COMPOSITIONS OF SUNFLOWER, NUSUN (MID-OLEIC SUNFLOWER) AND HIGH-OLEIC SUNFLOWER OILS

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Introduction

Compositions of vegetable oils are valuable information in understanding their functional, quality and nutritional properties. In addition, we need this essential compositional knowledge when buying and selling oilseeds domestically and internationally. NuSun, mid-oleic sunflower, has been developed to fill a crucial void for vegetable oils that can be used for high stability uses such as frying but without the need for hydrogenation or high levels of saturated fat. Moreover, mid-oleic sunflower oil is an all-purpose commodity oil that can be bottled for the consumer market as well as for the 6 billion pound/year market for frying oils in restaurants and food manufacturing. Acreage for NuSun has been steadily expanding during the last several years. Because of the increasing importance of NuSun in the U.S. and in export markets, the next steps toward recognition of this oil internationally need to be taken.

The Codex Committee on Fats and Oils (CCFO), an international organization that develops standards for international trade, meets every two years to discuss issues related to trade of fats and oils. At the 17th session of the CCFO in February, 2001, the process was initiated to include NuSun in the AStandard for Named Vegetable Oils@ based on a proposal from the United States. This decision was approved by the 49th Executive Committee of Codex Alimentarius, which is a division of the Food and Agriculture Organization of the United Nations/World Health Organization. The Proposed Draft Standard for Mid-Oleic Sunflower Oil, that was submitted by the United States for review prior to the February, 2003, meeting of CCFO, included this oil=s compositional characteristics. The purpose of this paper is to present the compositions of NuSun oil along with the compositions of sunflower oil and high-oleic sunflower oil. The following information for the draft amendment to the Codex Standard for Named Vegetable Oils to include mid-oleic sunflower oil is at step 3 of the 8-step Codex process.

Estimates of NuSun Acreage/Production /Crush/Export

The following table provides estimates of NuSun acreage, production, crush and export of oil. Steady increases are seen for the data for acreage of NuSun grown, crush and domestic use. The levels of oil produced and used are important aspects that the Codex committee is concerned about when determining if an oil should be included in the Standard for Named Vegetable Oils.

Table 1. Estimates of NuSun Acreage/Production /Crush/Export in Metric Tons.

Year	Acreage	Hectares	Production	Crush	Oil Produced	Domestic Use	Export
1999-00	150,000	61,000	94,000	60,000	24,600	20,000	4,600
2000-01	600,000	243,000	374,000	270,000	111,000	90,000	21,000
2001-02	650,500	263,000	406,000	275,000	113,000	95,000	18,000
2002-03	725,000	293,000	395,000	340,000	140,000	120,000	20,000

Methods of Sampling, Analysis, Production and Export Statistics

Sixty-six samples of NuSun seeds were collected from the major geographical areas in the U.S. where the crop is grown and included the states of Colorado, Kansas, Minnesota, Nebraska, North Dakota, Oklahoma, South Dakota and Texas. Crude oils were analyzed for fatty acid composition; relative density, refractive index, saponification value, and unsaponifiable matter; plant sterols; and tocopherol content. Iodine values were calculated from fatty acid composition. All of the procedures were done according to approved official protocols and methods.

Analyses of Fatty Acid Compositions

Table 2 presents the ranges for the fatty acid compositions of sunflower oil, NuSun and high-oleic sunflower oil. The seeds used in the analysis of fatty acid composition were from the 2001 harvest year.

Table 2. Fatty Acid Composition Ranges for Sunflower Oil, NuSun, and High-oleic Sunflower Oil for Codex Standard for Vegetable Oils (expressed as % of total fatty acids).

