Quality of Canadian Soybean

1997

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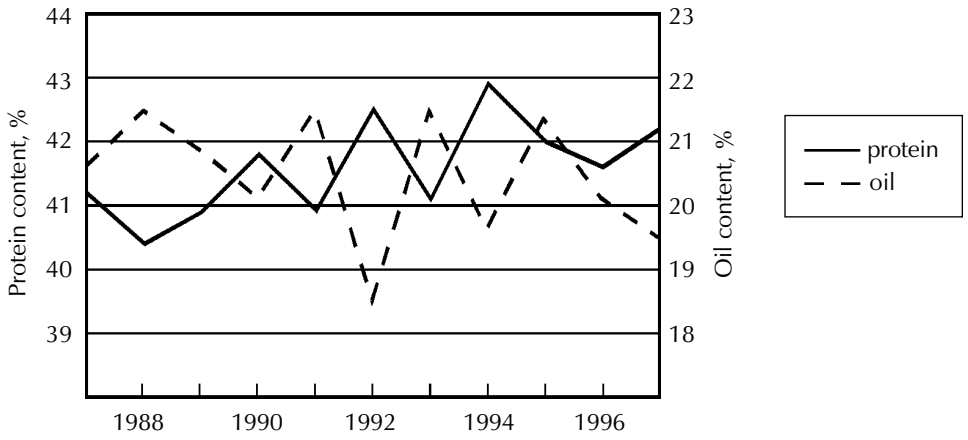
Figure 1 • Map of southern Ontario showing counties from which 1997 soybean survey sample were received

Introduction

Information on the quality of the 1997 crop of Ontario soybean (oil, protein, sugar content, NSI (nitrogen solubility index), and fatty acid composition) was obtained from analysis of newly harvested soybean samples collected by the Ontario Soybean Growers' Marketing Board. The 1997 survey consisted of 124 dark hilum and 103 white hilum samples. Industry Services, Canadian Grain Commission, Chatham, Ontario, indicated that 172 of the samples graded No. 1 Canada and 55 graded No. 2 Canada soybean. A single sample of natto-type soybean was not included in the statistical analyses. Survey samples came from 15 counties with 43% coming from the counties of Kent (36), Essex (32), and Lambton (31) (Figure 1). Trends in oil and protein data since 1987 are provided in graphical form (Figure 2).

Figure 2 • Annual mean oil and protein contents of Canadian soybean 1987 to 1997



Weather and production review

Soybean production in Canada reached a record 2.74 million tonnes in 1997 (Table 1), an increase of 26% from last year. In Ontario, the 936 800 hectares of harvested soybean yielded an average of 2.56 tonnes/ha for a total crop of 2.39 million tonnes. Ontario accounted for about 87% of the total Canadian soybean production.

In the major Ontario soybean growing regions, late plantings were common following a cool and wet spring. A large percentage of the fields were planted by the middle of June although seeding continued up to the first week in July in certain areas. Temperatures were low in the first part of the growing season, but rose gradually in June. July was generally hot and dry. Rainfall that began round the middle of August continued well into September. Maturity was promoted by excellent growing conditions in mid to late September. Harvest began in mid-October, peaked in late October, and continued into early November. Despite the late plantings, most of the crop matured before damaging frosts occurred. Ontario soybean yields were slightly better than last year, and at 2.56 tonnes/ha (38 bu/acre) were close to the long-term average.

Table 1 • Production statistics for Canadian soybeans

Year	Seeded area	Production	Yield
	hectares	tonnes	tonnes/ha
1987	453 000	1 252 000	2.76
1988	533 000	1 152 000	2.16
1989	539 500	1 219 000	2.26
1990	491 200	1 292 000	2.63
1991	575 500	1 459 900	2.44
1992	643 600	1 455 300	2.34
1993	728 700	1 851 300	2.57
1994	820 100	2 250 700	2.74
1995	826 000	2 293 000	2.78
1996	875 300	2 170 400	2.51
1997	1 061 700	2 737 700	2.58

Source—Statistics Canada, Field Crop Reporting Series, No. 8, 1987–97

Quality of 1997 soybean

There are two major types of soybeans grown in Canada, commonly referred to as oil beans and food beans.

