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Quality of western Canadian mustard 2021

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Introduction

This report presents data and information on the quality of oriental (*Brassica juncea*), brown (*Brassica juncea*), and yellow (*Sinapis alba*) mustard seed grown in western Canada in 2021 (Figure 1). Samples of mustard submitted to the Harvest Sample Program were analysed by the Oilseeds Program for quality traits, including oil, protein, total glucosinolate content, and fatty acid composition.

Figure 1 Mustard seed grown in western Canada

Oriental mustard (*Brassica juncea*)

Brown mustard (*Brassica juncea*)

Yellow mustard (*Sinapis alba*)

Summary

The mean oil content for the top grade of each type of mustard grown in 2021 was determined to be 34.9 % (oriental), 32.4% (brown) and 25.0% (yellow), all lower than their 10-year means (Figures 3, 4, and 5). In contrast, the mean protein content of the top grade of each type of mustard was determined to be 31.4% (oriental), 31.7 % (brown) and 36.6% (yellow), all much higher than their 10-year means. Total glucosinolate content of the top grade of oriental mustard was 143 micromoles per gram (µmol/g), 132 µmol/g for brown mustard and 147 µmol/g for yellow mustard. These values are higher than the 10-year means of 116 µmol/g (oriental) and 105 µmol/g (brown) (Figure 6). It should be noted that there are no historical data for total glucosinolate content of yellow mustard and that oil, protein and glucosinolates are reported on a dry matter basis in this report.

Weather and production review

Weather

Seeding started earlier than normal in 2021 but cooler than normal spring temperatures delayed field operations. By May 3, approximately 10 % of the mustard crop was seeded in Saskatchewan. Seeding progressed well into May and by the end of the month it was nearly completed in Saskatchewan and Alberta. Timely rains during the second half of May allowed for the emergence of crops that were seeded early but cool night temperatures slowed the growth of crops in some areas. Overall, seeding progress was well ahead of the 5-year average in both provinces in 2021.

High temperatures and drought stress began to affect all mustard crops in June and continued to do so for the entire growing season. Heat accelerated the ripening and maturation of all crops across Saskatchewan while drought conditions caused crops to deteriorate. By mid August, 28% of the mustard crop was combined and harvest was occurring at a pace similar to 2020 but ahead of the 5-year average. At the time, the Saskatchewan Crop Report indicated that producers had variable yields from early harvested crops, depending on precipitation. Crop yields ranged from poor (worse than expected) to average depending on when rain was received. Harvest was essentially completed by the end of September (Saskatchewan Crop Reports and Walter Dyck's Olds Products 2021 Crop Reports).

Information on the temperature and precipitation patterns from the 2021 growing season in western Canada can be obtained from Agriculture and Agri-Food Canada.

