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Quality of Canadian oilseed-type soybeans

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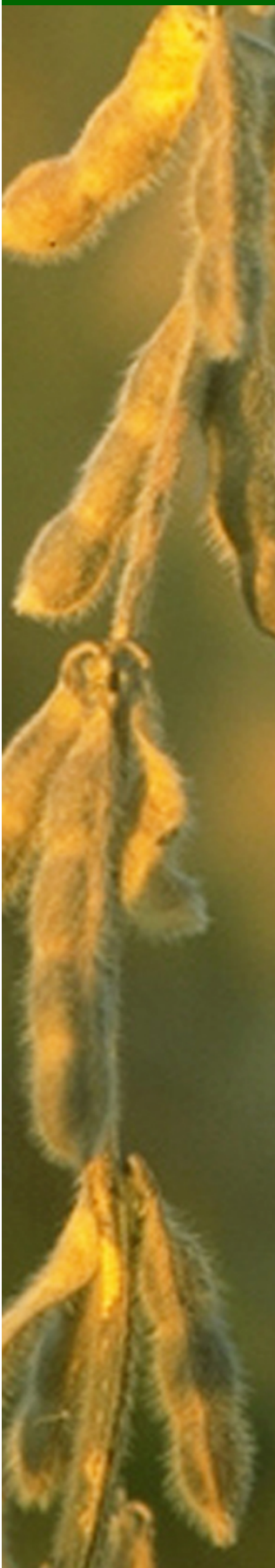


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Summary

In 2019 the average oil content for Soybean, No. 1 and No. 2 grades combined, was 21.1% on a dry matter basis (Table 1 and 3). This was lower than last year's average of 22.2% (Table 1) and the 5-year average (2014-18) of 21.4%. The average protein content for Soybean, No. 1 and No. 2 grades was 38.4%, which was also lower than last year's average of 38.9% and lower than the 5-year average of 39.4%. The oil and protein content averages for No. 1 and No. 2 grades combined varied between the eastern and western provinces; Manitoba and Saskatchewan had an oil content of 20.9% and a protein content of 36.8%, whereas Ontario and Quebec had an oil content of 21.2% and a protein content of 39.5%. New Brunswick and Prince Edward Island had an oil content and protein content of 21.1 and 38.4%, respectively.

Acknowledgments

The Grain Research Laboratory acknowledges the cooperation of the soybean producers, grain handling offices, and oilseed crushing plants in eastern and western Canada for supplying the samples of newly harvested soybean. We also, acknowledge the work of the Industry Services Division of the Canadian Grain Commission in grading producer samples. The technical assistance of the Oilseeds staff in the Grain Research Laboratory is recognized.

Introduction

Canadian soybean growing area has expanded in recent years to include crop areas from the Maritimes to the Prairie Provinces (Figure 1).

This harvest survey report is based on 386 samples of oilseed-type soybean (previously described as non-food grade), less than what was received in 2018 (402). Samples were from Manitoba (124), Saskatchewan (27), Alberta (1), Ontario (184), Québec (35), Prince Edwards Island (8) and New Brunswick (7). Of the submitted samples, 24.1% graded Soybean, No. 1 Canada (16.4% in 2018); 72.3% Soybean, No. 2 Canada (65.5% in 2018); Soybean, 2.1% No. 3 Canada (7.9% in 2018); 1.0% Soybean, No. 4 Canada (3.2% in 2018), 0.0% as Soybean, No.5 Canada (4.0% in 2018) and 0.5% as Soybean, Sample Canada (3.0% in 2018). The decrease percentage of samples of the lower grades compared to last year was a reflection of the decent growing conditions for the 2019 soybeans when compared to 2018.

Quality data (oil, protein, free fatty acid, chlorophyll and fatty acid composition) are based on the means of Soybean, No. 1 and No. 2 Canada grades combined for all oilseed-type samples received from the Maritimes (New Brunswick and Prince Edward Island), central Canada (Ontario and Québec), and western Canada (Manitoba, Saskatchewan and Alberta). Table 1 compares this year's data to last year and to the 5-year average. In Table 1, oil and protein content is provided on a dry matter basis and on a 13% moisture basis. Quality results for all combined grades for each province are in Tables 3 and 4.