Oil beans include soybeans designed primarily for producing oil used in salad oil, shortening and margarine products, and in defatted meal, which is used as a protein supplement in livestock rations. Key quality factors for oil beans include oil content, protein content, fatty acid composition, and nitrogen solubility. Oil and protein content give quantitative estimates of the seed as a source of oil and of the resulting meal as a source of protein for animal feed. The fatty acid composition provides information about the nutritional, physical and chemical characteristics of the oil extracted from the seed. Nitrogen solubility measurements on unprocessed seed give an indication of seed damage or immaturity although it has not been established whether there is a direct connection between nitrogen solubility index (NSI) values in seed and the resulting NSI in processed meal. In processed meal, low NSI values indicate excess damage as a result of heating and have been related to lower growth rates in animals.

Food beans are those varieties of soybeans that have been bred for specific attributes required in the production of traditional soyfoods. The quality of these beans is measured by such attributes as a clear or white hilum, larger seed size, higher protein content, NSI, and soluble sugar content.

Soyfoods are divided roughly into two classes: nonfermented and fermented. Nonfermented soyfoods include soymilk, tofu (soybean curd), toasted soy powder, and bean sprouts. Fermented products include soy sauce, miso, tempeh, and natto.

The soluble sugars are important factors in the nutritional quality and processing of food grade soybeans, particularly in the manufacture of fermented products. NSI is an indicator of protein quality and is related to the processing availability of final products such as tofu. White hilum soybeans that do not meet quality standards for food processing can be used as oil beans.

Table 2 • Quality data for GRL harvest survey soybean No. 1 and No. 2 Canada grades[1]

Quality parameter	1997	1996	1987–96
Oil content[2], %	19.8	20.3	20.7
Protein content[3], %	42.2	41.6	41.5

[1] means for the combined grades
[2] moisture-free basis
[3] %N x 6.25; moisture-free basis

Oil and protein content

The 1997 mean oil content of 19.8% was 0.5 percentage units lower than in 1996 (20.3%) and 0.9 percentage units lower than the ten-year mean (20.7%). The mean protein content in 1997 increased 0.6 percentage units to 42.2% from last year and was above the ten-year mean of 41.5% (Table 2). The No. 1 and No. 2 Canada soybeans were similar in both oil and protein contents. While the white hilum and dark hilum beans were similar in oil content, the white hilum beans were 0.7 percentage units higher in protein content (Table 3).

The oil and protein data are summarized by grade and county in Tables 4 and 5. The highest individual oil content, 21.4%, occurred in the counties of Essex and Norfolk while the highest individual protein content, 47.6%, came from Essex county. The oil content of major varieties ranged from 18.5% to 20.6% (not including natto beans with 15.5%) while protein ranged from 40.5% to 43.9%, with natto beans at 50.2% (Table 6).

Table 3 • Quality data for 1997 Ontario soybean by grade and type

Type	Oil content[1], %			Grade	Protein content[2],%			No. of samples
	mean	min.	max.		mean	min.	max.	
	%	%	%		%	%	%	
				No. 1 CY				
Dark Hilum	19.9	17.2	21.7		42.0	38.0	46.6	87
White Hilum	19.7	17.5	22.0		42.5	39.0	47.6	85
All types	**19.8**	**17.2**	**22.0**		**42.3**	**38.0**	**47.6**	**172**
				No. 2 CY				
Dark Hilum	20.0	18.9	21.3		41.8	38.8	46.6	37
White Hilum	19.6	19.0	20.6		42.8	39.8	45.1	18
All types	**19.9**	**18.9**	**21.3**		**42.1**	**38.8**	**46.6**	**55**
				No. 1 & 2				
Dark Hilum	19.9	17.2	21.7		41.9	38.0	46.6	124
White Hilum	19.7	17.5	22.0		42.6	39.0	47.6	103
All types	**19.8**	**17.2**	**22.0**		**42.2**	**38.0**	**47.6**	**227**