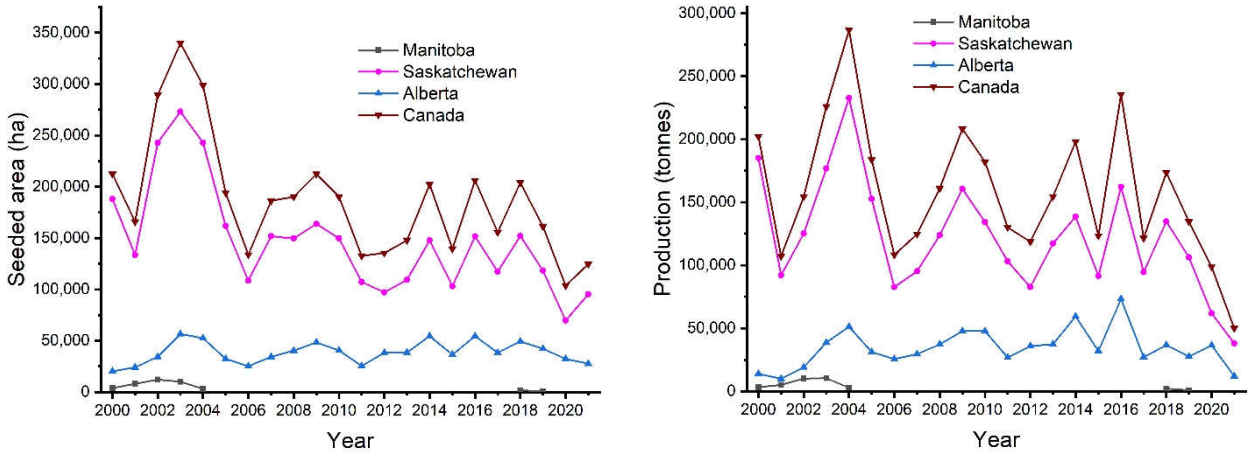
Production and grade information

In 2021, mustard seed production (49,955 tonnes) was dramatically lower than in 2020 (98,800 tonnes) and even lower than the 5-year average (152,840 tonnes) (Figure 2). The decrease was due mostly to growing conditions since there was a slight increase in seeded area in 2021 (124,700 ha) compared to 2020 (103,700 ha) (Figure 2). The 2021 yield in Saskatchewan was 436 kg/ha (905 kg/ha in 2020) and 458 kg/ha (1,131 kg/ha in 2020) in Alberta. The average yield in Canada was 441 kg/ha (976 kg/ha in 2020). These are the lowest yields in more than 25 years. Saskatchewan accounted for 76.3% of western Canada's total seeded area and 76% of mustard production while most of the remaining seeded area and production was in Alberta (Figure 2).

In 2021, 48.1% of domestic mustard seed samples received by the Harvest Sample Program were graded No. 1, Canada. This is well below the number in 2020 (70.5%) and the 10-year average of 64.6% (2011 to 2020).

Various types of damage were observed in mustard samples since crops were stressed due to excess heat and lack of moisture. Sprouting was also observed in many samples due to rain in late August. Conspicuous admixtures containing weed seeds and foreign material were also a factor in lowering the grades of samples received in 2021.

Figure 2 Seeded area and production of mustard in western Canada from 2000 to 2021[1]



[1] data from Statistics Canada Table 32-10-0359-01 Estimated areas, yield, production, average farm price and total farm value of principal field crops, in metric and imperial units

Harvest samples

In 2021 the Harvest Sample Program received 189 mustard samples from producers and grain companies, lower than the 277 received in 2020 and the 5-year average of 284. We analysed 122 yellow, 51 brown and only 16 oriental mustard samples. Most mustard samples (70%) came from Saskatchewan (66% in 2020), 27% came from Alberta (32% in 2020) and 3% came from Manitoba (2% in 2020). Individual samples were cleaned to remove dockage and were graded by Canadian Grain Commission grain inspectors, following Chapter 12 of the Official Grain Grading Guide.

The Canadian Grain Commission used a FOSS NIR Systems 6500 NIR spectrometer, calibrated to and verified against the appropriate listed reference methods, to determine the oil and protein content of all individual whole-seed samples. Total glucosinolate content was determined on individual oriental, brown and yellow mustard samples using NIR spectroscopy and all composite samples were analyzed using the high performance liquid chromatography reference method. All oilseed method and test procedures are detailed on our website.

Composite samples were prepared for each province by combining samples of each type of domestic mustard seed graded No. 1 Canada and by combining lower grade (No. 2, No. 3, No. 4 and Sample) samples of each type for western Canada. Variety composites were also prepared by combining the most common mustard varieties using only No. 1 Canada samples. Composites were analysed for oil, protein, total glucosinolates, and chlorophyll content, as well as fatty acid composition.

Quality of the 2021 mustard crop

The mustard crop grown in western Canada in 2021 had the general characteristics of a well matured crop but showed some stress due to warm and dry growing conditions, and rain during harvest. Historical data from the Harvest Sample Program indicate that warm and dry growing conditions tend to produce an oilseed crop with higher protein and lower oil content. Scientific literature also suggests that total glucosinolate levels increase in rapeseed when crops are exposed to dry conditions after flowering. We noticed an important increase in the total glucosinolate content of the three 2021 mustard crops when compared to 2020. Total glucosinolate values were approximately 20 micromole per gram (µmol/g) higher in all 2021 mustard seeds compared to 2020.

