CODEX ALIMENTARIUS
INTERNATIONAL FOOD STANDARDS

Food and Agriculture Organization of the United Nations
World Health Organization

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STANDARD FOR NAMED VEGETABLE OILS

CXS 210-1999

Adopted in 1999. Revised in 2001, 2003, 2009, 2017, 2019.
Amended in 2005, 2011, 2013, 2015, 2019, 2021, 2022, 2023.

2022 Amendments

Following decisions taken at the Forty-fifth Session of the Codex Alimentarius Commission in December 2022, amendments were made in Table 1 and Table 2 with regard to the values of the provisions for fatty acid C18:1 and C18:2, relative density, refractive density and saponification in sunflowerseed oil.

2023 Amendments

Following decisions taken at the Forty-sixth Session of the Codex Alimentarius Commission in December 2023, amendments were made in Section 4 Food additives, Section 8 Methods of analysis and sampling and in the Appendix, Section 5 Methods of analysis and sampling.

2023 Corrigendum

On 1 February 2023, the value for fatty acid C16:1 for pistachio oil (Table 1, column 4, row 7) was corrected to read ND-2.0 (instead of ND-0.2) to align it with the decision of the Forty-second Session of the Codex Alimentarius Commission in July 2019.

1. SCOPE

This standard applies to the vegetable oils described in Section 2.1 presented in a state for human consumption.

2. DESCRIPTION

2.1 Product definitions

(Note: synonyms are in brackets immediately following the name of the oil)

Almond oil is derived from the kernel of almond fruit (*Amygdalus communis* L.).

Arachis oil (peanut oil; groundnut oil) is derived from groundnuts (seeds of *Arachis hypogaea* L.).

Babassu oil is derived from the kernel of the fruit of several varieties of the palm *Orbignya* spp.

Coconut oil is derived from the kernel of the coconut (*Cocos nucifera* L.).

Cotton seed oil is derived from the seeds of various cultivated species of *Gossypium* spp.

Flaxseed (Linseed) oil is derived from the seeds of various cultivated species of *Linum usitatissimum*

Grape seed oil is derived from the seeds of the grape (*Vitis vinifera* L.).

Hazelnut oil is derived from the kernel of hazelnut fruit (*Corylus avellana* L.).

Maize oil (corn oil) is derived from maize germ (the embryos of *Zea mays* L.).

Mustard seed oil is derived from the seeds of white mustard (*Sinapis alba* L. or *Brassica hirta Moench*), brown and yellow mustard (*Brassica juncea* (L.) Czernajew and Cossen) and of black mustard (*Brassica nigra* (L.) Koch).

Palm kernel oil is derived from the kernel of the fruit of the oil palm (*Elaeis guineensis*).

Palm kernel olein is the liquid fraction derived from fractionation of palm kernel oil (described above).

Palm kernel stearin is the solid fraction derived from fractionation of palm kernel oil (described above).

Palm oil is derived from the fleshy mesocarp of the fruit of the oil palm (*Elaeis guineensis*).

Palm oil with a higher content of oleic acid is derived from the fleshy mesocarp of hybrid palm fruit (OxG) (*Elaeis oleifera* x *Elaeis guineensis*)

Palm olein is the liquid fraction derived from the fractionation of palm oil (described above).

Palm stearin is the high-melting fraction derived from the fractionation of palm oil (described above).

Palm superolein is a liquid fraction derived from palm oil (described above) produced through a specially controlled crystallization process to achieve an iodine value of 60 or higher.

Pistachio oil is derived from the kernel of pistachio fruit (*Pistacia vera* L.).

Rapeseed oil (turnip rape oil; colza oil; ravison oil; sarson oil: toria oil) is produced from seeds of *Brassica napus* L., *Brassica rapa* L., *Brassica juncea* L. and *Brassica tournefortii* Gouan species.

Rapeseed oil – low-erucic acid (low-erucic acid turnip rape oil; low-erucic acid colza oil; canola oil) is produced from low-erucic acid oil-bearing seeds of varieties derived from the *Brassica napus* L., *Brassica rapa* L. and *Brassica juncea* L., species.

Rice bran oil (rice oil) is derived from the bran of rice (*Oryza sativa* L.).

Safflower seed oil (safflower oil; carthamus oil; kurdee oil) is derived from safflower seeds (seeds of *Carthamus tinctorious* L.).

Safflower seed oil – high-oleic acid (high-oleic acid safflower oil; high-oleic acid carthamus oil; high-oleic acid kurdee oil) is produced from high-oleic acid oil-bearing seeds of varieties derived from *Carthamus tinctorious* L.

Sesame seed oil (sesame oil; gingelly oil; benne oil; ben oil; till oil; tillie oil) is derived from sesame seeds (seeds of *Sesamum indicum* L.).

Soya bean oil (soybean oil) is derived from soya beans (seeds of *Glycine max* (L.) Merr.).

Sunflower seed oil (sunflower oil) is derived from sunflower seeds (seeds of *Helianthus annuus* L.).

Sunflower seed oil – high-oleic acid (high-oleic acid sunflower oil) is produced from high-oleic acid oil-bearing seeds of varieties derived from sunflower seeds (seeds of *Helianthus annuus* L.).

Sunflower seed oil – mid-oleic acid (mid-oleic acid sunflower oil) is produced from mid-oleic acid oil-bearing sunflower seeds (seeds of *Helianthus annuus* L.).

Walnut oil is derived from the kernel of walnut fruit (Juglans *regia* L.).

2.2 Other definitions

Edible vegetable oils are foodstuffs which are composed primarily of glycerides of fatty acids being obtained only from vegetable sources. They may contain small amounts of other lipids such as phosphatides, of unsaponifiable constituents, and of free fatty acids naturally present in the fat or oil.