Table 1: Soybeans, No. 1 and No. 2 Canada: Quality data for 2019 and 2018 harvest plus the 5-year means

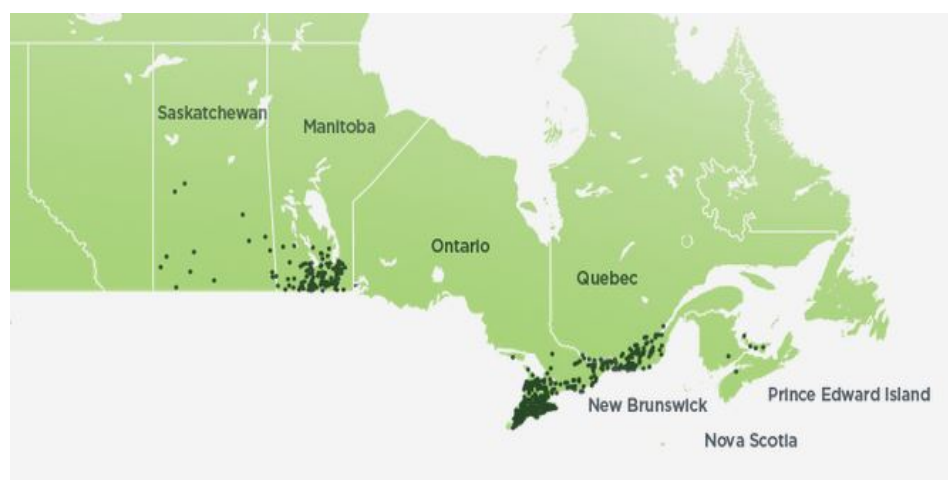
| Quality parameter | 2019 | 2018 | 2014-18 Mean |
|---|-------|-------|--------------|
| Number of Soybean, No. 1 and No. 2 Canada samples | 372 | 328 | |
| Oil content (% , dry basis) | 21.1 | 22.2 | 21.4 |
| Oil content (% , 13% moisture) | 18.4 | 19.3 | 18.7 |
| Protein content ¹ (% , dry basis) | 38.4 | 38.9 | 39.4 |
| Protein content (% , 13% moisture) | 33.4 | 33.8 | 34.2 |
| Oil-free protein of the meal (% , 13% moisture) | 42.3 | 43.5 | 43.6 |
| Chlorophyll content (mg/kg in seed) | 0.2 | 0.4 | 0.4 |
| Free fatty acids ² (%) | 0.18 | 0.15 | 0.13 |
| Oleic acid (% in oil) | 18.8 | 21.8 | 21.8 |
| Linoleic acid (% in oil) | 55.5 | 53.6 | 53.7 |
| Linolenic acid (% in oil) | 9.9 | 8.3 | 8.8 |
| Total saturated fatty acids ³ (% in oil) | 15.0 | 15.6 | 15.2 |
| Iodine value (units) | 138.5 | 133.5 | 135.0 |

¹ Protein content calculated from nitrogen content using N x 6.25

² Calculated as % of oleic acid

³ Sum of all saturated fatty acid from C12:0 to C24:0

Figure 1: Soybean production area in Canada



Source: Soy Canada <https://soycanada.ca/industry/growing-areas/>

Weather and production review

Weather review

Soybeans are typically seeded in early May in eastern Canada and from the last of week of May to the first week of June in western Canada. This year Ontario and Quebec experienced persistent rainfall in spring, which resulted in seeding being pushed back into June and even into July. This, however, was followed by a warm summer with adequate rains in August, a warm September and a delayed frost in the fall. This was key in developing a good crop considering the late seeding date.

In Manitoba, relatively good weather in spring allowed nearly all the crop to be seeded by the end of May. Topsoil moisture levels were a concern going into June and crop emergence was inconsistent. Towards the end of June, however, moisture conditions improved considerably along with the crop conditions. The soybean crop continued to develop well into July and August with most reports claiming the crop was in fair condition. While some regions received adequate moisture in August not every region received enough to reach their yield potential. Harvest started by the last week in September, but progress was slow and delayed by rain, snow and cool weather. By the middle of November 85% of the crop was harvested.

Source:

Canada weather maps: <http://www5.agr.gc.ca/DW-GS/historical-historiques.aspx?lang=eng&jsEnabled=true>

Ontario crop report: <http://www.omafra.gov.on.ca/english/crops/field/reports/2019summary-soybean.htm>