Fatty Acids	Sunflower†	NuSun Mid-Oleic Sunflower‡	High-Oleic Sunflower†
C6:0	ND	ND	ND
C8:0	ND	ND	ND
C10:0	ND	ND	ND
C12:0	ND-0.1	ND	ND
C14:0	ND-0.2	0.4-0.8	ND-0.1
C16:0	2.0-7.6	4.0-5.5	2.6-5.0
C16:1	ND-0.3	ND-0.05	ND-0.1
C17:0	ND-0.2	ND-0.05	ND-0.1
C17:1	ND-0.1	ND-0.06	ND-0.1
C18:0	1.0-6.5	2.1-5.0	2.9-6.2
C18:1	14-39.4	43.1-71.8	75-90.7
C18:2	48.3-74.0	18.7-45.3	2.1-17.0
C18:3	ND-0.3	ND-0.1	ND-0.3
C20:0	0.1-0.5	0.2-0.4	0.2-0.5
C20:1	ND-0.3	0.2-0.3	0.1-0.5
C20:2	ND	ND	ND
C22:0	0.3-1.5	0.6-1.1	0.5-1.6
C22:1	ND-0.3	ND	ND-0.3
C22:2	ND-0.3	ND-0.09	ND
C24:0	ND-0.5	0.3-0.4	ND-0.5
C24:1	ND	ND	ND
ND=not detectable (ND defined as <0.05%)			

† From Codex Alimentarius (2001)
‡ From Table 3

Oleic acid is the fatty acid of primary interest in comparing the three types of sunflower oils. Sunflower oil is currently in the Codex AStandard for Named Vegetable Oils.@ The process to include high-oleic sunflower oil as part of the standard was initiated in 1999 and in 2001 for NuSun. Oleic acid levels range from 14 to 39.4% for sunflower oil; from 43.1 to 71.8% for NuSun and from 75 to 90.7% for high-oleic sunflower oil. The data for sunflower oil and high-oleic sunflower oil were measured on seeds collected from various parts of the world where these crops are grown, but the data for NuSun were from seeds grown in the U.S.

The effects of location and climate of the fatty acid compositions are of interest to growers of oilseeds. Data on fatty acids in the three types of sunflower oils are sorted by states in Table 3. Of particular interest are the oleic contents of NuSun oils shown in this table. Oklahoma had the highest average for all states at 62.6% and the lowest average was from South Dakota at 56.4%. A seed sample from Texas yielded the highest oleic content of 71.8% with the lowest reported from Kansas at 43.1% (Table 4).

Table 3. Effect of Planting Location on Fatty Acid Compositions of NuSun Oils (by States).