Virgin oils are obtained, without altering the nature of the oil, by mechanical procedures, e.g. expelling or pressing, and the application of heat only. They may have been purified by washing with water, settling, filtering and centrifuging only.

Cold pressed oils are obtained, without altering the oil, by mechanical procedures only, e.g. expelling or pressing, without the application of heat. They may have been purified by washing with water, settling, filtering and centrifuging only.

3. ESSENTIAL COMPOSITION AND QUALITY FACTORS

3.1 Gas-liquid chromatography (GLC) ranges of fatty acid composition (expressed as percentages)

Samples falling within the appropriate ranges specified in Table 1 are in compliance with this standard. Supplementary criteria, for example national geographical and/or climatic variations, may be considered, as necessary, to confirm that a sample complies with the standard.

Low-erucic acid rapeseed oil must not contain more than 2 percent erucic acid (as percentage of total fatty acids).

High-oleic acid safflower oil must contain not less than 70 percent oleic acid (as percentage of total fatty acids).

High-oleic acid sunflower oil must contain not less than 75 percent oleic acid (as percentage of total fatty acids).

Palm oil with a higher content of oleic acid must contain not less than 48 percent oleic acid (as percentage of total fatty acids).

3.2 Slip point

Palm kernel olein	between 21 °C to 26 °C
Palm kernel stearin	between 31 °C to 34 °C
Palm olein	not more than 24 °C
Palm stearin	not less than 44 °C
Palm superolein	not more than 19.5 °C

4. FOOD ADDITIVES

Antifoaming agents, antioxidants and emulsifiers used in accordance with Table 1 and Table 2 of the *General Standard for Food Additives* (CXS 192-1995)[1] in food category 02.1.2 (vegetable oils and fats) are acceptable for use in foods conforming to this standard.

No food additives are permitted in virgin or cold pressed oils.

The flavourings used in products covered by this standard should comply with the *Guidelines for the Use of Flavourings* (CXG 66-2008)[2].

5. CONTAMINANTS

The products covered by this standard shall comply with the maximum levels of the *General Standard for Contaminants and Toxins in Food and Feed* (CXS 193-1995).[3]

The products covered by this standard shall comply with the maximum residue limits for pesticides established by the Codex Alimentarius Commission.

6. HYGIENE

It is recommended that the products covered by the provisions of this standard be prepared and handled in accordance with the appropriate sections of the *General Principles of Food Hygiene* (CXC 1-1969)[4] and other relevant Codex Alimentarius texts such as codes of hygienic practice and codes of practice.

The products should comply with any microbiological criteria established in accordance with the *Principles and Guidelines for the Establishment and Application of Microbiological Criteria Related to Foods* (CXG 21-1997).[5]

7. LABELLING

7.1 Name of the food

The product shall be labelled in accordance with the *General Standard for the Labelling of Pre-packaged Foods* (CXS 1-1985).[6] The name of the oil shall conform to the descriptions given in Section 2 of this standard.

Where more than one name is given for a product in Section 2.1, the labelling of that product must include one of those names acceptable in the country of use.

7.2 Labelling of non-retail containers

Information on the above labelling requirements shall be given either on the container or in accompanying documents, except that the name of the food, lot identification and the name and address of the manufacturer or packer shall appear on the container.

However, lot identification and the name and address of the manufacturer or packer may be replaced by an identification mark, provided that such a mark is clearly identifiable with the accompanying documents.

8. METHODS OF ANALYSIS AND SAMPLING

For checking the compliance with this standard, the methods of analysis and sampling contained in the *Recommended Methods of Analysis and Sampling* (CXS 234-1999)[7] relevant to the provisions in this standard, shall be used.

Table 1: Fatty acid composition of vegetable oils as determined by gas liquid chromatography from authentic samples[a, b] (expressed as percentage of total fatty acids) (see Section 3.1 of the standard)

Fatty acid	Arachis oil	Almond oil	Babassu oil	Coconut oil	Cotton seed oil	Flaxseed/ linseed oil	Grape seed oil	Hazelnut oil	Maize oil	Mustardseed oil
C6:0	ND	ND	ND	ND–0.7	ND	ND	ND	ND	ND	ND
C8:0	ND	ND	2.6–7.3	4.6–10.0	ND	ND	ND	ND	ND	ND
C10:0	ND	ND	1.2–7.6	5.0–8.0	ND	ND	ND	ND	ND	ND
C12:0	ND–0.1	ND	40.0–55.0	45.1–53.2	ND–0.2	ND–0.3	ND	ND	ND–0.3	ND
C14:0	ND–0.1	ND–0.1	11.0–27.0	16.8–21.0	0.6–1.0	ND–0.2	ND–0.3	ND–0.1	ND–0.3	ND–1.0
C16:0	5.0–14.0	4.0–9.0	5.2–11.0	7.5–10.2	21.4–26.4	4.0–11.3	5.5–11.0	4.2–8.9	8.6–16.5	0.5–4.5
C16:1	ND–0.2	0.2–0.8	ND	ND	ND–1.2	ND–0.5	ND–1.2	ND–0.5	ND–0.5	ND–0.5
C17:0	ND–0.1	ND–0.2	ND	ND	ND–0.1	ND–0.1	ND–0.2	ND–0.1	ND–0.1	ND
C17:1	ND–0.1	ND–0.2	ND	ND	ND–0.1	ND–0.1	ND–0.1	ND–0.1	ND–0.1	ND
C18:0	1.0–4.5	ND–3.0	1.8–7.4	2.0–4.0	2.1–3.3	2.0–8.0	3.0–6.5	0.8–3.2	ND–3.3	0.5–2.0
C18:1	35.0–80	62.0–76.0	9.0–20.0	5.0–10.0	14.7–21.7	9.8–36.0	12.0–28.0	74.2–86.7	20.0–42.2	8.0–23.0
C18:2	4.0–43.0	20.0–30.0	1.4–6.6	1.0–2.5	46.7–58.2	8.3–30.0	58.0–78.0	5.2–18.7	34.0–65.6	10.0–24.0
C18:3	ND–0.5	ND–0.5	ND	ND–0.2	ND–0.4	43.8–70.0	ND–1.0	ND–0.6	ND–2.0	6.0–18.0
C20:0	0.7–2.0	ND–0.5	ND	ND–0.2	0.2–0.5	ND–1.0	ND–1.0	ND–0.3	0.3–1.0	ND–1.5
C20:1	0.7–3.2	ND–0.3	ND	ND–0.2	ND–0.1	ND–1.2	ND–0.3	ND–0.3	0.2–0.6	5.0–13.0
C20:2	ND	ND	ND	ND	ND–0.1	ND	ND	ND	ND–0.1	ND–1.0
C22:0	1.5–4.5	ND–0.2	ND	ND	ND–0.6	ND–0.5	ND–0.5	ND–0.2	ND–0.5	0.2–2.5
C22:1	ND–0.6	ND–0.1	ND	ND	ND–0.3	ND–1.2	ND–0.3	ND–0.1	ND–0.3	22.0–50.0
C22:2	ND	ND	ND	ND	ND–0.1	ND	ND	ND	ND	ND–1.0
C24:0	0.5–2.5	ND–0.2	ND	ND	ND–0.1	ND–0.3	ND–0.4	ND	ND–0.5	ND–0.5
C24:1	ND–0.3	ND	ND	ND	ND	ND	ND	ND–0.3	ND	0.5–2.5

