

# THUJONE – HEALTH RISK AND CONTROL IN PRODUCTS

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**Chemical formula:** C<sub>10</sub>H<sub>16</sub>O

**IUPAC ID:** (1S,4R,5R)-4-Methyl-1-(propan-2-yl)bicyclo[3.1.0]hexan-3-one

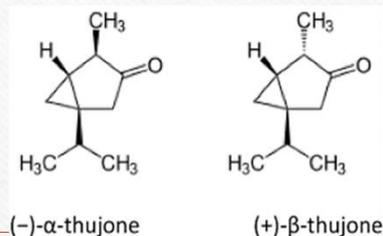
**Molar mass:** 152,23 g/mol

**Density:** 920 kg/m<sup>3</sup>

**Boiling point:** 201 °C

**Melting point:** < 25 °C

**Solubility in water:** 407 mg/L



**Thujone** is a ketone and a monoterpene that occurs predominantly in two diastereomeric (epimeric) forms: (-)-α-thujone and (+)-β-thujone. It is found in essential oil of bitter wormwood (*Artemisia absinthium*), essential oil of sage (*Salvia officinalis*), cypress, juniper, oregano, mint, essential oil of thuja, etc.

**Sage** (*Salvia officinalis*) is known for its wide range of effects, but it should be used cautiously and in moderation because its ingredient thujone can be very toxic and should not be consumed in combination with alcohol. Thujone is toxic to brain, kidney, and liver cells and causes anxiety, sleeplessness and convulsions if used in excessive doses, and it affects the central nervous system.

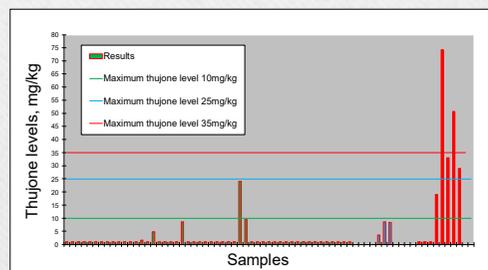
Thujone is best known compound in the spirit **absinthe** and unlikely it is responsible for psychoactive effects due to present small quantities. The thujones are potentially toxic compounds present in natural flavourings.



*Artemisia absinthium*



*Salvia officinalis*



- In the past, absinthe was thought to contain up to 260–350 mg/kg thujone but modern tests have shown this estimate to be far too high. A 2008 study, using gas chromatography-mass spectrometry (GC-MS) has been found amount of thujone between 0.5 and 48.3 mg/kg and averaged 25.4 mg/kg.
- The determination of thujone was carried out in commercial alcoholic beverages by HPLC (SHIMADZU prominence – 20A) using an RP-C18 (5 μm) (4,6 mm × 250 mm) column, and acetonitrile-water (85:15) as mobile phase, flow rate 1 ml/min at 30°C. The fluorescent properties of (+)-β-thujone have been used for the detection at λ<sub>ex</sub> 220 nm and λ<sub>em</sub> 288 nm. The selectivity of the fluorimetric detection allows the preparation of the analytical sample simply by diluting and extracting appropriately alcoholic beverages in n-hexane.
- In our analysis, herbal sage liqueur, contains thujone in concentration 24,02mg/kg, which is higher than allowed level (10mg/kg). In sample of absinthe, concentration of thujone is 74,3mg/kg, which is higher than allowed level (35mg/kg) etc. All analyzed results can be seen in a diagram with maximum thujone levels (10mg/kg, 25mg/kg and 35mg/kg).
- The method is precise and accurate and allows the determination of (+)-β-thujone, without interference, at concentrations down to 1mg/kg.

Maximum thujone levels in the EU are:

- 0.5 mg/kg in food prepared with *Artemisia* species, excluding those prepared with **sage** and non alcoholic beverages
- 10 mg/kg in alcoholic beverages not prepared with *Artemisia* species
- 25 mg/kg in food prepared with **sage** (*Salvia officinalis*)
- 35 mg/kg in alcoholic beverages prepared with *Artemisia* species

According to the Directive of substances that can be added to food and used in food production and substances, whose use in food is prohibited or restricted (Official Gazette 160/2013), the maximum permitted amount of thujone in food or food supplements is not specified, only for long-term use and consumption of sage.

The goal of the research is to determine the amount of thujone in the selected samples of alcoholic beverages and compare it with the highest allowed amounts prescribed by Regulation (EC) 1334/2008, and to raise the awareness of producers, authorities and the public about the risks associated with exceeding the allowed amount of thujone in products.

From the obtained results of analysis, we can see that there is a risk of exceeding the highest permitted amounts of thujone in alcoholic beverages on the market and that it needs to be controlled more systematically.