Sample	Location	State	Palmitic 16:0	Stearic 18:0	Oleic 18:1	Linoleic 18:2	Arachidic 20:0	Gondoic 20:1	Behenic 22:0	Lignoceric 24:0
CO1	Glyndon	MN	4.1	3.4	65.2	25.2	0.3	0.2	0.9	0.3
CO13	Glyndon	MN	4.2	3.3	61.5	29.0	0.3	0.2	0.9	0.3
CO5	Moorhead	MN	4.1	3.4	59.3	31.4	0.2	0.2	0.8	0.3
MN Average			**4.1**	**3.3**	**62.0**	**28.5**	**0.3**	**0.2**	**0.8**	**0.3**
CO10	Kloten	ND	4.0	3.8	60.7	29.5	0.3	0.2	0.9	0.3
CO11	Carrington	ND	4.1	3.9	57.3	32.6	0.3	0.2	0.9	0.3
CO12	Rugby	ND	4.3	3.8	56.0	33.9	0.3	0.2	0.9	0.3
CO14	Tolna	ND	4.2	3.1	60.1	30.6	0.2	0.2	0.8	0.3
CO15	Kloten	ND	4.1	3.7	57.9	32.4	0.3	0.2	0.8	0.3
CO16	Elgin	ND	4.4	3.8	57.4	32.2	0.3	0.2	0.8	
CO17	Turtle Lake	ND	4.5	4.7	62.0	26.2	0.4	0.2	1.1	0.3
CO18	New Leipzig	ND	4.3	4.3	60.5	28.8	0.3	0.2	0.9	
CO2	Pekin	ND	4.0	3.1	61.2	29.7	0.2	0.2	0.8	0.3
CO21	Sanborn	ND	4.1	3.2	63.3	27.3	0.3	0.2	0.8	0.3
CO22	Marion	ND	4.3	3.0	60.2	30.4	0.3	0.2	0.8	
CO23	Adrian	ND	4.1	3.8	58.8	31.3	0.3	0.2	0.9	0.3
CO27	Cleveland	ND	4.5	5.0	50.6	37.7	0.4	0.2	1.0	0.3
CO3	Rugby	ND	4.5	3.8	49.2	40.0	0.3	0.2	0.8	0.3
CO30	Enderlin	ND	4.5	4.0	48.9	40.5	0.3	0.2	0.9	0.3
CO32	Napoleon	ND	4.0	4.7	64.8	24.3	0.4	0.2	1.0	0.3
CO34	Scranton	ND	4.8	3.8	51.9	37.5	0.3	0.2	0.9	0.3
CO37	Linton	ND	4.3	3.6	57.5	32.5	0.3	0.2	0.8	0.3
CO39	Edgeley	ND	4.5	3.4	62.9	27.1	0.3	0.2	0.8	0.3
CO4	Tolna	ND	4.4	3.0	56.4	34.4	0.2	0.2	0.7	0.3
CO40	Ypsilanti	ND	4.2	3.7	58.4	31.7	0.3	0.2	0.9	
CO6	McVille	ND	4.1	4.0	58.6	31.2	0.3	0.2	0.9	0.3
CO66	Rugby	ND	4.2	4.0	54.0	35.8	0.3	0.2	0.9	0.3
CO7	Minto	ND	4.6	4.1	60.5	28.6	0.3	0.2	1.0	0.3
CO8	Bisbee	ND	4.3	3.6	56.6	33.7	0.3	0.2	0.8	0.3
CO9	Oberon	ND	4.1	4.0	60.6	29.3	0.3	0.2	0.9	0.3
ND Average			**4.3**	**3.8**	**57.9**	**31.9**	**0.3**	**0.2**	**0.9**	**0.3**
CO19	Onida	SD	4.5	3.6	58.1	31.5	0.3	0.2	0.9	
CO20	Ipswich	SD	4.7	4.3	57.8	31.4	0.3	0.2	0.9	0.3