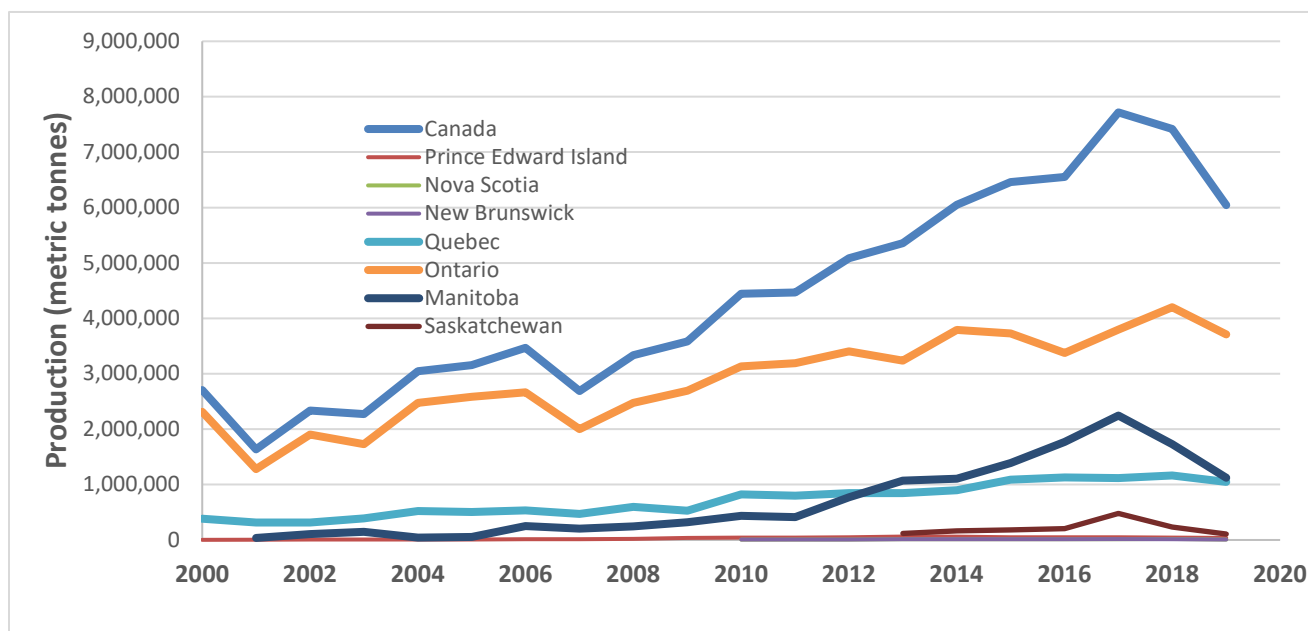
Manitoba crop report: <https://www.gov.mb.ca/agriculture/crops/seasonal-reports/crop-report-archive/>

Saskatchewan crop report: <https://www.saskatchewan.ca/crop-report>

Saskatchewan specialty crop report: <https://publications.saskatchewan.ca/#/products/103821>

Production and grade information

Figure 2: Historic soybean production data in Canada, 2000 to 2019



Seeded area and production data for 2019 and 2018 are in Table 2. In 2019, seeded soybean areas decreased in Canada when compared to 2018 with the decrease occurring primarily in western Canada where the planted area dropped 30%. The seeded areas in central Canada grew moderately by approximately 2% but overall the seeded areas decreased in Canada by close to 10%.

Up until two years ago, Canada's soybean production had been increasing steadily since 2007 (Figure 2) as production had been increasing in Ontario and expanding to Manitoba first and then Saskatchewan and Alberta. Production in the west has decreased in the last two years due mainly due to poor weather conditions for soybean production.

Production in Canada dropped in 2019 by around 18% compared to 2018, as there was a substantial yield decrease in nearly every region in the country. In 2019, about 61.3% of the Canadian soybean were produced in Ontario (57.8% in 2018), 18.6% on Manitoba and 17.3% in Québec. In Manitoba less than favourable growing and harvest conditions pushed the 2019 soybean yields to a low of 1964 kg/h while yields in Ontario averaged 2,966 kg/ha.

Table 2: Seeded area and production for Canadian soybeans¹

| Province | Seeded area | | Production | | 5-Year average production |
|-----------------------------------|------------------|------------------|------------------|------------------|---------------------------|
| | 2019 | 2018 | 2019 | 2018 | 2014-18 |
| | Hectares | | Tonnes | | Tonnes |
| Manitoba | 594,700 | 764,900 | 1,122,300 | 1,731,600 | 1,648,860 |
| Saskatchewan | 60,700 | 164,900 | 107,200 | 231,800 | 251,240 |
| Alberta | 2,800 | 7,400 | 4,900 | 11,600 | n/a |
| Western Canada | 658,200 | 937,200 | 1,234,400 | 1,975,000 | 1,900,100 |
| Québec | 366,700 | 370,300 | 1,045,900 | 1,164,000 | 1,078,900 |
| Ontario | 1,260,400 | 1,222,200 | 3,708,200 | 4,200,500 | 3,789,180 |
| Central Canada² | 1,627,100 | 1,592,500 | 4,754,100 | 5,364,500 | 4,868,080 |
| Prince Edward Island | 18,800 | 16,600 | 36,400 | 43,200 | 47,380 |
| New Brunswick | 4,500 | 5,700 | 9,500 | 14,900 | 13,300 |
| Nova Scotia | 3,900 | 5,600 | 10,700 | 18,500 | 14,880 |
| Maritimes | 27,200 | 27,900 | 56,600 | 76,600 | 75,560 |
| Total Canada | 2,312,500 | 2,557,600 | 6,045,100 | 7,416,100 | 6,843,740 |

¹ Statistics Canada. Table 001-0010 - Estimated areas, yield, production and average farm price of principal field crops, in metric units (<https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3210035901>)