ND - non detectable, defined as ≤ 0.05%

[a] Data taken from species as listed in Section 2.

[b] The fatty acid values in this table apply to the vegetable oils described in Section 2.1 presented in a state for human consumption. However, in order to provide clarity in trade of crude oils, the values of the table may also be applied for the corresponding crude forms of the vegetable oils described in Section 2.1.

Table 1: Fatty acid composition of vegetable oils as determined by gas liquid chromatography from authentic samples[a, b] (expressed as percentage of total fatty acids) (see Section 3.1 of the standard) (continued)

Fatty acid	Palm oil	Palm oil with a higher oleic acid	Palm kernel oil	Palm olein[c]	Palm kernel olein[c]	Palm kernel stearin[c]	Palm stearin[c]	Palm superolein[c]	Pistachio oil	Rapeseed oil
C6:0	ND	ND	ND–0.8	ND	ND–0.7	ND–0.2	ND	ND	ND	ND
C8:0	ND	ND	2.4–6.2	ND	2.9–6.3	1.3–3.0	ND	ND	ND	ND
C10:0	ND	ND	2.6–5.0	ND	2.7–4.5	2.4–3.3	ND	ND	ND	ND
C12:0	ND–0.5	ND–0.6	45.0–55.0	0.1–0.5	39.7–47.0	52.0–59.7	0.1–0.5	0.1–0.5	ND	ND
C14:0	0.5–2.0	ND–0.8	14.0–18.0	0.5–1.5	11.5–15.5	20.0–25.0	1.0–2.0	0.5–1.5	ND–0.6	ND–0.2
C16:0	39.3–47.5	23.0–38.0	6.5–10.0	38.0–43.5	6.2–10.6	6.7–10.0	48.0–74.0	30.0–39.0	8.0–13.0	1.5–6.0
C16:1	ND–0.6	ND–0.8	ND–0.2	ND–0.6	ND–0.1	ND	ND–0.2	ND–0.5	ND–0.2	ND–3.0
C17:0	ND–0.2	ND–0.2	ND	ND–0.2	ND	ND	ND–0.2	ND–0.1	ND–0.1	ND–0.1
C17:1	ND	ND	ND	ND–0.1	ND	ND	ND–0.1	ND	ND–0.1	ND–0.1
C18:0	3.5– 6.0	1.5–4.5	1.0–3.0	3.5–5.0	1.7–3.0	1.0–3.0	3.9–6.0	2.8–4.5	0.5–3.5	0.5–3.1
C18:1	36.0–44.0	48.0–60.0	12.0–19.0	39.8–46.0	14.4–24.6	4.1–8.0	15.5–36.0	43.0–49.5	50.0–70.0	8.0–60.0
C18:2	9.0–12.0	9.0–17.0	1.0–3.5	10.0–13.5	2.4–4.3	0.5–1.5	3.0–10.0	10.5–15.0	8.0–34.0	11.0–23.0
C18:3	ND–0.5	ND–0.6	ND–0.2	ND–0.6	ND–0.3	ND–0.1	ND–0.5	0.2–1.0	0.1–1.0	5.0–13.0
C20:0	ND–1.0	ND–0.4	ND–0.2	ND–0.6	ND–0.5	ND–0.5	ND–1.0	ND–0.4	ND–0.3	ND–3.0
C20:1	ND–0.4	ND–0.2	ND–0.2	ND–0.4	ND–0.2	ND–0.1	ND–0.4	ND–0.2	ND–0.6	3.0–15.0
C20:2	ND	ND–0.5	ND	ND	ND	ND	ND	ND	ND	ND–1.0
C22:0	ND–0.2	ND–0.3	ND–0.2	ND–0.2	ND	ND	ND–0.2	ND–0.2	ND	ND–2.0
C22:1	ND	ND	ND	ND	ND	ND	ND	ND	ND	>2.0–60.0
C22:2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND–2.0
C24:0	ND	ND–0.2	ND	ND	ND	ND	ND	ND	ND	ND–2.0
C24:1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND–3.0

ND – non detectable, defined as ≤ 0.05%

[c] Fractionated product from palm oil.