CO24	McLaughlin	SD	4.4	3.4	61.6	28.5	0.3	0.2	0.8	0.3
CO25	Faulkton	SD	4.3	4.8	59.2	29.5	0.4	0.2	0.9	0.3
CO26	Pierre	SD	5.3	3.9	50.1	38.6	0.3	0.2	0.8	0.3
CO28	Eureka	SD	4.5	3.7	59.2	30.7	0.3	0.2	0.9	.29
CO29	Gettysburg	SD	5.1	3.4	55.5	33.8	0.3	0.3	0.9	.33
CO31	Selby	SD	4.5	4.2	54.2	34.9	0.3	0.2	0.9	
CO33	McLaughlin	SD	4.7	3.8	60.0	29.3	0.3	0.2	0.9	0.3
CO35	Dupree	SD	4.4	5.0	50.6	37.8	0.4	0.2	0.9	
CO36	Onida	SD	4.6	3.5	56.6	33.2	0.3	0.2	0.8	
CO38	Isabel	SD	4.6	3.1	54.0	36.3	0.3	0.2	0.8	
SD Average			**4.6**	**3.9**	**56.4**	**33.0**	**0.3**	**0.2**	**0.9**	**0.3**
CO45	Palisade	NE	4.8	3.7	63.4	26.0	0.3	0.2	0.9	0.3
CO47	Edison	NE	4.4	3.4	57.8	32.5	0.3	0.2	0.8	0.3
CO58	Wauneta	NE	4.8	3.9	64.2	24.8	0.4	0.2	0.9	0.3
NE Average			**4.7**	**3.6**	**61.8**	**27.8**	**0.3**	**0.2**	**0.9**	**0.3**
CO46	Eads	CO	5.0	4.3	58.0	30.4	0.4	0.2	1.0	0.3
CO53	Burlington	CO	4.8	4.9	61.4	26.5	0.4	0.2	1.0	0.3
CO59	Two Buttes	CO	4.7	3.3	58.1	31.6	0.3	0.3	0.9	
CO65	Strasburg	CO	4.7	4.5	61.6	26.7	0.4	0.2	1.0	
CO Average			**4.8**	**4.3**	**59.8**	**28.8**	**0.3**	**0.2**	**0.9**	**0.3**
CO42	Kanorado	KS	4.5	3.4	57.9	32.4	0.3	0.2	0.8	0.3
CO43	Portis	KS	4.8	4.1	50.7	38.2	0.3	0.2	1.0	0.3
CO50	Oberlin	KS	4.3	3.3	67.4	23.0	0.3	0.3	0.8	0.3
CO51	Leoti	KS	4.4	3.7	64.9	24.9	0.3	0.2	0.9	0.3
CO52	Gorham	KS	5.0	4.6	43.1	45.3	0.3	0.2	0.8	0.3
CO54	Colby	KS	4.7	3.3	65.6	24.1	0.3	0.2	0.8	
CO55	Hays	KS	4.7	2.1	60.5	30.8	0.2	0.2	0.6	
CO57	Phillipsburg	KS	5.0	2.5	61.9	28.5	0.2	0.3	0.7	0.3
CO60	Kiowa	KS	5.5	2.8	65.9	23.4	0.3	0.3	0.8	
CO61	Hoxie	KS	4.6	2.9	59.1	31.6	0.2	0.2	0.7	0.3
CO62	Monument	KS	4.7	3.0	63.8	26.4	0.3	0.2	0.8	0.3
CO63	Weskan	KS	4.5	4.3	60.8	28.4	0.3	0.2	0.9	0.3
CO64	Goodland	KS	4.6	3.5	58.4	31.4	0.3	0.2	0.8	0.3
KS Average			**4.7**	**3.3**	**60.0**	**29.9**	**0.3**	**0.2**	**0.8**	**0.3**
CO44	Tyrone	OK	4.8	3.7	61.5	27.7	0.3	0.2	0.9	0.3
CO49	Guymon	OK	4.2	3.2	63.7	26.9	0.3	0.3	0.8	0.3
OK Average			**4.5**	**3.4**	**62.6**	**27.3**	**0.3**	**0.2**	**0.8**	**0.3**
CO41	Dalhart	TX	4.5	4.2	53.3	36.1	0.3	0.2	0.9	0.3
CO48	Lubbock	TX	4.8	2.5	71.8	18.7	0.2	0.3	0.9	
CO56	Muleshoe	TX	4.5	2.8	61.4	29.3	0.2	0.2	0.7	0.3
TX Average			**4.6**	**3.1**	**62.2**	**28.0**	**0.3**	**0.3**	**0.8**	**0.3**

Table 4. Range of Oleic Acid Contents in NuSun Oils (listed from low to high percent).

