due to the warmer temperatures received throughout the growing season. Cooler temperatures and frequent rainfall slowed crop development in Alberta and western Saskatchewan in August. The cooler weather also resulted in a number of locations in northwestern Saskatchewan and northern Alberta reporting spotty frost events in the first two weeks of the month. Eastern regions reported warmer-than-normal temperatures, which increased stress to crops in the late filling stage. Warm temperatures also boosted crop development in eastern Saskatchewan and Manitoba.

Harvest conditions

Southeastern areas of the Prairies began harvesting in the middle of August. The last week of August and the first two weeks of September were unseasonably wet, with heavy downpours falling across southern Alberta and into northeastern Saskatchewan. Crops in the regions that received the heaviest rainfall were downgraded. Weather conditions in the southern Prairies were better, with most of the harvest in Manitoba and the southern areas of Saskatchewan complete by the end of September. Harvesting in the northern areas of Saskatchewan and Alberta continued into October.

Production and grade information

As shown in Table 1, mustard seed production for 2005 decreased by 34% to 201.4 thousand metric tonnes as a result of lower seeded area and lower yields. About 41% of western Canadian mustard production was estimated to be the yellow type, followed by 32% oriental and 28% brown mustard. Saskatchewan accounted for 85% of western Canada's total seeded acreage and production of mustard. According to Saskatchewan Agriculture and Food, the 2005 Saskatchewan yield of 863 lb/acre (383 kg/acre) was well above the ten-year (1995-2004) average of 770 lb/acre (350 kg/acre) but 4% below the 2004 yield of 898 lb/acre (407 kg/acre). Detailed information on production factors and yields for Saskatchewan crop districts can be found at: http://www.agr.gov.sk.ca/DOCS/crops/special_crops/production_information/specialtycroprpt.asp

Saskatchewan Agriculture and Food estimated 77% of the 2005 Saskatchewan mustard crop graded No.1 Canada, compared to only 45% in 2004 and 74% for the 1995-2004 period. The good harvest conditions, particularly in southern Saskatchewan and Alberta, produced a mustard crop with significantly less visible damage and discoloration than in 2004. Compared to 2004, there were notably fewer yellow mustard samples in the lower grades.

Table 1 – Seeded area and production for western Canadian mustard

Region	Seeded area[1] 2005	Seeded area[2] 2004	Production[1] 2005	Production[2] 2004	Mean production[2] 1995-2004
	thousand hectares		thousand tonnes		thousand tonnes
Manitoba	n/a	3.2	n/a	2.7	4.9
Saskatchewan	180.1	259.0	170.3	250.4	185.4
Alberta	32.3	54.6	31.1	52.4	35.2
Western Canada	**212.4**	**316.8**	**201.4**	**305.5**	**225.5**

[1] *Field Crop Reporting Series No. 8*, December 7, 2005; Statistics Canada
[2] *Field Crop Reporting Series No. 8*, revised estimates for 1995-2004

Harvest survey samples

The 380 samples for the 2005 mustard survey included 151 yellow mustard, 109 brown mustard and 120 oriental mustard. Over 83% of the 2005 harvest survey samples came from Saskatchewan.

Producers, grain companies and elevators that routinely handle mustard seed submitted samples of mustard grown in 2005 to the CGC. The individual samples were cleaned to remove dockage and graded by the CGC's Industry Services Division.

The oil, protein, and glucosinolate contents were determined on all individual whole seed samples using a NIRSystems 6500 scanning near infra-red spectrometer calibrated to and verified against the appropriate listed reference methods. The glucosinolate contents of oriental and brown mustard are expressed as μmoles/g of allyl glucosinolate and mg/g of allyl isothiocyanate on a whole-seed, dry moisture basis. A molar mass of 99.16 g/mole for allyl isothiocyanate is used to convert μmoles of allyl glucosinolate (sinigrin) to mg/g of allyl isothiocyanate. Composite samples were tested for fatty acid composition.

Quality of western Canadian mustard 2005

The three mustard crops grown in western Canada in 2005 showed the general characteristics of a crop grown under generally good growing conditions, i.e. moderate temperatures and ample moisture. Some of the southern regions of the mustard growing area received some hot, dry weather in July which contributed to lower fixed oils and higher glucosinolate levels in those regions. The Grain Research Laboratory (GRL) long-term harvest survey results show that cool, wet growing conditions tend to produce an oilseed crop with higher oil contents and iodine values, but lower protein contents. Research also shows that glucosinolate levels may increase when Brassica crops are grown under hot, dry conditions.

