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Lycopene (synthetic)

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Lycopene (synthetic)

Specifications revised at the 96th JECFA (2023) and published in FAO JECFA Monographs 31 (2023) superseding specifications prepared at the 67th JECFA (2006). A group ADI “not specified” for lycopene from all sources was established at the 71st JECFA (2009).

SYNONYMS

INS 160d(i)

DEFINITION

Synthetic lycopene is produced by the Wittig condensation of synthetic intermediates commonly used in the production of other carotenoids used in food. Synthetic lycopene consists predominantly of all-trans-lycopene together with 5-cis-lycopene and minor quantities of other isomers. Commercial lycopene preparations intended for use in food are formulated as suspensions in edible oils or water-dispersible powders and are stabilised with antioxidants.

Chemical names

Ψ,Ψ-carotene
all-trans-lycopene (all-E)-lycopene
(all-E)-2,6,10,14,19,23,27,31-octamethyl-
2,6,8,10,12,14,16,18,20,22,24,26,30-dotriacontatridecaene

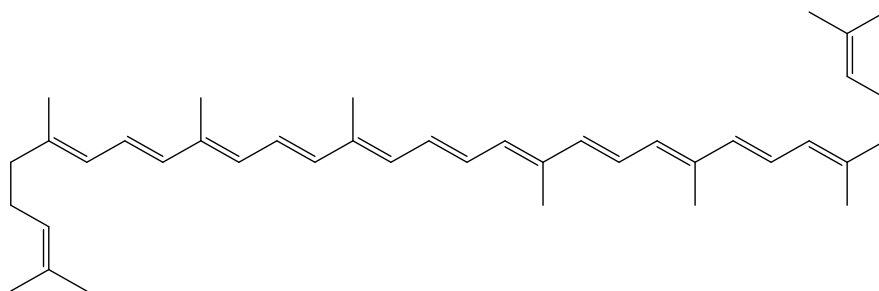
C.A.S. number

502-65-8

Chemical formula

C₄₀H₅₆

Structural formula



Formula weight

536.9

Assay

Not less than 96% total lycopenes; not less than 70% all-*trans*-lycopene

DESCRIPTION

Red crystalline powder

FUNCTIONAL USES

Colour, nutrient supplement

CHARACTERISTICS

IDENTIFICATION

<u>Solubility</u> (Vol. 4)	Insoluble in water, sparingly soluble in tetrahydrofuran (THF)
<u>Test for carotenoids</u>	The colour of the solution of the sample in acetone disappears after successive additions of a 5% solution of sodium nitrite and 1 N sulfuric acid
<u>Solution in THF</u>	A 1% solution is clear and has intensive red-orange colour
<u>Spectrophotometry</u> (Vol. 4)	A solution in hexane shows an absorption maximum at approximately 470 nm

PURITY

<u>Loss on drying</u> (Vol. 4)	Not more than 0.5% (40 °C, 4 h at 10 mm Hg)
<u>Lead</u> (Vol. 4)	Not more than 1 mg/kg Determine using an AAS/ICP-AES technique appropriate to the specified level. The selection of sample size and method of sample preparation may be based on principles of methods described in Volume 4 (under "General Methods, Metallic Impurities").
<u>Apo-12'-lycopenal</u>	Not more than 0.15% See description under TESTS
<u>Triphenyl phosphine oxide (TPPO)</u> (Vol. 4)	Not more than 0.01%

TESTS

PURITY TESTS

<u>Apo-12'-lycopenal</u>	Determine by HPLC using the following conditions: <u>Reagents</u> (Note: all solvents should be HPLC-grade) Hexane Triethylamine (TEA) Tetrahydrofuran (THF) Toluene stabilised with BHT (0.5 g BHT in 1000 ml toluene) Apo-12'-lycopenal (also known as lycopene C ₂₅ -aldehyde) standard (available from DSM Nutritional Products) <u>Apparatus</u> HPLC system with a suitable pump, injector, and integrator Column: Stainless steel (200x4.0 mm) Stationary phase: Nucleosil Si 100 3 µm (Macherey-Nagel or equivalent)
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Detector: UV-Vis

HPLC conditions

Flow: 2.0
ml/min
Injection volume: 5.0 µl
Pressure: approx. 135 bar
Detection: 435
nm
Mobile phase: A – Hexane
B – Hexane: TEA (99.9:0.1) (v/v)
C – Hexane: THF (80:20) (v/v)

Gradient

Time, min	A%	B%	C%
0	80	20	0
16	60	20	20
22	40	20	40
24.5	80	20	0

Run time

Approximately 25 min.

Standard solution

Accurately weigh between 14.5 and 15.5 mg of the *apo*-12'-lycopenal standard into a 50-ml volumetric flask. Dissolve in toluene stabilised with BHT and make up to volume. Transfer 2 ml of the solution into 100-ml volumetric flask and add toluene stabilised with BHT to volume.

Sample solution

Accurately weigh between 29.0 and 31.0 mg of the sample into a 10-ml volumetric flask and dissolve and dilute to volume with toluene stabilised with BHT. Put the solution in an ultrasonic bath for 10 min.