Table 1: Fatty acid composition of vegetable oils as determined by gas liquid chromatography from authentic samples[a, b] (expressed as percentage of total fatty acids) (see Section 3.1 of the standard) (continued)

Fatty acid	Rapeseed oil (low-erucic acid)	Rice bran oil	Safflower seed oil	Safflower seed oil (high-oleic acid	Sesame seed oil	Soyabean oil	Sunflower seed oil	Sunflower seed oil (high- oleic acid)	Sunflower seed oil (mid-oleic acid)	Walnut oil
C6:0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
C8:0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
C10:0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
C12:0	ND	ND–0.2	ND	ND–0.2	ND	ND–0.1	ND–0.1	ND	ND	ND
C14:0	ND–0.2	ND–1.0	ND–0.2	ND–0.2	ND–0.1	ND–0.2	ND–0.2	ND–0.1	ND–1	ND
C16:0	2.5–7.0	14–23	5.3–8.0	3.6–6.0	7.9–12.0	8.0–13.5	5.0–7.6	2.6–5.0	4.0–5.5	6.0–8.0
C16:1	ND–0.6	ND–0.5	ND–0.2	ND–0.2	ND– 0.2	ND–0.2	ND–0.3	ND–0.1	ND–0.05	ND–0.4
C17:0	ND–0.3	ND	ND–0.1	ND–0.1	ND–0.2	ND–0.1	ND–0.2	ND–0.1	ND–0.05	ND–0.1
C17:1	ND–0.3	ND	ND–0.1	ND–0.1	ND–0.1	ND–0.1	ND–0.1	ND–0.1	ND–0.06	ND–0.1
C18:0	0.8–3.0	0.9–4.0	1.9–2.9	1.5–2.4	4.5–6.7	2.0–5.4	2.7–6.5	2.9–6.2	2.1–5.0	1.0–3.0
C18:1	51.0–70.0	38–48	8.4–21.3	70.0–83.7	34.4–45.5	17–30	14.0–43.0	75–90.7	43.1–71.8	14.0–23.0
C18:2	15.0–30.0	21–42	67.8–83.2	9.0–19.9	36.9–47.9	48.0 –59.0	45.4–74.0	2.1–17	18.7–45.3	54.0–65.0
C18:3	5.0–14.0	0.1–2.9	ND–0.1	ND–1.2	0.2–1.0	4.5–11.0	ND–0.3	ND–0.3	ND–0.5	9.0–15.4
C20:0	0.2–1.2	ND–0.9	0.2–0.4	0.3–0.6	0.3–0.7	0.1–0.6	0.1–0.5	0.2–0.5	0.2–0.4	ND–0.3
C20:1	0.1–4.3	ND–0.8	0.1–0.3	0.1–0.5	ND–0.3	ND–0.5	ND–0.3	0.1–0.5	0.2–0.3	ND–0.3
C20:2	ND–0.1	ND	ND	ND	ND	ND–0.1	ND	ND	ND	ND
C22:0	ND–0.6	ND–1.0	ND–1.0	ND–0.4	NN–1.1	ND–0.7	0.3–1.5	0.5–1.6	0.6–1.1	ND–0.2
C22:1	ND–2.0	ND	ND–1.8	ND–0.3	ND	ND–0.3	ND–0.3	ND–0.3	ND	ND
C22:2	ND–0.1	ND	ND	ND	ND	ND	ND–0.3	ND	ND–0.09	ND
C24:0	ND–0.3	ND–0.9	ND–0.2	ND–0.3	ND–0.3	ND–0.5	ND–0.5	ND–0.5	0.3–0.4	ND
C24:1	ND–0.4	ND	ND–0.2	ND–0.3	ND	ND	ND	ND	ND	ND

ND – non detectable, defined as ≤ 0.05%

APPENDIX

OTHER QUALITY AND COMPOSITION FACTORS

These quality and composition factors are supplementary information to the essential composition and quality factors of the standard. A product, which meets the essential quality and composition factors but does not meet these supplementary factors, may still conform to the standard.

1. QUALITY CHARACTERISTICS

The **colour, odour and taste** of each product shall be characteristic of the designated product. It shall be free from foreign and rancid odour and taste.

	Maximum level
Matter volatile at 105 °C	0.2% m/m
Insoluble impurities	0.05% m/m
Soap content	0.005% m/m
Iron (Fe):	
Refined oils	1.5 mg/kg
Virgin oils	5.0 mg/kg
Crude palm kernel olein	5.0 mg/kg
Crude palm kernel stearin	7.0 mg/kg
Copper (Cu)	
Refined oils	0.1 mg/kg
Virgin oils	0.4 mg/kg
Acid value	
Refined oils	0.6 mg KOH/g oil
Cold pressed and virgin oils (except crude palm kernel oil and virgin palm oil)	4.0 mg KOH/g oil
Free fatty acid	
Virgin palm oil	5.0% (as palmitic acid)
Crude palm kernel oil	4.0% (as lauric acid)
Refined rice bran oil	0.3% (as oleic acid)
Peroxide value	
Refined oils	up to 10 milliequivalents of active oxygen/kg oil
Cold pressed and virgin oils	up to 15 milliequivalents of active oxygen/kg oil

2. COMPOSITION CHARACTERISTICS

The **arachidic and higher fatty acid content** of arachis oil should not exceed 48 g/kg.

The **Reichert values** for coconut, palm kernel and babassu oils should be in the ranges 6–8.5, 4–7 and 4.5–6.5, respectively.

The **Polenske values** for coconut, palm kernel and babassu oils should be in the ranges 13–18, 8–12 and 8–10, respectively.

The **Halphen test** for cotton seed oil should be positive.

The **erythrodiol content** of grapeseed oil should be more than 2 percent of the total sterols.

The **total carotenoids** (as beta-carotene) for unbleached palm oil, unbleached palm olein and unbleached palm stearin should be in the range 500–2000, 550–2500 and 300–1500 mg/kg, respectively.

The **Crismer value** for low-erucic acid rapeseed oil should be in the range 67–70.