Oil, protein and total glucosinolate content

Table 1 contains a summary of the oil, protein and total glucosinolate content of oriental, brown and yellow mustard samples according to grade in 2021. Comparisons with oriental, brown, and yellow mustard quality from previous years can be found in Figures 3, 4 and 5.

Samples of mustard graded Domestic Mustard Seed, No. 1 Canada, Oriental had a mean oil content that was lower in 2021 (34.9%) compared to 2020 (40.0%) and the 10-year mean (41.9%). Mean protein content was noticeably higher in 2021 (31.4%) when compared to 2020 (27.6%) and the 10-year mean (26.3%) (Figure 3). Oil content ranged from 30.4% to 41.8% and protein content ranged from 26.9% to 34.7% (Table 1).

Samples of mustard graded Domestic Mustard Seed, No. 1 Canada, Brown also had a mean oil content that was lower in 2021 (34.2%) than the 2020 mean (35.5%) and the 10-year-mean (37.0%). Mean protein content was higher in 2021 (31.7%) compared to 2020 (29.3%) and the 10-year mean (28.1%) (Figure 4). Oil content ranged from 28.9% to 36.3% and protein content ranged from 28.6% to 33.5% (Table 1).

Yellow mustard is characteristically lower in oil and higher in protein than oriental and brown mustard (Table1). The mean oil content of mustard graded Domestic Mustard Seed, No. 1 Canada, Yellow was lower in 2021 (25.0%) than in 2020 (27.6%) and lower than the 10-year mean (29.3%). However, mean protein content in 2021 (36.6%) was significantly higher than that in 2020 (33.1%) and the 10-year mean (32.1%) (Figure 5). Oil content ranged from 20.8% to 30.6% and protein content ranged from 30.0% to 42.1% (Table 1).

In 2021, the mean total glucosinolate content of the top grade of oriental mustard (135 µmol/g) and brown mustard (132 µmol/g) was higher than the 2020 means of 126 µmol/g (oriental) and 109 µmol/g (brown) (Figure 6). Total glucosinolate content of oriental and brown mustard ranged from 120 µmol/g to 168 µmol/g and 120 µmol/g to 145 µmol/g, respectively (Table 1). In 2021, the mean total glucosinolate content of the top grade of yellow mustard was 147 µmol/g compared to 141 µmol/g in 2020; there is no historical data for yellow mustard.

In 2021, the mean protein content of all mustards, especially yellow, was higher than the historical means. Warm and dry conditions during the seed development stage contributed to this increase in protein content. We also noticed a statistical difference in the amount of protein for yellow mustard when results obtained from our standard Dumas combustion method were compared with results from the Kjeldahl method using the same samples. For both methods, crude protein content is obtained by measuring the total nitrogen content within seeds. The two protein methods measure nitrogen content in a slightly different way, however, which may account for some differences in calculated protein content. The total nitrogen content of mustards seeds in 2021 was affected by growing conditions, leading to the different protein results obtained by the two methods.

The chlorophyll content of oriental, brown and yellow mustard samples from 2021 is provided in Table 2. For oriental and brown domestic mustard seed graded No.1 Canada, chlorophyll was 0.4 milligrams per kilograms (mg/kg) and 1.7 mg/kg, respectively (Figure 7). Chlorophyll in yellow domestic mustard seed graded No. 1 Canada was 0.6 mg/kg (Figure 7 and Table 2). Lower grades of yellow mustard had slightly elevated levels of chlorophyll, with Sample grade having the highest (2.4 mg/kg). Brown domestic mustard seed graded No. 2 Canada had the highest mean chlorophyll content (2.8 mg/kg). The hot and dry conditions caused crops to mature faster than normal and this resulted in relatively low chlorophyll content, an indication of well matured seeds.

Fatty acid composition

The fatty acid composition of brown, oriental and yellow mustard seed samples received in 2021 is presented in Table 2.