[1] moisture-free basis
[2] %N x 6.25; moisture-free-basis

Table 4 • Oil and protein content of 1997 Ontario soybean by county and grade

County	Oil content[1], %			Protein content[2], %			No. of Samples
	mean	min.	max.	mean	min.	max	
	%	%	%	%	%	%	
No. 1							
Brant	19.9	19.5	21.0	41.2	40.1	41.9	5
Bruce	18.4	17.2	19.5	43.7	42.8	45.1	11
Dundas	20.1	18.9	21.1	41.4	39.0	43.0	5
Durham-West	20.3	19.9	20.9	40.8	39.1	41.6	3
Elgin	19.7	19.6	19.8	42.6	42.4	42.9	3
Essex	19.9	18.1	21.4	42.5	39.4	47.6	27
Haldimand	19.8	17.5	20.9	41.7	39.3	46.3	10
Huron	19.9	19.1	20.7	41.9	38.5	43.5	5
Kent	20.2	18.4	22.0	41.8	38.0	44.4	33
Lambton	19.3	18.1	20.5	43.2	39.8	46.6	20
Middlesex	19.6	18.9	20.2	42.5	40.4	44.8	9
Norfolk	20.5	19.2	21.4	41.1	38.7	44.0	4
Perth	19.5	18.3	20.8	41.9	39.2	43.8	10
Stormont	20.4	20.4	20.4	41.4	41.4	41.4	1
Wellington	20.6	20.6	20.6	39.1	39.1	39.1	1
unknown	20.1	19.4	21.0	42.4	40.5	44.5	25
All samples	**19.8**	**17.2**	**22.0**	**42.3**	**38.0**	**47.6**	**172**
No. 2							
Bruce	19.2	19.2	19.2	43.5	43.3	43.7	2
Dundas	19.3	19.3	19.3	44.0	44.0	44.0	1
Durham-West	20.2	19.7	20.8	41.7	41.3	42.2	4
Essex	19.5	19.0	20.0	42.6	41.5	44.7	5
Haldimand	19.9	19.6	20.7	40.7	39.8	42.3	3
Huron	20.2	19.9	20.5	41.5	40.3	42.7	2
Kent	20.8	19.9	21.3	40.7	38.8	42.7	3
Lambton	19.6	19.1	20.2	42.7	41.3	44.0	11
Middlesex	20.2	19.4	20.7	41.1	38.8	43.1	6
Perth	20.1	18.9	20.9	40.9	38.8	43.1	5
Stormont	19.5	19.5	19.5	42.3	42.3	42.3	1
Wellington	20.6	20.6	20.6	40.3	40.3	40.3	1
unknown	19.8	18.9	20.7	43.1	40.7	46.6	11
All samples	**19.9**	**18.9**	**21.3**	**42.1**	**38.8**	**46.6**	**55**

[1] moisture-free basis

[2] %N x 6.25; moisture-free-basis

Table 5 • Oil and protein content of 1997 Ontario soybean by county No. 1 and No. 2 Canada grades combined

County	Oil content[1], %			Protein content[2], %			No. of samples
	mean	min.	max.	mean	min.	max.	
	%	%	%	%	%	%	
Brant	19.9	19.5	21.0	41.2	40.1	41.9	5
Bruce	18.6	17.2	19.5	43.7	42.8	45.1	13
Dundas	20.0	18.9	21.1	41.8	39.0	44.0	6
Durham-West	20.2	19.7	20.9	41.3	39.1	42.2	7
Elgin	19.7	19.6	19.8	42.6	42.4	42.9	3
Essex	19.9	18.1	21.4	42.5	39.4	47.6	32
Haldimand	19.8	17.5	20.9	41.4	39.3	46.3	13
Huron	20.0	19.1	20.7	41.8	38.5	43.5	7
Kent	20.2	18.4	22.0	41.7	38.0	44.4	36
Lambton	19.4	18.1	20.5	43.0	39.8	46.6	31
Middlesex	19.8	18.9	20.7	42.0	38.8	44.8	15
Norfolk	20.5	19.2	21.4	41.1	38.7	44.0	4
Perth	19.7	18.3	20.9	41.6	38.8	43.8	15
Stormont	20.0	19.5	20.4	41.9	41.4	42.3	2
Wellington	20.6	20.6	20.6	39.7	39.1	40.3	2
Unknown	20.0	18.9	21.0	42.6	40.5	46.6	36
All samples	**19.8**	**17.2**	**22.0**	**42.2**	**38.0**	**47.6**	**227**