The **concentration of brassicasterol** in low-erucic acid rapeseed oil should be greater than 5 percent of total sterols.

The **Baudouin test** should be positive for sesame seed oil.

The **gamma oryzanols** in crude rice bran oil should be in the range of 0.9–2.1 percent.

3. CHEMICAL AND PHYSICAL CHARACTERISTICS

Chemical and physical characteristics are given in Table 2.

4. IDENTITY CHARACTERISTICS

Levels of desmethylsterols in vegetable oils as a percentage of total sterols are given in Table 3.

Levels of tocopherols and tocotrienols in vegetable oils are given in Table 4.

5. METHODS OF ANALYSIS AND SAMPLING

For checking the compliance with this standard, the methods of analysis and sampling contained in the *Recommended Methods of Analysis and Sampling* (CXS 234-1999)[7] relevant to the provisions in this standard, shall be used.

Determination of gamma oryzanol content

Definition

This method is used to determine gamma oryzanol content (percentage) in oils from spectrophotometer absorption measurements at the wavelength of maximum absorption near 315 nm.

Scope

Applicable to crude rice bran oil.

Apparatus

- Spectrophotometer – for measuring extinction in the ultraviolet between 310 and 320 nm.
- Rectangular quartz cuvettes – having an optical light path of 1 cm.
- Volumetric flask – 25 ml.
- Filter paper – Whatman no.2, or equivalent.

Reagents

- n-Heptane – Spectrophotometrically pure.

Procedure

(i) Before using, the spectrophotometer should be properly adjusted to a zero-reading filling both the sample cuvette and the reference cuvette with n-Heptane.

(ii) Filter the oil sample through filter paper at ambient temperature.

(iii) Weigh accurately approximately 0.02 g of the sample so prepared into a 25 ml volumetric flask, make up to the mark with n-Heptane.

(iv) Fill a cuvette with the solution obtained and measure the extinction at the wavelength of maximum absorption near 315 m, using the same solvent as a reference.

(v) The extinction values recorded must lie within the range 0.3–0.6. If not, the measurements must be repeated using more concentrated or more diluted solutions as appropriate.

Calculation

Calculate gamma oryzanol content as follows:

$$\text{Gamma oryzanol content, \%} = 25 \times (1 / W) \times A \times (1 / E)$$

Where W = mass of sample, g

A = extinction (absorbance) of the solution

E = specific extinction $E^{1\%}_{1cm} = 359$

Table 2: Chemical and physical characteristics of crude vegetable oils (see Appendix of the standard)

	Arachis oil	Almond oil	Babassu oil	Coconut oil	Cotton seed oil	Flaxseed/ linseed oil	Grape seed oil	Hazelnut oil	Maize oil	Mustard seed oil
Relative density (x ºC/water at 20 ºC)	0.909–0.920 x=20ºC	0.911–0929 x=25ºC	0.914–0.917 x=25ºC	0.908–0.921 x=40ºC	0.918–0.926 x=20ºC	0.925–0.935 x=25ºC /water 25ºC;	0.920–0.926 x=20ºC	0.898–0.915 x=20˚C /water 20˚C	0.917–0.925 x=20ºC	0.910–0.921 x=20ºC
Apparent density (g/ml)										
Refractive index (ND 40 ºC)	1.460–1.465	1.468–1.475 at 20ºC	1.448–1.451	1.448–1.450	1.458–1.466	1.472–1.487 at 20˚C 1.472–1.475 at 40 ˚C	1.467–1.477	1.468–1.473 at 20˚C; 1.456–1.463 at 40˚C	1.465–1.468	1.461–1.469
Saponification value (mg KOH/g oil)	187–196	183–207	245–256	248–265	189–198	185–197	188–194	188–198	187–195	168–184
Iodine value	77–107	85–109	10–18	6.3–10.6	100–123	170–211	128–150	81–95	103–135	92–125
Unsaponifiable matter (g/kg)	≤ 10	≤20	≤ 12	≤ 15	≤ 15	≤20	≤ 20	≤15	≤ 28	≤ 15
Stable carbon isotope ratio *									–13.71 to –16.36	

* See the following publications:

Woodbury SP, Evershed RP and Rossell JB (1998). Purity assessments of major vegetable oils based on gamma 13C values of individual fatty acids. *JAOCS*, 75 (3), 371–379.
Woodbury SP, Evershed RP and Rossell JB (1998). Gamma 13C analysis of vegetable oil, fatty acid components, determined by gas chromatography-combustion-isotope ratio mass spectrometry, after saponification or regiospecific hydrolysis. *Journal of Chromatography* A, 805, 249–257.
Woodbury SP, Evershed RP, Rossell JB, Griffith R and Farnell P (1995). Detection of vegetable oil adulteration using gas chromatography combustion/isotope ratio mass spectrometry. *Analytical Chemistry,* 67 (15), 2685–2690.
Ministry of Agriculture, Fisheries and Food (1996). Authenticity of single seed vegetable oils. Working Party on Food Authenticity, MAFF, UK.

