L-Perillyl Alcohol (CAS 536-59-4)

**Market Research Report 2015** 





## **Contents**

| 1. | L-PERILLYL ALCOHOL (CAS 536-59-4)                                |                      |
|----|--|----------------------|
|    | 1.2. Composition, chemical structure                             |                      |
|    | 1.3. Safety information  |                      |
|    | 1.4. Hazards identification                                      | 6                    |
|    | 1.5. Handling and storage  | 7                    |
|    | 1.6. Toxicological & ecological information                      | 8                    |
| 2. | L-PERILLYL ALCOHOL APPLICATION                                   | . 10                 |
|    | 2.1. L-perillyl Alcohol application spheres, downstream products |                      |
| 3. | L-PERILLYL ALCOHOL MANUFACTURING METHODS                         | .11                  |
| 4. | L-PERILLYL ALCOHOL PATENTS                                       | .12                  |
| 5. | L-PERILLYL ALCOHOL MARKET WORLDWIDE                              | . 13                 |
| ٠. | 5.1. General L-perillyl alcohol market situation, trends         |                      |
|    | 5.2. Manufacturers of L-perillyl alcohol                         |                      |
|    | Europe   |                      |
|    | Finetech Industry Limited  |                      |
|    | CMS Chemicals  | 14                   |
|    | BIOSYNTH AG  |                      |
|    | Asia   |                      |
|    | RUIKE CHEMISTRY & BIOTECHNOLOGY CO.,LTD                          |                      |
|    | Taizhou Chemedir Biopharm-tech Co., Ltd                          | 15<br>15<br>16<br>16 |
|    | D&C Chemicals  |                      |
|    | Nippon Terpene Chemicals, Inc                                    | 17                   |
|    | J&K Chemical Ltd   |                      |
|    | Haihang Industry Co., LtdHangzhou Sage Chemical Co., Ltd         |                      |
|    | 3Way Pharm Inc.  |                      |
|    | North America  | . 20                 |
|    | Santa Cruz Biotechnology, Inc.                                   | 20                   |
|    | Sigma-Aldrich Corp   |                      |
|    | BOC Sciences   |                      |
|    | 5.3. Suppliers of L-perillyl alcohol                             |                      |
|    | Europe   |                      |
|    | Asia   |                      |
|    | North America  |                      |
|    | 5.4. L-permyr alconor market forecast                            | . 30                 |
| 6. | L-PERILLYL ALCOHOL MARKET PRICES                                 | 31                   |
|    | 6.1. L-perillyl alcohol prices in Europe                         | 31                   |
|    | 6.2. L-perillyl alcohol prices in Asia                           | . 32                 |
|    | 6.3. L-perillyl alcohol prices in North America                  | . 33                 |
| 7. | L-PERILLYL ALCOHOL END-USE SECTOR                                | . 34                 |
|    | 7.1. L-perillyl alcohol market by application sphere             | . 34                 |
|    | 7.2. L-perillyl alcohol downstream markets trends and prospects  |                      |
|    |  |                      |



| 7.3. L-perillyl alcohol consumers globally |    |
|--|----|
| Flavorings, for the food industry          | 36 |
| Europe                                     |    |
| Asia                                       |    |
| North America                              |    |
| Middle East & Africa                       | 60 |
| Oceania                                    | 63 |
| Oncology research                          | 64 |



## 1. L-PERILLYL ALCOHOL (CAS 536-59-4)

## 1.1. General information, synonyms

**IUPAC Name**: [(4S)-4-prop-1-en-2-ylcyclohexen-1-yl]methanol

CAS Registry Number: 536-59-4

**Synonyms**: Perillol, Perilla alcohol, Perillic alcohol, PERILLYL ALCOHOL, (-)-Perillyl alcohol, (-)-Perillylalcohol, Ambap2072, p-Mentha-1,8-dien-7-ol, (S)-(-)-Perillyl alcohol, p-Mentha-1,8-dien-7-ol