Sample	Location	State	Palmitic 16:0	Stearic 18:0	Oleic 18:1	Linoleic 18:2	Arachidic 20:0	Gondoic 20:1	Behenic 22:0	Lignoceric 24:0
CO52	Gorham	KS	4.99	4.61	**43.08**	45.34	0.32	0.20	0.78	0.26
CO30	Enderlin	ND	4.51	3.96	**48.92**	40.52	0.29	0.21	0.86	0.27
CO3	Rugby	ND	4.54	3.83	**49.19**	40.00	0.28	0.21	0.83	0.27
CO26	Pierre	SD	5.26	3.89	**50.12**	38.59	0.31	0.20	0.83	0.30
CO27	Cleveland	ND	4.45	4.99	**50.60**	37.73	0.35	0.19	0.96	0.27
CO35	Dupree	SD	4.43	4.97	**50.62**	37.77	0.35	0.20	0.94	
CO43	Portis	KS	4.75	4.14	**50.74**	38.15	0.31	0.22	0.98	0.29
CO34	Scranton	ND	4.78	3.75	**51.88**	37.50	0.29	0.21	0.86	0.27
CO41	Dalhart	TX	4.49	4.15	**53.26**	36.05	0.30	0.22	0.86	0.27
CO38	Isabel	SD	4.59	3.14	**53.99**	36.25	0.25	0.23	0.78	
CO66	Rugby	ND	4.23	3.95	**54.01**	35.79	0.27	0.20	0.85	0.26
CO31	Selby	SD	4.49	4.23	**54.18**	34.89	0.31	0.21	0.89	
CO29	Gettysburg	SD	5.07	3.43	**55.48**	33.81	0.28	0.25	0.87	0.33
CO12	Rugby	ND	4.25	3.83	**56.00**	33.88	0.28	0.22	0.85	0.29
CO4	Tolna	ND	4.36	3.02	**56.41**	34.44	0.24	0.23	0.74	0.27
CO36	Onida	SD	4.56	3.49	**56.56**	33.22	0.29	0.24	0.84	
CO8	Bisbee	ND	4.25	3.60	**56.59**	33.69	0.25	0.22	0.80	0.26
CO11	Carrington	ND	4.11	3.90	**57.34**	32.60	0.29	0.22	0.86	0.28
CO16	Elgin	ND	4.40	3.82	**57.42**	32.20	0.28	0.20	0.84	
CO37	Linton	ND	4.30	3.61	**57.50**	32.53	0.29	0.23	0.84	0.28
CO20	Ipswich	SD	4.67	4.26	**57.80**	31.41	0.31	0.21	0.91	0.30
CO47	Edison	NE	4.39	3.35	**57.83**	32.50	0.27	0.24	0.79	0.31
CO42	Kanorado	KS	4.45	3.39	**57.86**	32.37	0.27	0.23	0.81	0.27
CO15	Kloten	ND	4.12	3.67	**57.89**	32.42	0.26	0.21	0.84	0.28
CO46	Eads	CO	4.99	4.32	**57.98**	30.42	0.35	0.20	0.96	0.31
CO19	Onida	SD	4.50	3.64	**58.11**	31.54	0.30	0.23	0.86	
CO59	Two Buttes	CO	4.73	3.26	**58.13**	31.64	0.26	0.25	0.87	
CO40	Ypsilanti	ND	4.22	3.65	**58.40**	31.65	0.27	0.21	0.85	
CO64	Goodland	KS	4.55	3.50	**58.41**	31.37	0.29	0.23	0.83	0.28
CO6	McVille	ND	4.08	3.96	**58.59**	31.17	0.28	0.21	0.88	0.27
CO23	Adrian	ND	4.07	3.80	**58.80**	31.27	0.27	0.21	0.86	0.28
CO61	Hoxie	KS	4.56	2.87	**59.11**	31.62	0.23	0.23	0.72	0.28
CO28	Eureka	SD	4.45	3.71	**59.15**	30.69	0.28	0.21	0.85	0.29
CO25	Faulkton	SD	4.33	4.79	**59.18**	29.46	0.35	0.21	0.93	0.29
CO5	Moorhead	MN	4.10	3.40	**59.29**	31.35	0.24	0.22	0.80	0.26
CO33	McLaughlin	SD	4.74	3.78	**60.04**	29.33	0.30	0.21	0.86	0.31
CO14	Tolna	ND	4.18	3.11	**60.14**	30.63	0.24	0.23	0.77	0.28
CO22	Marion	ND	4.30	3.03	**60.18**	30.42	0.25	0.23	0.78	
CO18	New Leipzig	ND	4.31	4.26	**60.46**	28.75	0.32	0.20	0.93	
CO7	Minto	ND	4.57	4.08	**60.48**	28.56	0.33	0.22	0.99	0.32
CO55	Hays	KS	4.73	2.12	**60.53**	30.81	0.19	0.24	0.60	
CO9	Oberon	ND	4.05	3.98	**60.55**	29.34	0.29	0.21	0.91	0.29
CO10	Kloten	ND	4.04	3.78	**60.65**	29.54	0.27	0.22	0.87	0.29
CO63	Weskan	KS	4.45	4.26	**60.77**	28.35	0.32	0.21	0.92	0.30
CO2	Pekin	ND	4.04	3.12	**61.17**	29.73	0.24	0.24	0.77	0.28
CO56	Muleshoe	TX	4.48	2.79	**61.40**	29.34	0.23	0.24	0.74	0.29
CO53	Burlington	CO	4.75	4.91	**61.42**	26.50	0.39	0.20	0.96	0.32
CO44	Tyrone	OK	4.84	3.65	**61.49**	27.68	0.32	0.24	0.89	0.32
CO13	Glyndon	MN	4.15	3.27	**61.54**	29.02	0.27	0.24	0.85	0.30
CO65	Strasburg	CO	4.71	4.53	**61.58**	26.68	0.36	0.21	0.97	
CO24	McLaughlin	SD	4.40	3.36	**61.64**	28.51	0.28	0.23	0.83	0.30
CO57	Phillipsburg	KS	5.03	2.52	**61.89**	28.52	0.23	0.27	0.72	0.34
CO17	Turtle Lake	ND	4.50	4.74	**61.98**	26.18	0.39	0.21	1.10	0.33
CO39	Edgeley	ND	4.53	3.38	**62.89**	27.05	0.28	0.24	0.83	0.32
CO21	Sanborn	ND	4.12	3.19	**63.30**	27.32	0.27	0.24	0.81	0.30
CO45	Palisade	NE	4.75	3.66	**63.39**	26.01	0.32	0.24	0.86	0.34
CO49	Guymon	OK	4.17	3.19	**63.72**	26.93	0.26	0.25	0.80	0.32
CO62	Monument	KS	4.70	3.03	**63.82**	26.40	0.27	0.24	0.75	0.33