² In this table Central Canada represents Ontario and Québec

Harvest survey samples

For the 2019 soybean survey of the 386 samples received (402 in 2018), 234 were from eastern Canada (196 in 2018 including central Canada and the Maritimes) and 152 (206 in 2018) from western Canada (Table 3). Canadian Grain Commission inspectors graded these samples according to the Official Grain Grading Guide (<https://www.grainscanada.gc.ca/en/grain-quality/official-grain-grading-guide/>). In the 2019 survey, 96.4% (82.0% in 2018) of the submitted samples were in the top two grades while 3.6% of the samples graded Soybean, No. 3 Canada and lower. The grade distribution was not quite the same between eastern and western Canada, 98.7% of the samples from the east (Ontario, Québec & Maritimes) were graded Soybean, No. 1 and No. 2 Canada versus 92.8% from the west (Manitoba, Saskatchewan & Alberta).

Individual samples were analyzed for oil and protein content using either a FOSS NIRSystems 6500 or a DS2500 near-infrared (NIR) spectrometer, calibrated and verified against the appropriate laboratory reference method. Grade composite samples were analyzed by reference methods for oil, protein, fatty acid composition and free fatty acids. The reference procedures are listed under Oilseeds Methods <https://www.grainscanada.gc.ca/en/grain-research/export-quality/oilseeds/methods-tests.html>.

The data presented in this report for areas where there is a low number of samples received might not reflect the true quality of the crop. The average data presented in this report were weighted using a combination of provincial production data (2019 as reported by Statistics Canada, <https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3210035901>) and sample numbers from the area.

There are two major types of soybeans grown in Canada: those commonly referred to as oilseed-type beans (“crush” or non-food grade) and food grade beans (used for tofu and other soy products). This report deals with the oilseed-type soybean samples used for the feed or crushing industry.

Oilseed-type soybeans are grown to produce oil and high-protein meal. Soybean oil is used in salad oil, shortening and margarine products. Defatted soybean meal is protein supplement in livestock rations. Key quality factors for oilseed soybeans are oil content, protein content, and fatty acid composition. Oil and protein content give quantitative estimates of the beans as a source of oil, and of the defatted meal as a source of protein for animal feed. Fatty acid composition provides information about the nutritional, physical and chemical characteristics of the oil extracted from the beans.

Oil and protein content

The average protein content was 38.4% on dry basis (equivalent at 33.4% at 13% moisture) in 2019, lower than last year's results (38.9% on dry basis or 33.8% at 13% moisture) and lower than the 5-year (2014-18) average of 39.4% (equivalent at 34.3% at 13% moisture). Samples from central Canada showed a higher protein content than from the Maritimes and western Canada; 39.5% for central Canada, 36.7% for the Maritimes and 36.8% for western Canada. For all grades combined, the protein content of individual producer samples ranged from 31.5% (or 27.4 at 13% moisture) to 44.4% (38.6 at 13% moisture). Figure 3 shows the protein content trend since 2006 between eastern (Québec, Ontario and Maritimes) and western Canada (Manitoba, Saskatchewan and Alberta). Western averages have been consistently lower than eastern averages since 2006. Western yearly averages also show higher yearly variability when compared eastern averages.

The average oil content was 21.1% on dry basis (18.4% at 13% moisture) for soybean graded No. 1 and No. 2 Canada, lower than what was observed in 2018 at 22.2% (or 19.3% at 13% moisture), and lower than the 5-year average of 21.4% (or 18.7% at 13% moisture) (Tables 1 and 3). All grades combined the oil content of individual

samples ranged from 18.0% (15.7% at 13% moisture) to 25.6% (22.3% at 13% moisture) on dry basis. Figure 5 shows the oil content trend since 2006 for eastern, western and all of Canada.

Figure 4 presents the protein content of fully defatted soybean meal. The protein content of the fully defatted soybean meal from western Canada is lower than the protein content of the samples from the east. This difference reflects the protein content difference between the two sets of samples.

Canadian averages have been following eastern averages as up to now Ontario produced over 50% of the Canadian soybean. There is a marked difference between the eastern and western averages for seed protein and oil contents (Figures 3 & 5). Typically, there is an inverse relationship between oil and protein content for Canadian soybeans (as all oilseeds), the higher the oil content the lower the protein, however this year both protein and oil contents decreased when compared to 2018 averages.

Environmental growing conditions are usually responsible for year-to-year variations whereas genetics (varietal differences) is usually responsible for trends over several years. The combination of genetics and environmental growing conditions are responsible for the east-west differences. Currently breeding is primarily looking at yield and other agronomic factors, so quality factors such as oil or protein contents are not taken into account when registering new soybean varieties in Canada.

Fatty acid composition

Table 4 shows fatty acid composition for the combined No. 1 and 2 grade composites from the various provinces. Linolenic acid (C18:2), the main fatty acid found in soybean oil, averaged 55.5% whereas last years average was 53.6%. Oleic acid, the second most important soybean fatty acid, averaged 18.8% in 2019, much lower than the 2018 value of 21.8%. The other important unsaturated fatty acid, α -linolenic acid (C18:3), averaged 9.9% (8.3% in 2018). Total saturates averaged 15.0% in Canada varying from 14.8% (Saskatchewan) to 15.2% (Ontario).