Yellow mustard contained more oleic acid (C18:1) and erucic acid (C22:1) than brown and oriental mustard. Concurrently, the amount of linoleic acid (C18:2) and α-linolenic acid (C18:3) was higher in brown and oriental mustard than in yellow mustard. Mean erucic acid content of yellow domestic mustard seed graded No.1 Canada was 34.7% (34.0% in 2020) while the mean erucic acid content of brown and oriental mustard seed was 23.9% and 20.3%, respectively. This resulted in higher iodine values for brown (118 units) and oriental (117 units) mustard than yellow mustard (103 units). Mean total saturated fatty acids levels in domestic mustard seed ranged from 5.2% (yellow) to 6.5% (oriental).

There were some varietal differences in the distribution of fatty acids in 2021 mustard samples. There was a 4.4% difference between the oleic acid content of Cutlass and Forge mustard (oriental) and a 5.5% difference in the erucic acid content. AC Pennant and Andante mustard (yellow) had a 2.0% difference in oleic acid and a 2.8% difference in erucic acid content.

Free fatty acid (FFA) levels are an indicator of seed stress and oil degradation. In 2021, the mean FFA content of domestic mustard seed graded No.1 Canada was low (ranging from 0.03% to 0.07%) and was similar to 2020 values.

Table 1 Oil, protein and total glucosinolate content of 2021 western Canadian mustard

Grade	Province	Number of samples	Oil content[1] %			Protein content[2] %			Glucosinolates µmol/g[3]		
			Mean	Min[4]	Max[5]	Mean	Min[5]	Max[6]	Mean	Min[4]	Max[5]
Domestic Mustard Seed, Canada, Oriental											
No. 1	**Canada**	**11**	**34.9**	**30.4**	**41.8**	**31.4**	**26.9**	**34.7**	**135**	**120**	**168**
	Saskatchewan	6	36.3	33.8	41.8	30.3	26.9	32.3	130	120	163
	Alberta	5	33.1	30.4	35.0	32.6	31.6	34.7	141	141	168
No. 2	Canada	1	41.2	NS[6]	NS	28.5	NS	NS	115	NS	NS
No. 3	Canada	0	NS	NS	NS	NS	NS	NS	NS	NS	NS
No. 4	Canada	3	34.2	33.0	37.2	31.6	28.1	33.2	133	144	153
Sample	Canada	1	34.8	NS	NS	30.4	NS	NS	135	NS	NS
Cutlass, No. 1	Canada	3	38.5	34.8	41.8	28.7	26.9	31.3	120	120	132
Forge, No.1	Canada	8	34.2	30.4	37.3	31.6	28.6	34.7	141	133	168
Domestic Mustard Seed, Canada, Brown											
No. 1	**Canada**	**7**	**34.2**	**28.9**	**36.3**	**31.7**	**28.6**	**33.5**	**132**	**120**	**145**
	Saskatchewan	7	34.2	28.9	36.3	31.7	28.6	33.5	132	120	145
No. 2	Canada	22	31.6	27.7	37.4	32.5	27.5	35.8	127	94	151
No. 3	Canada	11	30.9	28.6	34.3	32.9	29.6	35.3	131	109	153
No. 4	Canada	10	31.6	28.1	34.6	32.5	29.8	36.2	138	118	152
Sample	Canada	1	34.2	NS	NS	28.9	NS	NS	127	NS	NS
Centennial Br., No.1	Canada	6	32.9	28.9	36.3	31.3	28.6	33.5	127	120	145
Domestic Mustard Seed, Canada, Yellow											
No. 1	**Canada**	**73**	**25.0**	**20.8**	**30.6**	**36.6**	**30.0**	**42.1**	**147**	**-**	**-**
	Saskatchewan	39	25.0	20.8	30.6	36.5	30.0	40.7	148	-	-
	Alberta	34	24.9	21.7	30.2	36.9	30.3	42.1	147	-	-
No. 2	Canada	20	25.4	22.4	31.0	36.7	30.9	39.9	145	-	-
No. 3	Canada	8	25.8	22.5	29.9	35.8	30.0	39.2	144	-	-
No. 4	Canada	17	26.1	23.4	30.0	34.7	29.7	37.9	141	-	-
Sample	Canada	4	24.6	23.4	31.0	34.3	25.8	38.3	134	-	-
AC Pennant, No. 1	Canada	5	26.3	25.8	28.0	34.8	32.0	36.1	146	-	-
Andante, No. 1	Canada	48	24.8	20.8	30.1	36.7	30.3	42.1	141	-	-