CO58	Wauneta	NE	4.82	3.92	**64.16**	24.84	0.35	0.23	0.91	0.34
CO32	Napoleon	ND	4.01	4.66	**64.78**	24.34	0.36	0.23	1.00	0.29
CO51	Leoti	KS	4.38	3.65	**64.90**	24.92	0.29	0.24	0.85	0.32
CO1	Glyndon	MN	4.06	3.36	**65.18**	25.23	0.27	0.24	0.86	0.30
CO54	Colby	KS	4.69	3.34	**65.63**	24.08	0.28	0.22	0.81	
CO60	Kiowa	KS	5.46	2.81	**65.92**	23.35	0.30	0.28	0.75	
CO50	Oberlin	KS	4.32	3.30	**67.36**	22.98	0.27	0.25	0.83	0.33
CO48	Lubbock	TX	4.80	2.45	**71.80**	18.65	0.24	0.29	0.86	
Average			**4.49**	**3.68**	**58.87**	**30.85**	**0.29**	**0.23**	**0.85**	**0.29**

Analyses of Tocopherols

Sunflower oils are excellent sources of vitamin E (alpha tocopherol). The levels in crude NuSun oil ranged from 488-668 mg/kg or ppm which was within the wider range reported from around the world for sunflower oil and high-oleic sunflower oil (Table 5). The location and climate of the areas where oilseeds are grown has a significant effect on tocopherol levels. The wider ranges for tocopherols in sunflower oil and high-oleic sunflower oil are probably because of the diversity of growing locations.

Table 5. Range of Tocopherol Levels in Crude Sunflower Oil, NuSun Oil and High-oleic Sunflower Oil.