Iodine value estimates the level of fatty acid unsaturation in oil; the higher the number of double bonds in the oil the higher the iodine value and the level of unsaturation. For 2019, both α -linolenic acid and linoleic acid averages were higher than last year; the iodine value average being much higher than last years average, 138.5 units in 2019 versus 133.5 units in 2018, reflects this. Figure 6 presents the iodine value trend since 2006 for eastern Canada and western Canada and the overall Canadian averages. The yearly variations are a reflection of the environmental differences that includes geography (temperature and precipitation being different between eastern and western Canada).

There is no requirement to control the fatty acid composition of the Canadian oilseed-type soybeans; therefore, variety can show large variation in the fatty acid composition. These variations are amplified as weather also plays a part in year-to-year fatty composition changes. In hot and dry weather conditions, seeds tend to produce an oil with more saturation, e.g. less polyunsaturated fatty acids such as linolenic and linoleic acids and more total saturates and oleic acid. The opposite is observed if seeds are grown in cool conditions.

Free fatty acid (FFA) content

Grade composites of Soybean, No. 1 Canada and Soybean, No. 2 Canada showed free fatty acid levels averaging 0.18% in 2019 (Table 1 and 3). This is slightly higher than last year's results (0.15%).

High free fatty acid values are mainly due to seed damage which results from increased exposure to moisture and oxygen from wet harvesting conditions and improper storage. Free fatty acid levels could increase during storage due to storage and environmental conditions.

Figure 3: Seed protein content averages of Canadian oilseed type soybean, 2006 to 2019

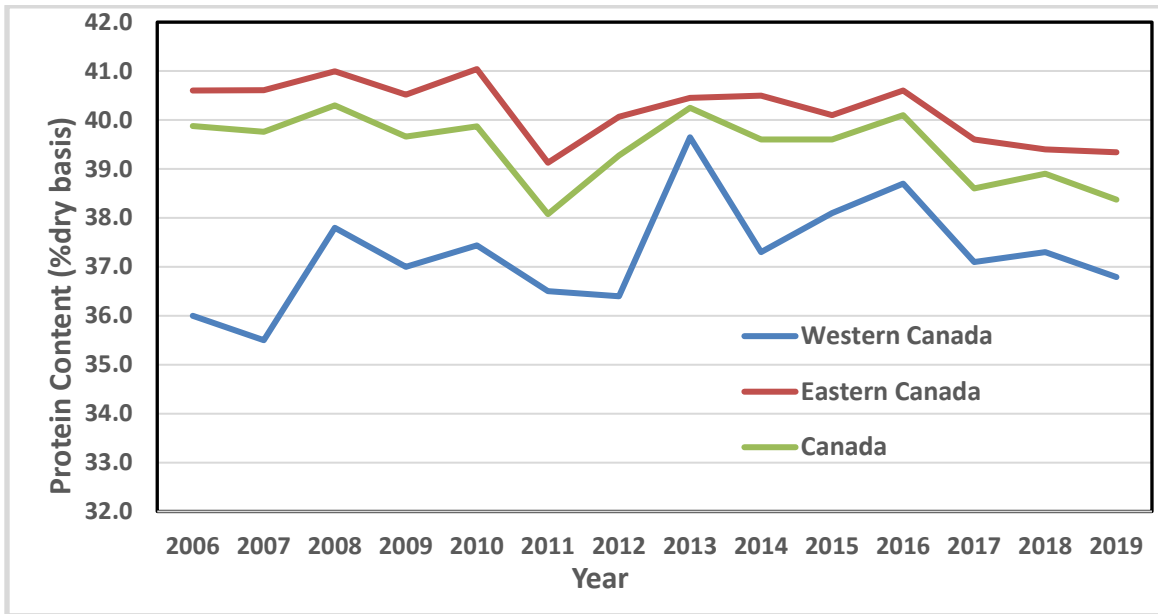


Figure 4: Defatted meal protein content averages of Canadian oilseed type soybean, 2006 to 2019