[1] dry matter basis
[2] protein content calculated from nitrogen content using N x 6.25, dry matter basis
[3] µmol/g = micromole per gram; total glucosinolate content calculated on a dry matter basis with a near infrared instrument calibrated to ISO 9167-3:2007 (Glucose Release)
[4] Min = minimum
[5] Max = maximum
[6] NS = insufficient number of samples to generate a representative sample

Table 2 Fatty acid composition, chlorophyll content and free fatty acid content of 2021 western Canadian mustard

Grade	Province	Number of samples	Fatty acid composition (%)[1]					Iodine value (units)	Chl[2] (mg/kg)	FFA[3] (%)
			C18:1	C18:2	C18:3	C22:1	Total SFA[4]			
Domestic Mustard Seed, Canada, Oriental										
No. 1	**Canada**	**11**	**22.9**	**24.5**	**10.7**	**20.3**	**6.5**	**117.3**	**0.4**	**0.04**
	Saskatchewan	6	22.1	23.6	10.8	21.6	6.4	116.5	0.5	0.03
	Alberta	5	23.7	25.6	10.6	18.9	6.6	118.2	0.2	0.04
No. 2	Canada	1	19.0	21.4	13.3	24.3	5.5	119.2	6.2	0.53
No. 3	Canada	0	NS[5]	NS	NS	NS	NS	NS	NS	NS
No. 4	Canada	3	21.4	23.6	11.5	21.9	6.1	118.1	1.6	0.05
Sample	Canada	1	25.3	25.9	9.4	17.8	7.1	116.1	0.7	0.07
Cutlass, No. 1	Canada	3	20.1	22.1	11.3	24.1	6.3	115.8	0.6	0.03
Forge, No.1	Canada	8	24.5	25.5	10.2	18.6	6.7	117.4	0.2	0.03
Domestic Mustard Seed, Canada, Brown										
No. 1	**Canada**	**7**	**19.1**	**22.1**	**12.5**	**23.9**	**6.1**	**118.3**	**1.7**	**0.03**
	Saskatchewan	7	19.1	22.1	12.5	23.9	6.1	118.3	1.7	0.03
No. 2	Canada	22	19.8	22.4	12.7	23.1	6.2	118.9	2.8	0.08
No. 3	Canada	11	21.3	23.1	12.5	21.4	6.5	119.2	1.4	0.06
No. 4	Canada	10	26.3	25.4	13.0	15.2	7.1	122.1	1.4	0.04
Sample	Canada	1	21.5	21.1	13.3	21.5	5.9	119.2	2.5	0.05
Centennial Br., No.1	Canada	6	19.3	22.0	12.6	23.9	6.0	118.4	1.8	0.05
Domestic Mustard Seed, Canada, Yellow										
No. 1	**Canada**	**73**	**25.0**	**10.5**	**10.3**	**34.7**	**5.2**	**102.7**	**0.6**	**0.07**
	Saskatchewan	39	25.4	10.6	10.1	34.4	5.3	102.5	0.8	0.09
	Alberta	34	24.5	10.5	10.5	35.0	5.2	103.1	0.4	0.05
No. 2	Canada	20	24.8	10.2	10.6	35.0	5.1	103.0	1.4	0.07
No. 3	Canada	8	25.7	10.1	10.5	34.2	5.1	102.8	0.5	0.08
No. 4	Canada	17	24.9	10.4	10.3	34.8	5.2	102.5	1.6	0.10
Sample	Canada	4	25.3	10.6	10.6	33.9	5.2	103.4	2.4	0.15
AC Pennant, No. 1	Canada	5	22.6	10.1	10.1	37.9	5.1	101.6	0.4	0.18
Andante, No. 1	Canada	48	24.6	10.5	10.4	35.1	5.2	102.8	0.4	0.05