Table 2: Chemical and physical characteristics of crude vegetable oils (see Appendix of the standard) (continued)

	Palm oil	Palm oil with a higher oleic acid	Palm kernel oil	Palm kernel olein[c]	Palm kernel stearin[c]	Palm olein[c]	Palm stearin[c]	Palm super olein[c]	Pistachio oil	Rapeseed oil
Relative density (x ºC/water at 20 ºC)	0.891–0.899 x=50ºC	0.896–0.910 x=50ºC	0.899–0.914 x=40ºC	0.906–0.909 x=40ºC	0.902–0.908 x=40ºC	0.899–0.920 x=40ºC	0.881–0.891 x=60ºC	0.900–0.925 x=40ºC	0.915–0.920 15.5˚C/water 15.5˚C	0.910–0.920 x=20ºC
Apparent density (g/ml)	0.889–0.895 (50ºC)	ND		0.904–0.907	0.904–0.906	0.896–0.898 at 40ºC	0.881–0.885 at 60ºC	0.886–0.900 at 40 ºC		
Refractive index (ND 40 ºC)	1.454– 1.456 at 50ºC	1.459–1.462	1.448–1.452	1.451–1.453	1.449–1.451	1.458–1.460	1.447–1.452 at 60ºC	1.459–1.460	1.467–1.470 at 25˚C; 1.460–1.466 at 40˚C	1.465–1.469
Saponification value (mg KOH/g oil)	190–209	189–199	230–254	231–244	244–255	194–202	193–205	180–205	187–196	168–181
Iodine value	50.0–55.0	58–75	14.1–21.0	20–28	4–8.5	≥ 56	≤ 48	≥ 60	84–98	94–120
Unsaponifiable matter (g/kg)	≤ 12	≤12	≤ 10	<15	<15	≤ 13	≤ 9	≤ 13	≤30	≤ 20
Stable carbon isotope ratio *										

* See the following publications:

Woodbury SP, Evershed RP and Rossell JB (1998). Purity assessments of major vegetable oils based on gamma 13C values of individual fatty acids. *JAOCS*, 75 (3), 371–379.
Woodbury SP, Evershed RP and Rossell JB (1998). Gamma 13C analysis of vegetable oil, fatty acid components, determined by gas chromatography-combustion-isotope ratio mass spectrometry, after saponification or regiospecific hydrolysis. *Journal of Chromatography* A, 805, 249–257.
Woodbury SP, Evershed RP, Rossell JB, Griffith R and Farnell P (1995). Detection of vegetable oil adulteration using gas chromatography combustion/isotope ratio mass spectrometry. *Analytical Chemistry,* 67 (15), 2685–2690.
Ministry of Agriculture, Fisheries and Food (1996). Authenticity of single seed vegetable oils. Working Party on Food Authenticity, MAFF, UK.

Table 2: Chemical and physical characteristics of crude vegetable oils (see Appendix of the standard) (continued)

	Rapeseed oil (low-erucic acid)	Rice bran oil	Safflower seed oil	Safflower seed oil (high- oleic acid)	Sesame seed oil	Soyabean oil	Sunflower seed oil	Sunflower seed oil (high- oleic acid)	Sunflower seed oil (mid-oleic acid)	Walnut oil
Relative density (x ºC/water at 20 ºC)	0.914–0.920 x=20 ºC	0.910–0.929	0.922–0.927 x=20 ºC	0.913–0.919 x=20 ºC; 0.910–0.916 x=25 ºC	0.915– 0.924 x=20 ºC	0.919–0.925 x=20 ºC	0.916–0.923 x=20 ºC	0.909–0.915 x=25 ºC	0.914–0.916 x=20 ºC	0.923–0.925 25˚C/water 25 ˚C
Apparent density (g/ml)				0.912–0.914 at 20 °C						
Refractive index (ND 40 ºC)	1.465–1.467	1.46– 1.473	1.467–1.470	1.460–1.464 at 40 ºC; 1.466–1.470 at 25 ºC	1.465–1.469	1.466–1.470	1.461– 1.475	1.467– 1.471 at 25 ºC	1.461– 1.471 at 25 ºC	1.472–1.475 at 25 ˚C; 1.469–1.471 at 40 ˚C
Saponification value (mg KOH/g oil)	182–193	180– 199	186–198	186–194	186–195	189–195	187–194	182–194	190–191	189–198
Iodine value	105–126	90–115	136–148	80–100	104–120	124–139	118–141	78–90	94–122	132–162
Unsaponifiable matter (g/kg)	≤ 20	≤ 65	≤ 15	≤ 10	≤ 20	≤ 15	≤ 15	≤ 15	≤ 15	≤ 20
Stable carbon isotope ratio *										

* See the following publications:

Woodbury SP, Evershed RP and Rossell JB (1998). Purity assessments of major vegetable oils based on gamma 13C values of individual fatty acids. *JAOCS*, 75 (3), 371–379.
Woodbury SP, Evershed RP and Rossell JB (1998). Gamma 13C analysis of vegetable oil, fatty acid components, determined by gas chromatography-combustion-isotope ratio mass spectrometry, after saponification or regiospecific hydrolysis. *Journal of Chromatography* A, 805, 249–257.
Woodbury SP, Evershed RP, Rossell JB, Griffith R and Farnell P (1995). Detection of vegetable oil adulteration using gas chromatography combustion/isotope ratio mass spectrometry. *Analytical Chemistry,* 67 (15), 2685–2690.
Ministry of Agriculture, Fisheries and Food (1996). Authenticity of single seed vegetable oils. Working Party on Food Authenticity, MAFF, UK.

Table 3: Levels of desmethylsterols in crude vegetable oils from authentic samples[a,c] as a percentage of total sterols (see Appendix of the standard)