[1] moisture-free basis

[2] %N x 6.25; moisture-free-basis

Table 6 • Oil and protein content of 1997 Ontario soybean by variety No. 1 and No. 2 Canada grades combined

Variety[1]	Oil content[2], %			Protein content[3], %			No. of samples
	mean	min.	max.	mean	min.	max.	
	%	%	%	%	%	%	
S24-12	19.4	18.1	20.1	43.6	42.1	45.8	16
OAC Bayfield	20.0	18.8	21.4	41.9	38.7	44.5	15
9305	19.7	18.9	20.1	42.3	41.5	42.9	10
S19-90	20.1	19.7	20.7	41.7	40.3	42.7	8
S20-20	20.4	19.8	22.0	42.2	39.6	44.1	7
S24-92	20.1	19.6	21.1	42.6	41.0	43.5	7
CX232	20.0	19.3	21.1	42.7	39.5	44.4	6
J-251	20.3	19.6	21.1	42.0	39.9	43.3	5
9281	20.6	19.8	21.4	41.1	39.3	42.5	4
Elgin 87	20.2	19.6	20.7	40.5	39.5	41.5	4
KG 41	19.8	19.1	20.6	42.3	40.3	43.6	4
Korada	18.9	18.2	19.2	43.3	42.7	44.4	4
M-210	20.1	19.6	20.6	41.5	40.9	42.4	4
Marathon	19.4	19.1	19.6	41.9	41.4	42.5	4
PS 42	18.5	17.8	19.2	43.9	43.4	44.5	4
PS 50	19.5	18.2	20.4	42.4	41.4	44.1	4
Natto	15.1	15.1	15.1	50.2	50.2	50.2	1

[1] as designated on sample envelope
[2] moisture-free basis
[3] %N x 6.25; moisture-free-basis

Fatty acid composition

Compared to 1996, the No. 1 and No. 2 Canada composites had increased linoleic and linolenic acid contents and decreased palmitic, stearic, and oleic acid contents (Table 7).

Soluble sugars

This is the first year sugar data have been provided for the GRL soybean survey. The main soluble sugars are the disaccharide sucrose, the trisaccharide raffinose and the tetrasaccharide stachyose. Traces of glucose, fructose, and the pentasaccharide verbascose were also found. Total soluble sugar contents ranged from 10.7% to 13.6% (Table 8).

Nitrogen solubility

This is also the first year NSI data have been provided for the GRL soybean survey. The NSI values ranged from 72.0% to 88.0%, with the No. 1 Canada grade composite being 83.8% (Table 8).

Table 7 • Fatty acid composition for 1997 Ontario soybean by variety No. 1 and No. 2 Canada grades combined

Variety[2]	Fatty acid composition[1]					Iodine value[3]	No. of samples
	C16:0	C18:0	C18:1	C18:2	C18:3		
	%	%	%	%	%		
S24-12	8.9	3.4	23.3	54.4	8.9	137.6	16
OAC Bayfield	9.4	3.6	17.7	58.3	9.9	142.1	15
9305	9.3	3.6	20.6	55.3	10.2	140.2	10
S19-90	9.2	3.9	19.9	55.8	10.0	140.0	8
S20-20	10.1	4.1	22.5	52.7	9.3	135.0	7
S24-92	10.1	4.0	20.3	54.2	10.1	137.8	7
CX232	10.4	4.1	19.5	54.2	10.6	138.4	6
J-251	10.4	3.9	20.2	54.1	10.3	137.9	5
9281	10.0	3.7	19.0	55.6	10.4	140.1	4
Elgin 87	10.0	3.8	17.9	55.7	11.5	142.0	4
KG 41	9.7	3.4	19.1	56.2	10.4	141.1	4
Korada	10.2	3.3	15.6	57.7	12.1	144.9	4
M-210	9.8	3.4	22.4	53.7	9.6	137.3	4
Marathon	9.6	3.9	20.3	53.9	11.1	139.9	4
PS 42	10.2	3.6	18.3	55.4	11.4	141.4	4
PS 50	9.1	3.6	21.2	54.5	10.3	139.7	4
Natto	9.2	3.5	16.3	56.5	13.1	146.3	1
No. 1 Canada (all)	**9.7**	**3.7**	**19.9**	**55.1**	**10.4**	**139.9**	**172**
No. 2 Canada (all)	**9.6**	**3.7**	**19.7**	**55.3**	**10.5**	**140.2**	**55**