## 1.2. Composition, chemical structure

#### **Chemical structure:**

#### 3d structure:





Molecular Weight 152.23344 g/mol

Molecular Formula C10H16O

**XLogP3** 2.1

H-Bond Donor 1
H-Bond Acceptor 1

**Rotatable Bond Count** 2

**Exact Mass** 152.120115 g/mol

**MonoIsotopic Mass** 152.120115 g/mol

**Topological Polar Surface Area** 20.2 A^2

**Heavy Atom Count** 11

Formal Charge 0

Complexity 179

**Isotope Atom Count** 0

**Defined Atom Stereocenter Count** 1

**Undefined Atom Stereocenter Count** 0

**Defined Bond Stereocenter Count** 0

**Undefined Bond Stereocenter Count** 0

Covalently-Bonded Unit Count 1

Canonical SMILES: CC(=C)C1CCC(=CC1)CO

**InChI**: 1S/C10H16O/c1-8(2)10-5-3-9(7-11)4-6-10/h3,10-11H,1,4-7H2,2H3/t10-/m1/s1

InChIKey: NDTYTMIUWGWIMO-SNVBAGLBSA-N

#### **Physical and Chemical Properties:**

Physical State: Liquid

Color: clear, colorless

Flash Point: 99.6 °C

Boiling Point: 119 - 121 °C

Density: 0.94 g/cm3

Vapor density: 5.2

Vapor Pressure: 0.00628 mmHg at 25°C

Refractive Index: n20/D 1.501



## 1.3. Safety information

Hazard Codes XI

Risk Statements R 36/38

Safety Statements S 24/25

WGK Germany 3

RTECS OS8395000

#### 1.4. Hazards identification

#### **Potential Health Effects**

Eye: Causes eye irritation.

Skin: Causes skin irritation.

Ingestion: May cause gastrointestinal irritation with nausea, vomiting and

diarrhea.

Inhalation: May cause respiratory tract irritation.

#### **First Aid Measures**

Eyes: Immediately flush eyes with plenty of water for at least 15 minutes,

occasionally lifting the upper and lower eyelids. Get medical aid

immediately.

Skin: Get medical aid immediately. Immediately flush skin with plenty of

water for at least 15 minutes while removing contaminated clothing

and shoes. Wash clothing before reuse.

Ingestion: Never give anything by mouth to an unconscious person. Get medical

aid. Do NOT induce vomiting. If conscious and alert, rinse mouth and

drink 2-4 cupfuls of milk or water.

Inhalation: Remove from exposure and move to fresh air immediately. If not

breathing, give artificial respiration. If breathing is difficult, give

oxygen. Get medical aid.

#### **Fire Fighting Measures**

General Information: As in any fire, wear a self-contained breathing apparatus in pressure

demand, MSHA/NIOSH (approved or equivalent), and full protective gear. During a fire, irritating and highly toxic gases may be generated by thermal decomposition or combustion. Vapors may be heavier than air. They can spread along the ground and collect in low or confined areas. Runoff from fire control or dilution water may

cause pollution.



Extinguishing Media: Use agent most appropriate to extinguish fire. Use water spray, dry

chemical, carbon dioxide, or appropriate foam.

NFPA Rating: Health: 2; Flammability: 0; Instability: 0

#### **Accidental Release Measures**

General Information: Use proper personal protective equipment.

Spills/Leaks: Absorb spill with inert material (e.g. vermiculite, sand or earth), then

place in suitable container. Avoid runoff into storm sewers and ditches which lead to waterways. Clean up spills immediately, observing precautions in the Protective Equipment section. Provide

ventilation.

## 1.5. Handling and storage

Handling: Wash thoroughly after handling. Remove contaminated clothing and

wash before reuse. Avoid contact with eyes, skin, and clothing. Keep container tightly closed. Avoid ingestion and inhalation. Use with

adequate ventilation.

Storage: Store in a tightly closed container. Store in a cool, dry, well-

ventilated area away from incompatible substances.

#### **Exposure Controls, Personal Protection**

Engineering Controls: Facilities storing or utilizing this material should be equipped with an

eyewash facility and a safety shower. Use process enclosure, local exhaust ventilation, or other engineering controls to control airborne

levels.