	Arachis oil	Almond oil	Babassu oil	Coconut oil	Cotton seed oil	Flaxseed/linseed oil	Grapeseed oil	Hazelnut oil	Maize oil	Palm oil
Cholesterol	ND–3.8	ND–1.0	1.2–1.7	ND–3.0	0.7–2.3	ND	ND–0.5	ND–1.1	0.2–0.6	2.6–6.7
Brassicasterol	ND–0.2	ND–0.3	ND–0.3	ND–0.3	0.1–0.3	ND–1.0	ND–0.2	ND	ND–0.2	ND
Campesterol	12.0–19.8	2.0–5.0	17.7–18.7	6.0–11.2	6.4–14.5	25.0– 31.0	7.5–14.0	3.0–6.2	16.0–24.1	18.7–27.5
Stigmasterol	5.4–13.2	0.4–4.0	8.7–9.2	11.4–15.6	2.1–6.8	7.0–9.0	7.5–12.0	ND–2.0	4.3–8.0	8.5–13.9
Beta-sitosterol	47.4–69.0	73.0–86.0	48.2–53.9	32.6–50.7	76.0–87.1	45.0–53.0	64.0–70.0	76.45–96.0	54.8–66.6	50.2–62.1
Delta-5-avenasterol	5.0–18.8	5.0–14.0	16.9–20.4	20.0–40.7	1.8–7.3	8.0–12.0	1.0–3.5	1.0–5.1	1.5–8.2	ND–2.8
Delta-7-stigmastenol	ND–5.1	ND–3.0	ND	ND–3.0	ND–1.4	ND	0.5–3.5	ND–4.3	0.2–4.2	0.2–2.4
Delta-7-avenasterol	ND–5.5	ND–3.0	0.4–1.0	ND–3.0	0.8–3.3	ND	0.5–1.5	ND–1.6	0.3–2.7	ND–5.1
Others	ND–1.4	ND–6.0	ND	ND–3.6	ND–1.5	ND	ND–5.1	ND	ND–2.4	ND
Total sterols (mg/kg)	900–2900	1590– 4590	500–800	400–1200	2700–6400	2300 – 6900	2000–7000	1200 – 1800	7000–22100	300–700

ND - Non-detectable, defined as ≤ 0.05%

Table 3: Levels of desmethylsterols in crude vegetable oils from authentic samples[a,c] as a percentage of total sterols (see Appendix of the standard) (continued)

	Palm oil with a higher oleic acid	Palm olein[c]	Palm kernel oil	Palm kernel olein[c]	Palm kernel stearin[c]	Palm stearin[c]	Palm superolein[c]	Pistachio oil	Rapeseed oil (low-erucic acid)	Rice bran oil
Cholesterol	1.7–4.7	2.6–7.0	0.6–3.7	1.5–1.9	1.4–1.7	2.5–5.0	2.0–3.5	ND–1.0	ND–1.3	ND– 0.5
Brassicasterol	ND–0.4	ND	ND–0.8	ND–0.2	ND–2.2	ND	ND	ND	5.0–13.0	ND–0.3
Campesterol	16.6–21.9	12.5–39.0	8.4–12.7	7.9–9.1	8.2–9.7	15.0–26.0	22.0–26.0	4.0–6.5	24.7–38.6	11.0– 35.0
Stigmasterol	11.2–15.5	7.0–18.9	12.0–16.6	13.4–14.7	14.1–15.0	9.0–15.0	18.2–20.0	0.5–7.5	0.2–1.0	6.0– 40.0
Beta-sitosterol	57.2–67.0	45.0–71.0	62.6–73.1	67.1–69.2	67.0–70.0	50.0–60.0	55.0–70.0	75.0–94.0	45.1–57.9	25.0–67.0
Delta-5-avenasterol	ND–1.9	ND–3.0	1.4–9.0	3.3–4.6	3.3–4.1	ND–3.0	0–1.0	6.0–8.0	2.5–6.6	ND– 9.9
Delta-7-stigmastenol	ND–0.2	ND–3.0	ND–2.1	ND–0.6	ND–0.3	ND–3.0	0–0.3	ND–0.7	ND–1.3	ND–14.1
Delta-7-avenasterol	ND–1.0	ND–6.0	ND–1.4	ND–0.5	ND–0.3	ND–3.0	0–0.3	ND–0.5	ND–0.8	ND – 4.4
Others	ND–3.8	ND–10.4	ND–2.7	2.9–3.7	1.0–3.0	ND–5.0	0–2.0	ND	ND–4.2	7.5–12.8
Total sterols (mg/kg)	519–1723	270–800	700–1400	816–1339	775–1086	250–500	100	1840–4500	4500–11300	10500–31000

ND - Non-detectable, defined as ≤ 0.05%

Table 3: Levels of desmethylsterols in crude vegetable oils from authentic samples[a,c] as a percentage of total sterols (see Appendix of the standard) (continued)

	Safflower seed oil	Safflower seed oil (high-oleic acid)	Sesame seed oil	Soyabean oil	Sunflower seed oil	Sunflower seed oil (high-oleic acid)	Sunflower seed oil (mid-oleic acid)	Walnut oil
Cholesterol	ND– 0.7	ND–0.5	0.1–0.5	0.2–1.4	ND–0.7	ND–0.5	0.1–0.2	ND
Brassicasterol	ND–0.4	ND–2.2	0.1–0.2	ND–0.3	ND–0.2	ND–0.3	ND–0.1	ND
Campesterol	9.2–13.3	8.9–19.9	10.1–20.0	15.8–24.2	6.5–13.0	5.0–13.0	9.1–9.6	4.0–6.5
Stigmasterol	4.5–9.6	2.9–8.9	3.4–12.0	14.9–19.1	6.0–13.0	4.5–13.0	9.0–9.3	ND
Beta-sitosterol	40.2–50.6	40.1–66.9	57.7–61.9	47.0–60	50–70	42.0–70	56–58	70.0–92.0
Delta-5-avenasterol	0.8–4.8	0.2–8.9	6.2–7.8	1.5–3.7	ND–6.9	1.5–6.9	4.8–5.3	0.5–6.0
Delta-7-stigmastenol	13.7–24.6	3.4–16.4	0.5–7.6	1.4–5.2	6.5–24.0	6.5–24.0	7.7–7.9	ND–3.0
Delta-7-avenasterol	2.2–6.3	ND–8.3	1.2–5.6	1.0–4.6	3.0–7.5	ND–9.0	4.3–4.4	ND–2.0
Others	0.5–6.4	4.4–11.9	0.7–9.2	ND–1.8	ND–5.3	3.5–9.5	5.4–5.8	ND
Total sterols (mg/kg)	2100–4600	2000–4100	4500–19000	1800–4500	2400–5000	1700–5200		500– 1760