Results

The retention time of *apo*-12'-lycopenal is approximately 14 min. The relative retention time of *apo*-12'-lycopenal with respect to *all-trans*-lycopene is 1.6.

Calculation

$$\text{Apo-12'-lycopene (\%)} = \frac{A_S \times W_{St} \times 10}{A_{St} \times W_S \times 2500} \times 100$$

where

- A_S is the peak area of the sample;
- A_{St} is the peak area of the standard;
- W_{St} is the weight of the standard (mg);
- W_S is the weight of the sample (mg);

10 is the volume of the volumetric flask in which the sample was dissolved (ml); and
2500 is the volume of the volumetric flask in which the standard was dissolved (50 ml) multiplied by dilution (50).

METHOD OF ASSAY Determine total lycopenes and all-*trans*-lycopene by HPLC using the following conditions:

Reagents (Note: all solvents should be HPLC-grade)

Hexane

Tetrahydrofuran stabilised with 0.025%

BHT N-Ethyl-diisopropylamine

Lycopene standard (purity 95% or higher; available from CaroteNature GmbH)

Apparatus

Spectrophotometer with a 1-cm cuvette

HPLC system with a suitable pump, injector, thermostated column compartment, and integrator

Column: Two serially-connected stainless steel columns (250x4.0 mm)

Stationary phase: Nucleosil 300-5, 5 µm (Macherey-Nagel or equivalent)

Detector: UV-Vis

HPLC conditions

Flow rate: 0.8 ml/min

Injection volume: 20 µl

Pressure: approx. 80 bar

Column temperature: 20 °C

Detection: 470 nm

Mobile phase: 0.15% solution of N-ethyl-diisopropylamine in hexane (v/v)

Run time: 30 min

HPLC standard solution

Accurately weigh between 5.5 and 6.5 mg of the lycopene standard into a 100-ml volumetric flask. Dissolve in 5 ml of tetrahydrofuran stabilised with BHT and make up to volume with hexane. This is a standard solution for the HPLC assay.

Spectrophotometric standard solution

Transfer 5.0 ml of the HPLC standard solution into a 100-ml volumetric flask and make up to volume with hexane. This is a standard solution for the spectrophotometric determination of lycopene in the lycopene standard.

Sample solution

Accurately weigh between 4.5 and 5.5 mg of the sample into a 100-ml volumetric flask. Dissolve in 5 ml of tetrahydrofuran stabilised with BHT and make up to volume with hexane.

Spectrophotometric determination of lycopene

Measure the absorbance of the spectrophotometric standard solution in a 1-cm cuvette at the wavelength of maximum absorption (approximately 470 nm). Use hexane as the blank.

Calculation

$$C_{St}(\text{mg/l}) = \frac{A \times 10000}{3450}$$

where

C_{St} is the lycopene concentration in the spectrophotometric standard solution (mg/l)

A is absorbance at the wavelength of maximum absorption;

3450 is the specific absorbance $A_{1\text{ cm}}^{1\%}$ of all trans-lycopene in hexane; and

10000 is the scaling factor.

HPLC analysis

Repeatedly inject 20 μl of the HPLC standard solution. Record the total peak area of all detected lycopene isomers (exclude the solvent peak). Calculate the mean peak area from repeated injections and calculate the lycopene response factor (RF) according to the formula:

$$\text{RF} = \frac{A_{St}}{C_{St}} \times 20$$

where

RF is the response factor of lycopene (AU x l/mg);

A_{St} is the mean peak area of all lycopene peaks (AU);

C_{St} is the concentration of lycopene in the spectrophotometric standard solution (mg/l); and

20 is the dilution factor used in the preparation of the spectrophotometric standard solution from the HPLC standard solution.

Inject the sample solution and record the peak areas of lycopene isomers.

Results

Retention times

Lycopene isomer	Relative retention time*	Absolute retention time (approx.)
13- <i>cis</i> -lycopene	0.6	14 min
9- <i>cis</i> -lycopene	0.8	19 min
All- <i>trans</i> -lycopene	1.0	22 min
5- <i>cis</i> -lycopene	1.1	24 min

* relative to all-*trans*-lycopene

Calculations

Calculate the content of total lycopenes according to the formula:

$$\text{Total lycopenes (\%)} = \frac{A_{trans} + A_{5cis} + A_{9cis} + A_{13cis} + A_{xcis} \times 0.1}{RF \times W_S} \times 100$$

Where:

A_{trans} is the peak area of all-*trans*-lycopene (AU);

A_{5cis} , A_{9cis} , and A_{13cis} are the peak areas of 5-*cis*-, 9-*cis*-, and 13-*cis*-lycopene (AU);

A_{xcis} is the peak area of other *cis* isomers, if detected (AU);

0.1 is the volume, in litres, of the flask in which the sample was dissolved;

RF is the response factor of lycopene (AU x l/mg); and W_S is the weight of the sample (mg).

Calculate the content of all-*trans*-lycopene as follow

$$\text{All-}i>trans\text{-lycopene (\%)} = \frac{A_{trans} \times 0.1}{RF \times W_S} \times 100$$