[1] total fatty acids include oleic (C18:1), linoleic (C18:2), α-linolenic (C18:3) and erucic (C22:1)

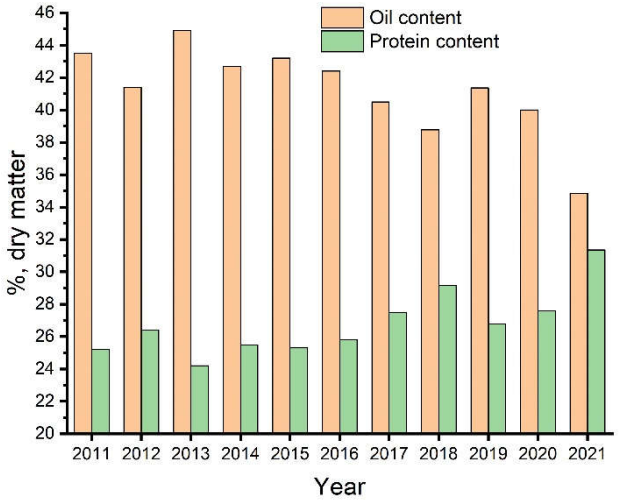
[2] Chl = chlorophyll, mg/kg = milligram per kilogram

[3] FFA = free fatty acids

[4] SFA = saturated fatty acids, total SFA are the sum of palmitic (C16:0), stearic (C18:0), arachidic (C20:0), behenic (C22:0) and lignoceric (C24:0)

[5] NS = insufficient number of samples to generate a representative sample

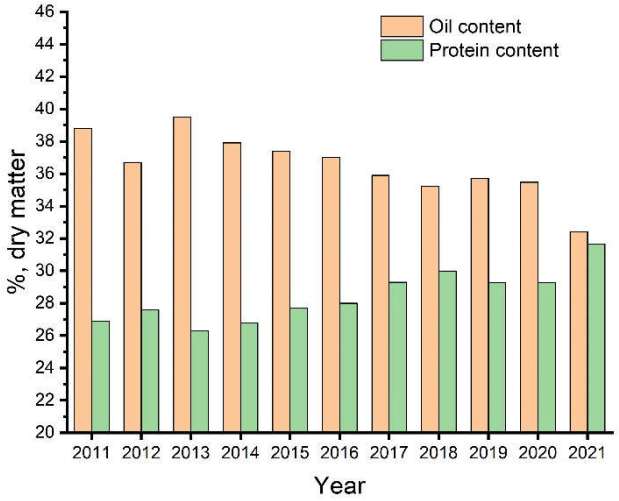
Figure 3 Oil and protein content of oriental domestic mustard seed graded No.1 Canada from 2011 to 2021



2021 oil content.....34.9%
2020 oil content 40.0%
2011-2020 mean oil content.....41.9%

2021 protein content 31.4%
2020 protein content 27.6%
2011-2020 mean protein content.....26.3%

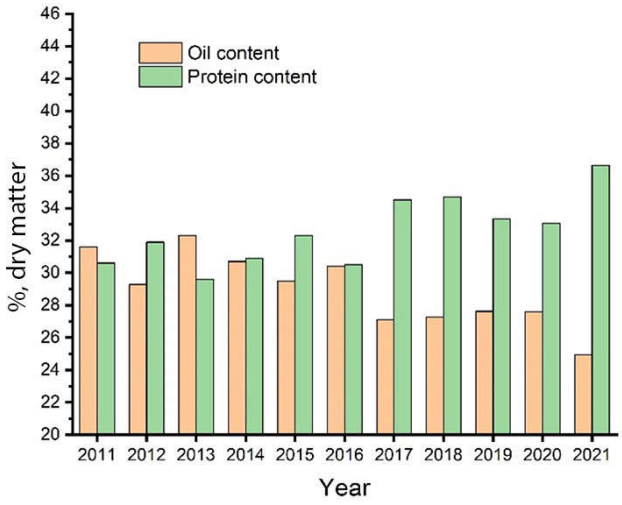
Figure 4 Oil and protein content of brown domestic mustard seed graded No.1 Canada from 2011 to 2021