The oil, protein, and glucosinolate contents for yellow, brown and oriental mustard are summarized by grade in Table 2. The fatty acid compositions of the mustard oils are detailed in Table 3. A comparison of the 2005 quality data with the previous years' surveys is provided in Table 4. The means and standard deviations of the 2005 analytical data by grade and province can be found at

http://www.grainscanada.gc.ca/Quality/Mustard/mustardmenu-e.htm

Quality of Domestic Mustard Seed, Canada, Oriental and Domestic Mustard Seed, Canada, Brown

The average fixed oil content of the 2005 No.1 Canada oriental mustard decreased 1.7% to 42.7% while the average protein content increased by 1.1% to 26.2%. The fixed oil contents of No. 1 Canada oriental mustard from producers in western Canada ranged from 37.3% to 48.0%. The protein content of No. 1 Canada oriental mustard from producers in western Canada ranged from 22.3% to 31.1%.

The average fixed oil content of No. 1 Canada brown mustard decreased 1.0% to 40.6% while the average protein content increased by 0.9% to 25.7%. The fixed oil content of No. 1 Canada brown mustard from producers in western Canada ranged from 35.5% to 44.7%. The protein content of No. 1 Canada brown mustard from producers in western Canada ranged from 21.5% to 32.6%.

In 2005, the average glucosinolate contents for oriental mustard increased by 7 μmol/g to 130 μmol/g while brown mustard decreased one μmol/g to 108 μmol/g. The glucosinolate contents of No. 1 Canada oriental mustard from producers in western Canada ranged from 103 to 150 μmol/g. The glucosinolate contents of No. 1 Canada brown mustard from producers in western Canada ranged from 88 to 130 μmol/g. The provincial and grade differences are detailed in the statistical tables for oriental and brown mustard:

http://www.grainscanada.gc.ca/Quality/Mustard/mustardmenu-e.htm

Fatty acid compositions for the oriental and brown mustard composites are provided in Table 3. The 2005 erucic acid levels decreased 1.8% and 0.6% respectively for

No.1 Canada oriental and brown mustards. The mean 2005 erucic acid values of 21.2% and 23.7% for oriental and brown mustards are typical of *Brassica juncea* condiment mustards. The oriental mustard variety Forge showed some differences in oleic (C18:1), linoleic (C18:2), and erucic acid (C22:1) content compared to varieties Cutlass and AC Vulcan.

The total saturated fatty acids for the No.1 Canada oriental and brown mustard samples increased by 0.2% and 0.1% respectively to produce means of 6.1% for both types of *Brassica juncea* mustard. In addition, the 2005 mustard composites also had decreased levels of linolenic acid and increased levels of oleic acid. This was a general trend that all western Canadian oilseed crops exhibited in the 2005 surveys. As a result, the iodine value, an indicator of oil unsaturation, will be slightly lower in most 2005 oilseed samples.

The growing season temperatures for the 2004 season were among the coolest reported in over 100 years. This caused the oilseed plants to increase the amount of unsaturation in the oil. The plant's objective in making the oil unsaturated is to give a more liquid (i.e. unsaturated) oil at lower temperatures. To do this, the plants have evolved mechanisms in the form of enzyme systems that are more active in making the oil unsaturated when the weather is cool and less active when it is hot. A return to warmer temperatures in 2005 resulted in the shifts in fatty acid profiles.

Quality of Domestic Mustard Seed, Canada, Yellow

The yellow mustard had the characteristically lower oil content and higher protein content than oriental and brown mustards. For No. 1 Canada yellow mustard, the average fixed oil content decreased 0.8% to 30.8% while average protein content increased 0.4% to 31.4% (Table 4). The fixed oil contents of No. 1 Canada yellow mustard from producers in western Canada ranged from 25.7% to 37.0%. The protein content of No. 1 Canada yellow mustard from producers in western Canada ranged from 25.9% to 36.3%. Regional and grade differences in seed quality are detailed at:

http://www.grainscanada.gc.ca/Quality/Mustard/mustardmenu-e.htm

Fixed oil in yellow mustard contained higher amounts of oleic (C18:1) and erucic acid (C22:1) but lower amounts of linoleic (C18:2) and linolenic (C18:3) acid compared to the oriental and brown mustard oils. The oil from the 2005 No.1 Canada Yellow mustard seed had a mean erucic acid content of 35.5% compared to the 37.9% in 2004. Total saturated fatty acids, at 5.2%, were slightly higher than the 5.1% in 2004.