[1] % of total fatty acids including: Palmitic (C16:0), Stearic (C18:0), Oleic (C18:1), Linoleic (C18:2), and Linolenic (C18:3)
[2] as designated on the sample envelope
[3] calculated from the fatty acid composition

Table 8 • NSI and soluble sugar content for 1997 Ontario soybean by variety No. 1 and No. 2 Canada grades combined

Variety[1]	NSI[2]	Sucrose	Raffinose	Stachyose	Total sugars[3]	Samples in composite
	%	%	%	%	%	
S24-12	78.6	8.4	0.5	3.9	12.8	16
OAC Bayfield	78.2	7.6	0.7	4.4	12.7	15
9305	82.5	7.4	0.7	4.1	12.2	10
S 19-90	79.2	8.2	0.8	4.1	13.1	8
S 20-20	88.0	7.5	0.6	4.5	12.6	7
S 24-92	79.5	7.1	0.6	4.0	11.7	7
CX232	80.9	6.4	0.6	4.3	11.3	6
J-251	78.6	7.0	0.6	4.1	11.7	5
9281	85.4	6.6	0.6	4.6	11.8	4
Elgin 87	77.6	7.5	0.8	4.3	12.6	4
KG 41	86.3	6.8	0.6	4.2	11.6	4
Korada	72.4	7.0	0.7	4.2	11.9	4
M-210	80.7	7.5	0.6	4.3	12.4	4
Marathon	79.0	8.8	0.6	4.2	13.6	4
PS 42	81.3	7.3	0.7	4.3	12.3	4
PS 50	82.8	7.3	0.5	4.2	12.0	4
Dominator	77.5	7.2	0.7	4.3	12.2	3
Harovinton	74.2	6.5	0.6	4.3	11.5	2
RCAT Calico	76.1	6.9	0.7	3.8	11.5	2
TK 89	80.0	7.3	0.6	4.2	12.1	2
Thompson Tofu	72.0	7.1	0.6	4.6	12.3	1
natto	74.2	6.0	0.9	3.8	10.7	1
No. 1 Canada (all)	**83.8**	**7.3**	**0.6**	**4.1**	**12.0**	**172**
No. 2 Canada (all)	**82.5**	**7.4**	**0.7**	**4.1**	**12.2**	**55**

[1] as designated on the sample envelope

[2] nitrogen solubility in 0.5% KOH, using analysis of composites; moisture-free basis

[3] % of total soluble sugars including: sucrose, raffinose, and stacchyose; moisture-free basis.

Appendix A • Soybean varieties registered in Canada[1]