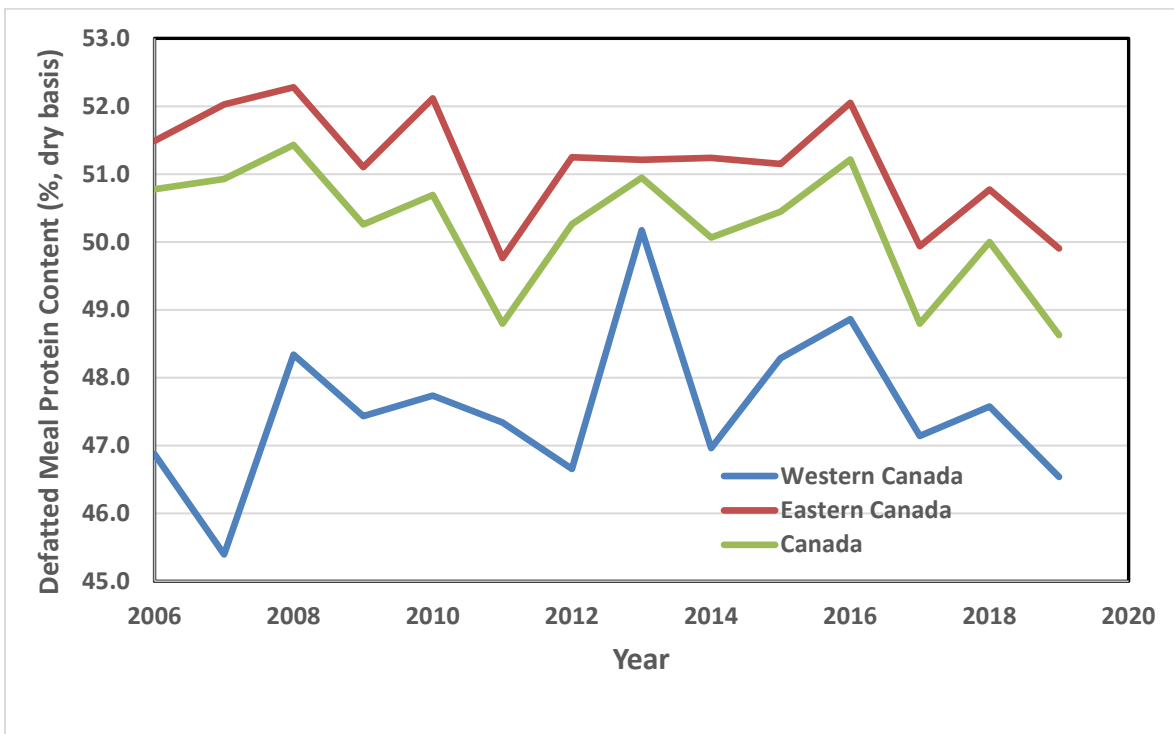


Figure 5: Seed oil content averages of Canadian oilseed type soybean, 2006 to 2019

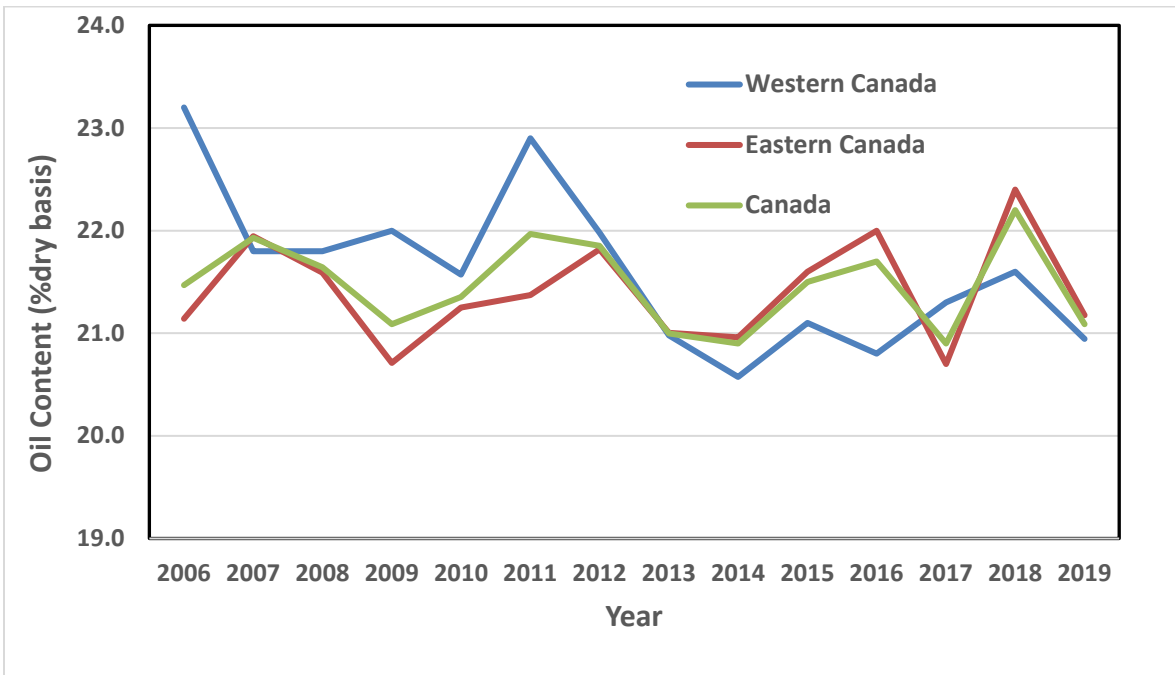


Figure 6: Oil iodine value averages of Canadian oilseed type soybean, 2006 to 2019