Table 2 – Quality of 2005 western Canadian mustard

Grade	Number of samples	Oil content[1]	Protein content[2]	Glucosinolate content[3]	
		%	%	µmol/g	mg/g
Domestic Mustard Seed, Canada, Oriental					
No. 1 Canada	90	42.7	26.2	130	—
No. 2 Canada	8	43.2	26.8	131	—
No. 3 Canada	6	40.9	28.3	135	—
No. 4 Canada	7	43.4	25.3	131	—
Sample Canada	9	43.0	25.2	121	—
Domestic Mustard Seed, Canada, Brown					
No. 1 Canada	91	40.6	25.7	108	—
No. 2 Canada	7	40.0	26.8	111	—
No. 3 Canada	4	41.9	23.6	106	—
No. 4 Canada	3	38.7	26.3	111	—
Sample Canada	4	40.3	26.4	106	—
Domestic Mustard Seed, Canada, Yellow					
No. 1 Canada	94	30.8	31.4	—	—
No. 2 Canada	16	33.0	29.6	—	—
No. 3 Canada	10	32.6	30.0	—	—
No. 4 Canada	16	30.3	32.1	—	—
Sample Canada	15	31.1	31.4	—	—

[1] Dry matter basis

[2] % N x 6.25; dry matter basis

[3] Allyl glucosinolate (µmoles/g) and allyl isothiocyanate (mg/g); dry matter basis

Table 3a – Fatty acid composition of 2005 western Canadian mustard

Grade/variety	Number of samples	Fatty acid composition[1]								
		C16:0	C16:1	C18:0	C18:1	C18:2	C18:3	C20:0	C20:1	C20:2
		%	%	%	%	%	%	%	%	%
Domestic Mustard Seed, Canada, Oriental										
No. 1 Canada										
Saskatchewan	76	2.9	0.2	1.5	22.3	21.9	12.0	0.9	12.8	1.1
Alberta	14	3.0	0.2	1.6	22.5	22.9	11.4	0.9	12.3	1.0
No. 2 Canada	8	2.8	0.2	1.4	20.3	21.4	13.0	0.9	12.6	1.2
No. 3 Canada	6	2.9	0.2	1.4	20.8	22.1	12.8	0.9	12.0	1.1
No. 4 Canada	7	2.9	0.2	1.5	22.8	21.5	12.0	0.9	12.8	1.0
Sample Canada	10	3.0	0.2	1.6	22.5	22.1	12.6	0.9	12.5	1.1
AC Vulcan	11	2.7	0.2	1.5	20.0	21.0	12.2	1.0	13.4	1.1
Cutlass	28	2.8	0.2	1.5	20.6	20.6	12.3	0.9	13.2	1.1
Forge	43	3.1	0.2	1.6	24.6	23.6	11.5	0.9	12.1	1.0
Domestic Mustard Seed, Canada, Brown										
No. 1 Canada										
Saskatchewan	86	3.0	0.2	1.5	21.1	20.6	13.2	0.9	12.9	1.0
Alberta	3	3.0	0.2	1.4	20.5	21.3	13.5	0.9	12.3	1.0
No. 2 Canada	7	3.0	0.2	1.5	20.9	20.9	13.5	0.9	12.6	1.0
No. 3 Canada	4	3.1	0.2	1.5	20.6	21.4	13.3	0.9	12.8	1.1
No. 4 Canada	3	3.1	0.2	1.5	21.0	20.9	13.1	0.9	12.8	1.0
Sample Canada	4	3.0	0.2	1.5	21.7	20.8	12.8	0.9	12.8	1.0
Common	18	3.0	0.2	1.5	20.8	20.8	13.3	0.9	12.8	1.0
Duchess	42	3.0	0.2	1.5	21.5	20.6	12.9	0.9	13.0	1.0
Domestic Mustard Seed, Canada, Yellow										
No. 1 Canada										
Manitoba	2	2.6	0.2	1.0	24.0	9.2	11.2	0.6	10.9	0.3
Saskatchewan	62	2.7	0.2	1.0	24.6	9.5	10.5	0.7	11.0	0.3
Alberta	28	2.7	0.2	1.0	24.9	9.3	10.4	0.7	11.4	0.3
No. 2 Canada	16	2.7	0.2	1.0	24.0	9.1	11.3	0.7	10.9	0.3
No. 3 Canada	9	2.7	0.2	1.1	24.1	9.2	11.1	0.7	10.9	0.3
No. 4 Canada	16	2.7	0.2	1.1	24.9	9.6	11.1	0.7	11.0	0.3
Sample Canada	15	2.7	0.2	1.0	24.0	9.7	10.9	0.7	10.8	0.3
AC Pennant	34	2.7	0.2	1.0	24.7	9.5	10.2	0.7	11.1	0.3
Ace	4	2.7	0.2	1.0	23.0	9.7	10.0	0.7	10.8	0.3
Andante	20	2.7	0.2	1.0	24.3	9.6	11.1	0.7	11.0	0.3
Tilney	4	2.7	0.2	1.0	26.0	9.3	10.7	0.7	11.4	0.3