ND - Non-detectable, defined as ≤ 0.05%

Table 4: Levels of tocopherols and tocotrienols in crude vegetable oils from authentic samples[a, b] (mg/kg) (see Appendix of the standard)

	Arachis oil	Almond oil	Babassu oil	Coconut oil	Cottonseed oil	Flaxseed/lin seed oil	Grape seed oil	Hazelnut oil	Maize oil	Palm oil
Alpha-tocopherol	49–373	20–545	ND	ND–17	136–674	2–265	16–38	100– 420	23–573	4–193
Beta-tocopherol	ND–41	ND–10	ND	ND–11	ND–29	ND	ND–89	6–12	ND–356	ND–234
Gamma-tocopherol	88–389	ND–104	ND	ND–14	138–746	100–712	ND–73	18–194	268–2468	ND–526
Delta-tocopherol	ND–22	ND–5	ND	ND	ND–21	ND–14	ND–4	ND–10	23–75	ND–123
Alpha-tocotrienol	ND	ND	25–46	ND–44	ND	ND	18–107	ND	ND–239	4–336
Gamma-tocotrienol	ND	ND	32–80	ND–1	ND	ND	115–205	ND	ND–450	14–710
Delta-tocotrienol	ND	ND	9–10	ND	ND	ND	ND–3.2	ND	ND–20	ND–377
Total (mg/kg)	170–1300	20–600	60–130	ND–50	380–1200	150–905	240–410	200– 600	330–3720	150–1500

Table 4: Levels of tocopherols and tocotrienols in crude vegetable oils from authentic samples[a, b] (mg/kg) (see Appendix of the standard) (continued)

	Palm oil with a higher oleic acid	Palm olein[c]	Palm kernel oil	Palm kernel olein[c]	Palm kernel stearin[c]	Palm stearin[c]	Palm superolein[c]	Pistachio oil	Rapeseed oil (low-erucic acid)	Rice bran oil
Alpha-tocopherol	49–188	30–280	ND–44	ND–11	ND–10	ND–100	130–240	10–330	100–386	49–583
Beta-tocopherol	ND	ND–250	ND–248	ND–6	ND–2	ND–50	ND–40	ND	ND–140	ND – 47
Gamma-tocopherol	4–138	ND–100	ND–257	ND–3	ND–1	ND–50	ND–40	0–100	189–753	ND–212
Delta-tocopherol	ND–31	ND–100	ND	ND–4	ND	ND–50	ND–30	ND–50	ND–22	ND–31
Alpha-tocotrienol	74–256	50–500	ND	ND–70	ND–73	20–150	170–300	ND	ND	ND–627
Gamma-tocotrienol	406–887	20–700	ND–60	1–10	ND–8	10–500	230–420	ND	ND	142–790
Delta-tocotrienol	33–86	40–120	ND	ND–2	ND–1	5–150	60–120	ND	ND	ND – 59
Total (mg/kg)	562–1417	300–1800	ND–260	ND–90	ND–89	100–700	400–1400	100–600	430–2680	191–2349

Table 4: Levels of tocopherols and tocotrienols in crude vegetable oils from authentic samples[a, b] (mg/kg) (see Appendix of the standard) (continued)

	Safflower seed oil	Safflower seed oil (high-oleic acid)	Sesame seed oil	Soyabean oil	Sunflower seed oil	Sunflower seed oil (high-oleic acid)	Sunflower seed oil (mid-oleic acid)	Walnut oil
Alpha-tocopherol	234–660	234–660	ND–3.3	9–352	403–935	400–1090	488–668	ND–170
Beta-tocopherol	ND–17	ND–13	ND	ND–36	ND–45	10–35	19–52	ND–110
Gamma-tocopherol	ND–12	ND–44	521–983	89–2307	ND–34	3–30	2.3–19.0	120–400
Delta-tocopherol	ND	ND–6	4–21	154–932	ND–7.0	ND–17	ND–1.6	ND–60
Alpha-tocotrienol	ND	ND	ND	ND–69	ND	ND	ND	ND
Gamma-tocotrienol	ND–12	ND–10	ND–20	ND–103	ND	ND	ND	ND
Delta-tocotrienol	ND	ND	ND	ND	ND	ND	ND	ND
Total (mg/kg)	240–670	250–700	330–1010	600–3370	440–1520	450–1120	509–741	309–455

ND - Non-detectable.

Note: Maize oil also contains ND–52 mg/kg beta tocotrienol.

NOTES

[1] FAO and WHO. 1995. *General Standard for Food Additives.* Codex Alimentarius Standard, No. CXS 192-1995. Codex Alimentarius Commission. Rome.

[2] FAO and WHO. 2008. *Guidelines for the Use of Flavourings.* Codex Alimentarius Guideline, No. CXG 66-2008. Codex Alimentarius Commission. Rome.

[3] FAO and WHO. 1995. *General Standard for Contaminants and Toxins in Food and Feed.* Codex Alimentarius Standard, No. CXS 193-1995. Codex Alimentarius Commission. Rome.

[4] FAO and WHO. 1969. *General Principles of Food Hygiene.* Codex Alimentarius Code of Practice, No. CXC 1-1969. Codex Alimentarius Commission. Rome.

[5] FAO and WHO. 1997. *Principles and Guidelines for the Establishment and Application of Microbiological Criteria Related to Foods*. Codex Alimentarius Guideline, No. CXG 21-1997. Codex Alimentarius Commission. Rome.

[6] FAO and WHO. 1985. *General Standard for the Labelling of Pre-packaged Foods.* Codex Alimentarius Standard, No. CXS 1-1985. Codex Alimentarius Commission. Rome.

[7] FAO and WHO. 1999. *Recommended Methods of Analysis and Sampling.* Codex Alimentarius Standard, No. CXS 234-1999. Codex Alimentarius Commission. Rome.