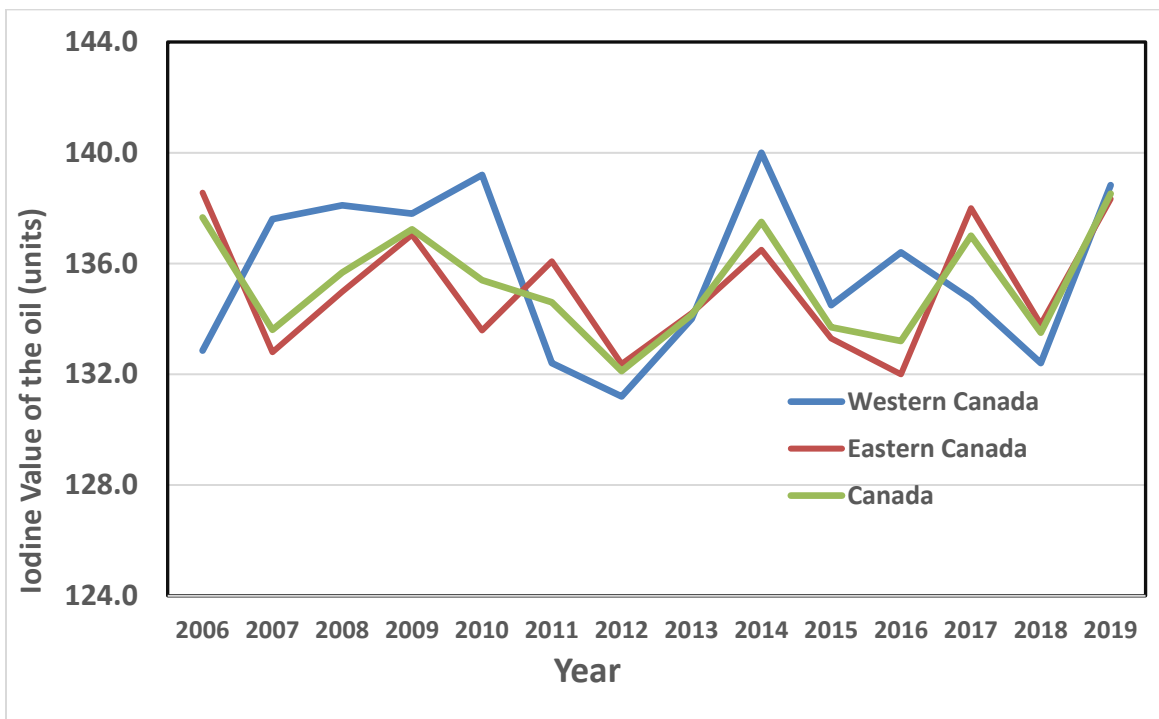


Table 3: Oil, protein, chlorophyll contents and free fatty acid content of the oil of the 2019 soybean survey by province and grade

| Province | N | Oil | | | Protein ¹ | | | Chlorophyll Mg/Kg | Free Fatty Acid ² %, in oil |
|---|------------|-------------|-------------|-------------|----------------------|-------------|-------------|----------------------|--|
| | | Mean | Min | Max | Mean | Min | Max | | |
| Soybean, No. 1 Canada and Soybean No. 2 Canada | | | | | | | | | |
| Manitoba | 119 | 21.0 | 18.8 | 24.8 | 36.9 | 32.2 | 41.2 | 0.1 | 0.16 |
| Saskatchewan | 22 | 20.7 | 19.6 | 23.1 | 36.1 | 31.5 | 39.1 | 0.6 | 0.33 |
| Western Canada | 141 | 20.9 | 18.8 | 24.8 | 36.8 | 31.5 | 41.2 | 0.2 | 0.18 |
| Ontario | 184 | 21.3 | 19.2 | 25.6 | 39.4 | 31.8 | 42.8 | 0.2 | 0.15 |
| Québec | 32 | 20.5 | 18.8 | 23.9 | 40.1 | 36.6 | 44.4 | 0.7 | 0.34 |
| Central Canada | 216 | 21.2 | 18.8 | 25.6 | 39.5 | 31.8 | 44.4 | 0.2 | 0.18 |
| Prince Edward Island | 8 | 21.8 | 21.3 | 23.5 | 36.7 | 32.8 | 39.3 | 0.4 | 0.27 |
| New Brunswick | 7 | 20.4 | 19.8 | 22.4 | 36.8 | 33.0 | 39.8 | 0.1 | 0.09 |
| Maritimes | 15 | 21.2 | 19.8 | 23.5 | 36.7 | 33.0 | 39.8 | 0.3 | 0.18 |
| Canada | 372 | 21.1 | 18.8 | 25.6 | 38.4 | 31.5 | 44.4 | 0.2 | 0.18 |
| Soybean, No. 3 | | | | | | | | | |
| Western Canada | 6 | 19.8 | 18.0 | 22.3 | 37.1 | 32.6 | 39.8 | 1.1 | 0.34 |
| Eastern Canada³ | 2 | 20.5 | 21.5 | 22.3 | 41.3 | 41.2 | 41.4 | 0.5 | 0.33 |
| Canada | 8 | 20.0 | 18.0 | 22.3 | 38.2 | 32.6 | 41.4 | 0.8 | 0.34 |
| Soybean, No. 4 | | | | | | | | | |
| Western Canada | 3 | 20.1 | 19.5 | 21.9 | 37.0 | 34.3 | 39.1 | 2.2 | 0.35 |
| Eastern Canada | 1 | 21.2 | | | 39.3 | | | 0.0 | 0.57 |
| Canada | 4 | 20.4 | 19.5 | 21.9 | 37.6 | 34.3 | 39.3 | 1.7 | 0.41 |
| Soybean, Sample | | | | | | | | | |
| Western Canada | 2 | 17.7 | 17.5 | 17.9 | 39.9 | 39.5 | 40.2 | 1.7 | 1.00 |
| Eastern Canada | NA | | | | | | | | |
| Canada | 2 | 17.7 | 17.5 | 17.9 | 39.9 | 39.5 | 40.2 | 1.7 | 1.00 |