[1] Percentage of total fatty acids including: palmitic (C16:0), palmitoleic (C16:1), stearic (C18:0), oleic (C18:1), linoleic (C18:2), linolenic (C18:3), arachidic (C20:0), eicosenoic (C20:1), eicosadienoic (C20:2), behenic (C22:0), erucic (C22:1), docosadienoic (C22:2), lignoceric (C24:0), and nervonic (C24:1)

[2] Saturated fatty acids are defined as the sum of C16:0, C18:0, C20:0, C22:0, and C24:0.

Table 3b – Fatty acid composition of 2005 western Canadian mustard

Grade/variety	Number of samples	Fatty acid composition[1]						
		C22:0	C22:1	C22:2	C24:0	C24:1	Saturated fatty acids[2]	Iodine value
		%	%	%	%	%	%	units
Domestic Mustard Seed, Canada, Oriental								
No. 1 Canada								
Saskatchewan	76	0.5	21.3	0.4	0.3	1.4	6.1	117
Alberta	14	0.5	20.9	0.4	0.3	1.4	6.4	117
No. 2 Canada	8	0.4	23.0	0.4	0.3	1.5	5.8	119
No. 3 Canada	6	0.5	22.4	0.4	0.3	1.6	5.9	119
No. 4 Canada	7	0.5	21.4	0.4	0.3	1.4	6.1	117
Sample Canada	10	0.4	20.6	0.4	0.3	1.4	6.2	118
AC Vulcan	11	0.5	23.7	0.4	0.3	1.4	6.0	117
Cutlass	28	0.5	23.5	0.4	0.3	1.4	6.0	116
Forge	43	0.4	18.5	0.3	0.3	1.3	6.4	118
Domestic Mustard Seed, Canada, Brown								
No. 1 Canada								
Saskatchewan	86	0.5	22.7	0.4	0.3	1.2	6.1	118
Alberta	3	0.5	22.7	0.4	0.3	1.3	6.1	119
No. 2 Canada	7	0.5	22.6	0.4	0.2	1.3	6.1	119
No. 3 Canada	4	0.5	22.1	0.4	0.3	1.3	6.3	119
No. 4 Canada	3	0.5	22.5	0.4	0.3	1.2	6.2	118
Sample Canada	4	0.5	22.3	0.4	0.3	1.2	6.1	118
Common	18	0.5	22.6	0.4	0.3	1.3	6.2	118
Duchess	42	0.5	22.5	0.4	0.3	1.2	6.2	118
Domestic Mustard Seed, Canada, Yellow								
No. 1 Canada								
Manitoba	2	0.5	35.9	0.3	0.3	2.4	5.0	103
Saskatchewan	62	0.5	35.6	0.3	0.3	2.3	5.2	102
Alberta	28	0.5	35.2	0.2	0.3	2.2	5.2	102
No. 2 Canada	16	0.5	36.0	0.2	0.3	2.3	5.1	103
No. 3 Canada	9	0.5	35.8	0.3	0.3	2.3	5.2	103
No. 4 Canada	16	0.5	34.5	0.3	0.3	2.3	5.2	103
Sample Canada	15	0.5	35.6	0.3	0.3	2.3	5.2	103
AC Pennant	34	0.6	35.6	0.3	0.3	2.2	5.2	101
Ace	4	0.6	37.5	0.3	0.3	2.4	5.2	101
Andante	20	0.5	35.1	0.3	0.3	2.3	5.1	103
Tilney	4	0.5	34.0	0.2	0.3	2.0	5.3	102

[1] Percentage of total fatty acids including: palmitic (C16:0), palmitoleic (C16:1), stearic (C18:0), oleic (C18:1), linoleic (C18:2), linolenic (C18:3), arachidic (C20:0), eicosenoic (C20:1), eicosadienoic (C20:2), behenic (C22:0), erucic (C22:1), docosadienoic (C22:2), lignoceric (C24:0), and nervonic (C24:1)

[2] Saturated fatty acids are defined as the sum of C16:0, C18:0, C20:0, C22:0, and C24:0.