Tocopherols	**Sunflower (mg/kg)**	**NuSun Mid-Oleic Sunflower (mg/kg)**	**High-Oleic Sunflower (mg/kg)**
Alpha tocopherol	403-935	488-668	400-1090
Beta tocopherol	ND-45	19-52	10.0-35
Gamma tocopherol	ND-34	2.3-19.0	3.0-30
Delta tocopherol	ND-7	ND-1.6	ND-17
Alpha tocotrienol	ND	ND	ND
Gamma tocotrienol	ND	ND	ND
Delta tocotrienol	ND	ND	ND
Total	440-1520	509-741	450-1120

ND=not detectable

Analyses of Sterols

The levels of the phytosterols are of interest because of their properties for lowering cholesterol and inhibiting the deterioration of frying oils. The amounts of sterols in Table 6 showed that ranges for the sterols were within the ranges for sunflower oil and high-oleic sunflower oil. The data for NuSun oil also include results on the actual amounts of the various sterols expressed as mg/kg or ppm in addition to the data expressed as a percent of the total amount of sterols. The data for sunflower oil and high-oleic sunflower oil were collected when the amount of each sterol was required to be expressed only as a percent of the total sterols.

Table 6. Range of Sterol Levels in Crude Sunflower Oil, NuSun Oil, High-oleic Sunflower Oil.

Sterols	Sunflower	NuSun Mid-Oleic Sunflower Oil		High-Oleic Sunflower
	% of total	mg/kg	% of total	% of total
Cholesterol	ND-0.7	4.7-9.5	0.1-0.2	ND-0.5
Brassicasterol	ND-0.2	ND-4.8	ND-0.1	ND-0.3
Campesterol	6.5-13.0	428-449	9.1-9.6	5.0-13.0
Stigmasterol	6.0-13.0	423-440	9.0-9.3	4.5-13.0
Beta-sitosterol	50-70	2650-2790	56-58	42-70
Delta-5-avenasterol	ND-6.9	230-249	4.8-5.3	1.5-6.9
Delta-7-stigmasterol	6.5-24.0	360-382	7.7-7.9	6.5-24.0
Delta-7-avenasterol	3.0-7.5	201-214	4.3-4.4	ND-9.0
Others	ND-5.3	262-276	5.4-5.8	3.5-9.5
Total sterols (mg/kg)	2400-5000 mg/kg	4558-4815 mg/kg		2400-5000 mg/kg

ND=not detectable

Analyses of Chemical and Physical Characteristics

Finally, the physical and chemical characteristics can be important in trading of oilseeds. These properties of sunflower oils are presented in Table 7.

Table 7. Chemical and Physical Characteristics of Crude Sunflower Oil, NuSun Oil and High-oleic Sunflower Oil

Chemical and Physical Characteristics	Sunflower	NuSun Mid-Oleic Sunflower	High-Oleic Sunflower
Relative Density (x^{o}C/water at 20^{o}C)	0.918-0.923 (x=20^{o}C)	0.914	0.909-0.915 (x=25^{o}C)
Refractive Index (ND 40C)	1.461-1.468	1.461-1.471 at 25C	1.467-1.471 at 25^{o}C
Saponification Value (mg KOH/g oil)	188-194	190-191	182-194
Iodine Value (by calculation from fatty acid content)	118-141	94-122	78-90
Unsaponifiable matter (g/kg)	$\leq$15	$\leq$15	$\leq$15

The 18th session of the CCFO will meet in February, 2003, to continue the process of adding NuSun oil to the AStandard for Named Vegetable Oils@ based on the data presented in this paper. Although there are several more steps in the process to approve mid-oleic sunflower oil (presently at step 3 of 8 steps), the rest of the process is largely administrative.

Acknowledgments

The authors would like to thank all those who participated in the collection of the seed samples, analysis of the oils and in the processing of the data. This study will not only facilitate the Codex process but also be of value and interest to growers, processors and users of NuSun oil.