Exposure Limits: none listed

## **Personal Protective Equipment**

Eyes: Wear chemical splash goggles.

Skin: Wear appropriate protective gloves to prevent skin exposure.

Clothing: Wear appropriate protective clothing to prevent skin exposure.

Respirators: A respiratory protection program that meets OSHA's 29 CFR

1910.134 and ANSI Z88.2 requirements or European Standard EN 149 must be followed whenever workplace conditions warrant

respirator use.



#### **Stability and Reactivity**

Chemical Stability: Stable at room temperature in closed containers under normal

storage and handling conditions.

Conditions to Avoid: Excess heat.

Incompatibilities with Other Materials: Strong oxidizing agents.

Hazardous Decomposition Products: Carbon monoxide, carbon monoxide, carbon

dioxide.

Hazardous Polymerization: Has not been reported

## 1.6. Toxicological & ecological information

#### **Toxicological Information**

RTECS#: OS8395000

LD50/LC50: Draize test, rabbit, skin: 500 mg/24H Severe;

Oral, rat: LD50 = 2100 mg/kg;

Skin, rabbit: LD50 = >5 gm/kg

Carcinogenicity: Not listed by ACGIH, IARC, NTP, or CA Prop 65.

#### **Regulatory Information**

**US FEDERAL** 

**TSCA** 

CAS# 536-59-4 is listed on the TSCA inventory.

Health & Safety Reporting List

None of the chemicals are on the Health & Safety Reporting List.

Chemical Test Rules

None of the chemicals in this product are under a Chemical Test Rule.

Section 12b

None of the chemicals are listed under TSCA Section 12b.

TSCA Significant New Use Rule

None of the chemicals in this material have a SNUR under TSCA.

CERCLA Hazardous Substances and corresponding RQs

None of the chemicals in this material have an RQ.

SARA Section 302 Extremely Hazardous Substances

None of the chemicals in this product have a TPQ.

Section 313 No chemicals are reportable under Section 313.



#### Clean Air Act:

This material does not contain any hazardous air pollutants.

This material does not contain any Class 1 Ozone depletors.

This material does not contain any Class 2 Ozone depletors.

#### Clean Water Act:

None of the chemicals in this product are listed as Hazardous Substances under the CWA.

None of the chemicals in this product are listed as Priority Pollutants under the CWA.

None of the chemicals in this product are listed as Toxic Pollutants under the CWA.

#### OSHA:

None of the chemicals in this product are considered highly hazardous by OSHA.

#### **STATE**

CAS# 536-59-4 is not present on state lists from CA, PA, MN, MA, FL, or NJ.

California Prop 65

California No Significant Risk Level: None of the chemicals in this product are listed.

European/International Regulations

European Labeling in Accordance with EC Directives

Hazard Symbols:

ΧI

Risk Phrases:

R 36/38 Irritating to eyes and skin.

Safety Phrases:

S 24/25 Avoid contact with skin and eyes.

WGK (Water Danger/Protection)

CAS# 536-59-4: No information available.

Canada - DSL/NDSL

CAS# 536-59-4 is listed on Canada's DSL List.

Canada - WHMIS

This product has a WHMIS classification of D2B.

This product has been classified in accordance with the hazard criteria of the Controlled Products

Regulations and the MSDS contains all of the information required by those regulations.

Canadian Ingredient Disclosure List

CAS# 536-59-4 is listed on the Canadian Ingredient Disclosure List.



## 2. L-PERILLYL ALCOHOL APPLICATION

## 2.1. L-perillyl Alcohol application spheres, downstream products

L-perillyl Alcohol, also called p-metha,1,7-diene-6-ol or 4-isopropenylcyclohexenecarbinol, is a monoterpene, and thus consists of two isoprene units manufactured by the mevalonate pathway. L-perillyl Alcohol is a clear to pale yellow liquid that is soluble in alcohol and water.

It is found in small concentrations in the essential oils of lavendin, peppermint, spearmint, sage, cherries, cranberries, perilla (Perilla frutescens), lemongrass, wild bergamot, gingergrass, savin, caraway, and celery seeds.