Table 4 – Quality of western Canadian mustard from CGC surveys

Year	Number of samples	Oil content[1]	Protein content[2]	Glucosinolate content[3]	
		%	%	µmol/g	mg/g
Domestic Mustard Seed, No. 1 Canada, Oriental					
2005	90	42.7	26.2	130	12.9
2004	64	44.4	25.1	123	12.2
1995-04	601	42.1	26.4	128	12.7
Domestic Mustard Seed, No. 2 Canada, Oriental					
2005	8	43.2	26.8	131	12.9
2004	13	44.4	25.2	122	12.1
1995-04	70	42.1	26.8	123	12.6
Domestic Mustard Seed, No. 3 Canada, Oriental					
2005	6	40.9	28.3	135	13.3
2004	6	41.8	27.2	129	12.7
1995-04	30	42.7	25.6	124	12.3
Domestic Mustard Seed, No. 1 Canada, Brown					
2005	91	40.6	25.7	108	10.7
2004	67	41.6	24.8	109	10.8
1995-04	552	40.0	25.9	106	11.0
Domestic Mustard Seed, No. 2 Canada, Brown					
2005	7	40.0	26.8	111	11.0
2004	7	40.6	25.7	110	10.9
1995-04	29	38.1	27.6	111	11.0
Domestic Mustard Seed, No. 3 Canada, Brown					
2005	4	41.9	23.6	106	10.6
2004	2	39.5	26.1	109	10.8
1995-04	44	38.7	26.7	109	10.8
Domestic Mustard Seed, No. 1 Canada, Yellow					
2005	94	30.8	31.4	—	—
2004	115	31.6	31.0	—	—
1995-04	604	30.6	31.8	—	—
Domestic Mustard Seed, No. 2 Canada, Yellow					
2005	16	33.0	29.6	—	—
2004	48	31.8	31.1	—	—
1995-04	154	30.6	31.9	—	—
Domestic Mustard Seed, No. 3 Canada, Yellow					
2005	10	32.6	30.0	—	—
2004	12	32.0	30.7	—	—
1995-04	60	31.3	31.3	—	—

[1] Dry matter basis

[2] % N x 6.25; dry matter basis

[3] Allyl glucosinolate (µmoles/g) and allyl isothiocyanate (mg/g); dry matter, seed basis

Chlorophyll content

Chlorophyll content is determined by International Organization for Standardization method reference number ISO 10519:1997 (E), Rapeseed—Determination of chlorophyll content—Spectrometric method. Results are expressed as milligrams per kilogram (mg/kg), seed basis.

Fatty acid composition

Fatty acid composition is determined by the International Organization for Standardization methodreference number ISO 5508:1990 (E), Animal and vegetable fats and oils—Analysis by gas chromatography of methyl esters of fatty acids. A 15m by 0.32mm column with a 0.25μm Supelcowax 10 coating is used. Major and important fatty acids are reported although samples may also contain as much as 1% of other minor fatty acids which are included in the calculations.

Free fatty acid content

Free fatty acid content is determined by a method adapted from the procedure of Ke et al, Analytica Chemica Acta 99:387–391 (1978), and is expressed as a percentage by weight of oleic acid in the oil. Oleic acid with a molecular weight of 282 is used as the fatty acid for the expression of the results.

Glucosinolate content

Glucosinolate content is determined by International Organization for Standardization method reference number ISO 9167–1:1992(E), Rapeseed—Determination of glucosinolate content—Part 1: Method using high performance liquid chromatography. Results are total seed glucosinolates expressed as micromoles per gram (μmol/g), calculated to an 8.5% moisture basis for canola or on a dry matter basis for all mustard seeds.

Iodine value

Iodine value is a measure of unsaturation calculated from the fatty acid composition according to AOCS Recommended Practice Cd 1c-85, revised 1995 and re-approved 1997, Calculated Iodine Value.

Oil content

Oil content is determined by nuclear magnetic resonance (NMR) according to the International Organization for Standardization, reference number ISO 10565:1992(E) Oilseeds—Simultaneous determination of oil and moisture contents—Method using pulsed nuclear magnetic resonance spectroscopy. A Bruker NMS 110 Minispec NMR Analyzer calibrated with appropriate oilseed samples extracted with petroleum ether is used. Results are reported as a percentage, calculated to a specified moisture basis. Canola is calculated to an 8.5% moisture basis, and flaxseed, solin, soybean and all mustard seeds are calculated on a dry matter basis.

Protein content

Protein content is determined by the AOCS Official Method Ba 4e-93, revised 1995 and re-approved 1997, Combustion method for determination of crude protein, using a LECO FP-428 Nitrogen and Food Protein Determinator. Results are reported as a percentage, N x 6.25, calculated to specified moisture basis. Canola is calculated to an 8.5% moisture basis, and flaxseed, solin, soybean and all mustard seeds are calculated on a dry matter basis.