2021 oil content.....34.2%
2020 oil content 35.5%
2011-2020 mean oil content.....37.0%

2021 protein content 31.7%
2020 protein content 29.3%
2011-2020 mean protein content.....28.1%

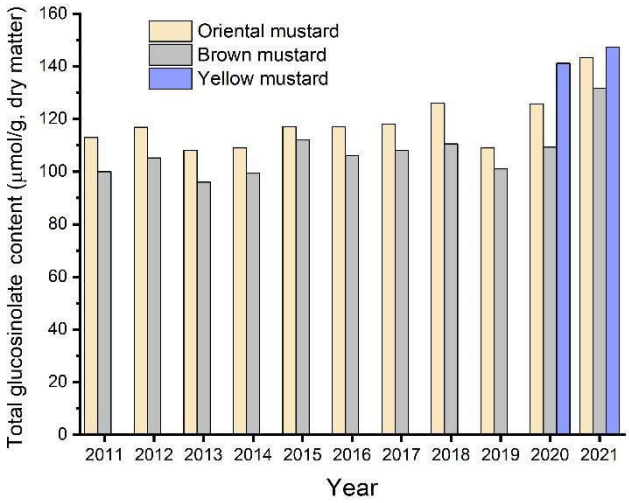
Figure 5 Oil and protein content of yellow domestic mustard seed graded No.1 Canada from 2011 to 2021



2021 oil content.....25.0%
2020 oil content 27.6%
2011-2020 mean oil content.....29.3%

2021 protein content..... 36.6%
2020 protein content 33.1%
2011-2020 mean protein content.....32.1%

Figure 6 Total glucosinolate content of oriental, brown and yellow[1] domestic mustard seed graded No.1 Canada from 2011 to 2021

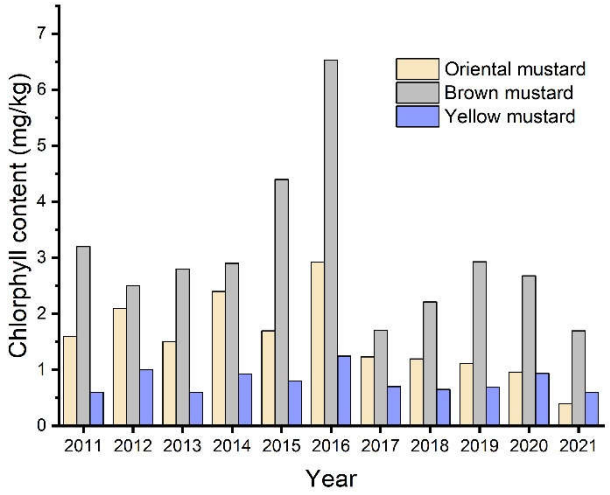


2021 total glucosinolate content: oriental.....135 µmol/g
2020 total glucosinolate content: oriental.....126 µmol/g
2011-2020 total glucosinolate content: oriental.....116 µmol/g
2021 total glucosinolate content: yellow ..... 47 µmol/g

2020 total glucosinolate content: yellow .....141 µmol/g
2021 total glucosinolate content: brown ..... 132 µmol/g
2020 total glucosinolate content: brown..... 109 µmol/g
2011-2020 mean total glucosinolate content: brown..105 µmol/g

[1] data only from 2020 and 2021

Figure 7 Chlorophyll content of oriental, brown and yellow domestic mustard seed graded No.1 Canada from 2011 to 2021



2021 chlorophyll content: oriental.....0.4 mg/kg
2021 chlorophyll content: brown.....1.7 mg/kg
2021 chlorophyll content: yellow..... 0.6 mg/kg

2011-2020 mean chlorophyll content: oriental .....1.7 mg/kg
2011-2020 mean chlorophyll content: brown..... 3.3 mg/kg
2011-2020 mean chlorophyll content: yellow..... 0.8 mg/kg

Acknowledgements

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