OILSEED TYPE

A0756	Corona	J-251	OAC Shire	Spitfire
A0949	CX145	Kenwood 94	OAC Vision	Sterling
A1123	CX173	KG 20	OAC Wingham	T8508
A1139	CX210	KG 30	ORLEANS	T8902
A1511	CX228	KG 41	Prémia	Talon
A1662	CX229	KG 60	PRO 280	Tecumseh
A1875	CX232	KG 62	PS 32	Tiger
A1923	CX235c	KG 92	PS 33	Tornado
A2242	CX260c	KG 93	PS 42	Toucan
A2349	CX267	Klaxon	PS 50	Trooper
A2540	CX278	Korada	PS 63	TS205
A2553	CX280c	LaSalle	PS 83	TS255
A2604	DB1926	M-080	PS 85	TS282
A2615	DB1953	M-210	Quantum	UGO
AC 2001	DB1979	Maitland	Quest	Vautour
AC Albatros	Dominator	Maple Amber	RCAT Angora	Westag 97
AC Brant	Elgin	Maple Arrow	RCAT Bobcat	Yamaska
AC Bravor	Elgin 87	Maple Belle	RCAT Calico	York
AC Cormoran	Enterprise	Maple Donovan	RCAT Columbus	Zest
AC Harmony	F1408	Maple Glen	RCAT Persian	013
AC Orford	Fiesta	Maple Isle	Resnik	022
Achiever	FISTON	Maple Ridge	Richelieu	040
AG1901	Fraser	Marathon	Riel	140
Alta	Frima	Maverick	Rigel	200
AP1347	Frisquet	Medallion	RS1493	2240
AP1394	FS271	MS0747	S00-55	9007
AP1876	FS481	MS1855	S00-66	9008
AP2880	FS4455	Nankino	S00-88	9042
Apache	FS11041	Nemeecys 19	S02-30	9063
Aquilon	G-3197	Nemeecys 28	S03-C3	9071
Autan	G-3202	Nordet	S07-57	9092
Ayr	Galt	OAC Arthur	S08-80	9111
Beck	Gentleman	OAC Atwood	S12-49	9132
Bell	GRAND PRIX	OAC Auburn	S14-H4	9161
Bethune	Hallmark	OAC Bayfield	S14-M7	9163
Bicentennial	Hammer	OAC Bright	S15-20	9173
Blackjack 21	Hanlon	OAC Brussels	S15-50	9202
BLIZZARD	Haroson	OAC Concorde	S16-60	9203
Bounty	HS 2578	OAC Dorado	S18-11	9234
Carr	HS 2689	OAC Eclipse	S19-90	9242
Cayla	HS 2778	OAC Embro	S20-20	9244
CÉSAR	HS 2868	OAC Eramosa	S20-91	9273
CHALLENGER	HS 2888	OAC Erin	S24-12	9281
Clara	HS 2988	OAC Exeter	S24-92	9294
CM1070	HS 3168	OAC Glencoe	S25-07	9303
CM9403	HS 3268	OAC Libra	Sapphire	9305
Colfax	IA 2007	OAC Millennium	Sara	80451
Conrad	J-083	OAC Mirage	Secord	
Conrad 94	J-144	OAC Salem	Sentry	

[1]Agriculture Canada, Food Production and Inspection Branch, *List of Varieties Registered in Canada*; October 1, 1997

Methods

Method

Samples of newly harvested soybean were collected by the Ontario Soybean Growers' Marketing Board and sent to Industry Services, Canadian Grain Commission, Chatham, for grading. All samples were analysed for oil and protein content by near infrared (NIR) spectroscopy using a Tecator Infratec 1225 Grain Analyzer. The instrument was calibrated and verified against the appropriate listed reference method. Variety composites were also tested for fatty acid composition, soluble sugar content, and NSI.

Oil content

Oil content was determined by nuclear magnetic resonance (NMR) according to International Organization for Standardization Method ISO 10565:1993(E), Oilseeds—Simultaneous determination of oil and moisture contents—Method using pulsed nuclear magnetic resonance spectrometry. Results were obtained with a Bruker NMS 110 Minispec NMR Analyzer and are reported as percentage, moisture-free basis.

Protein content

Protein content was determined by the AOCS Official Method Ba 4e-93 using a LECO FP-428 Nitrogen/Food Protein Determinator. Results are reported as percentage protein (N x 6.25) on a whole-seed, moisture-free basis.

Fatty acid composition

Fatty acid composition was determined by the International Organization for Standardization Method ISO 5508:1990 (E), Animal and vegetable fats and oils—Analysis by gas chromatography of methyl esters of fatty acids. A 15 m by 0.32 mm column with a 0.5 micrometer Supelcowax 10 coating was used to separate the methyl esters that are formed by base-catalysed transesterification of the oil. As much as 1% of minor fatty acids that are not listed in the fatty acid composition tables are included in the calculations.

Iodine value

Iodine value was calculated from the fatty acid composition, according to AOCS Recommended Practice Cd 1c-85.

Total soluble sugars

Total soluble sugars were extracted with boiling water from ground full-fat seed samples and determined with a Dionex CarboPac HPLC System, expressed on a moisture-free basis.

Nitrogen solubility index (NSI)

Nitrogen solubility index (NSI) was determined as the percentage of total seed nitrogen in an extract of ground soybeans with a 0.5% potassium hydroxide (KOH) solution. Nitrogen in the extract and the original seed was estimated using a LECO FP-428 Nitrogen/Food Protein Determinator.

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