¹ Calculated from nitrogen content with N x 6.25

² Calculated as % of oleic acid

³ Eastern Canada represent Central Canada and the Maritimes

NA non-applicable, no samples

Table 4: Main fatty acid contents and iodine value of the oil of the 2019 soybean survey by province and grade

| Province | N | C16:0 | C18:0 | C18:1 | C18:2 | C18:3 | SATS ¹ | Iodine Value ² Units |
|---|------------|-------------|------------|-------------|-------------|-------------|-------------------|------------------------------------|
| %, in oil | | | | | | | | |
| Soybean, No. 1 Canada and Soybean No. 2 Canada | | | | | | | | |
| Manitoba | 119 | 9.9 | 4.0 | 19.4 | 55.3 | 9.8 | 14.9 | 138.6 |
| Saskatchewan | 22 | 9.8 | 3.9 | 17.9 | 56.0 | 10.7 | 14.6 | 140.7 |
| Western Canada | 141 | 9.9 | 4.0 | 18.9 | 55.4 | 10.0 | 14.8 | 138.8 |
| Ontario | 184 | 10.6 | 3.8 | 19.0 | 55.2 | 9.7 | 15.2 | 137.8 |
| Québec | 32 | 10.3 | 3.5 | 17.8 | 56.9 | 10.0 | 14.6 | 140.3 |
| Central Canada | 216 | 10.6 | 3.8 | 18.8 | 55.5 | 9.8 | 15.1 | 138.2 |
| Prince Edward Island | 8 | 10.8 | 3.4 | 17.1 | 56.9 | 10.1 | 15.0 | 140.1 |
| New Brunswick | 7 | 10.7 | 3.5 | 16.3 | 57.1 | 10.9 | 15.0 | 141.7 |
| Maritimes | 15 | 10.7 | 3.4 | 16.7 | 57.0 | 10.5 | 15.0 | 140.8 |
| Canada | 372 | 10.3 | 3.8 | 18.8 | 55.5 | 9.9 | 15.0 | 138.5 |
| Soybean, No. 3 | | | | | | | | |
| Western Canada | 6 | 9.5 | 3.9 | 17.3 | 56.4 | 11.2 | 14.3 | 142.0 |
| Eastern Canada³ | 2 | 9.6 | 4.1 | 23.3 | 53.2 | 7.8 | 14.6 | 132.8 |
| Canada | 8 | 9.5 | 4.0 | 18.8 | 55.6 | 10.3 | 14.4 | 139.7 |
| Soybean, No. 4 | | | | | | | | |
| Western Canada | 3 | 9.8 | 4.3 | 18.8 | 55.0 | 10.4 | 15.0 | 138.8 |
| Eastern Canada | 1 | 10.6 | 3.6 | 18.6 | 54.9 | 10.6 | 15.0 | 139.2 |
| Canada | 2 | 10.0 | 4.1 | 18.7 | 55.0 | 10.4 | 15.0 | 138.9 |
| Soybean, Sample | | | | | | | | |
| Western Canada | 2 | 9.1 | 3.6 | 16.8 | 55.9 | 12.7 | 13.4 | 144.7 |
| Eastern Canada | NA | | | | | | | |
| Canada | 2 | 9.1 | 3.6 | 16.8 | 55.9 | 12.7 | 13.4 | 144.7 |

¹ Sum of all saturated fatty acid from C12:00 to C24:0

² Calculated from the fatty acid composition

³ Eastern Canada represent Central Canada and the Maritimes

NA non-applicable, no samples