#### **Application & Uses**

#### **Food Flavoring and Fragrance Agent**

This flavoring and fragrance agent has a woody-spicy odor and an orange peel, floral taste. This agent finds application in foods requiring cardamom, cumin, hops, lavender, or caraway flavors and fragrances. It is also used to add odors to food reminiscent of bergamot, spearmint, cranberry, gingergrass, huckleberry, root beer, and vanilla.

#### **Cancer Prevention/Treatment**

Laboratory evidence suggests that it interferes with the replication of dividing cells. L-perillyl Alcohol has shown antitumor activity against a range of cancer types including pancreatic, lung, colon, and liver cancers in laboratory and animal studies, but these results have not yet translated into benefits in humans. Clinical trials of oral L-perillyl Alcohol for various cancers including breast, prostate, and ovarian cancers did not find benefit and also noted adverse side effects, even after modifying dosing regimens to try to improve effectiveness and tolerability. However, an inhaled form of L-perillyl Alcohol has shown preliminary evidence of safety and effectiveness in patients with recurrent gliomas. In addition, other purified forms are being studied as chemical modifiers of established drugs used to treat cancer in order to improve outcomes.

Source: Perillyl Alcohol: Applications in Oncology by James T. Belanger, N.D. [Available Online] www.altmedrev.com/publications/3/6/448.pdf

www.pentamfg.com

www.mskcc.org



## 3. L-PERILLYL ALCOHOL MANUFACTURING METHODS

Perillyl alcohol is isolated from the essential oils of several plants including cherries, lavender, peppermint, spearmint, celery seeds, sage, cranberries, lemongrass, ginger grass, savin juniper, Conyza newii, caraway, Perilla frutescens, and wild bergamont.

Since this natural product is present only at low levels in a few plant oils, an alternative, synthetic source is desirable.

L-perillyl Alcohol can be obtained from D-Limonene (1-methyl-4-(1-methylethenyl)-cyclohexene) via hydroxylation by cytochrome P450-type enzymes.

# Biocatalytic Production of Perillyl Alcohol from Limonene by Using a Novel Mycobacterium sp. Cytochrome P450 Alkane Hydroxylase Expressed in Pseudomonas putida

Jan B. van Beilen, René Holtackers, Daniel Lüscher, Ulrich Bauer, Bernard Witholt and Wouter A. Duetz

A number of oxygenated monoterpenes present at low concentrations in plant oils have anticarcinogenic properties. One of the most promising compounds in this respect is (–)-perillyl alcohol. Since this natural product is present only at low levels in a few plant oils, an alternative, synthetic source is desirable. Screening of 1,800 bacterial strains showed that many alkane degraders were able to specifically hydroxylate L-limonene in the 7 position to produce enantiopure (–)-perillyl alcohol. The oxygenase responsible for this was purified from the best-performing wild-type strain, Mycobacterium sp. strain HXN-1500. By using N-terminal sequence information, a 6.2-kb ApaI fragment was cloned, which encoded a cytochrome P450, a ferredoxin, and a ferredoxin reductase. The three genes were successfully coexpressed in Pseudomonas putida by using the broad-host-range vector pCom8, and the recombinant converted limonene to perillyl alcohol with a specific activity of 3 U/g (dry weight) of cells. The construct was subsequently used in a 2-liter bioreactor to produce perillyl alcohol on a scale of several grams.

Source: Preclinical development and clinical use of perillyl alcohol for chemoprevention and cancer therapy. by Thomas C Chen, Clovis O Da Fonseca, Axel H Schönthal [Available Online] http://www.ajcr.us/files/ajcr0007197.pdf

http://aem.asm.org/content/71/4/1737.full



## 4. L-PERILLYL ALCOHOL PATENTS

#### Process for the preparation of perillyl alcohol

WO 2002066662 A1

The invention provides a process for the preparation of a hydroxymethylated terpene analog, for example (+) or (-) perillyl alcohol, which process comprises contacting a terpene analog having a terminal methyl group, for example D- or L-limonene, with a microbial cell, which microbial cell is capable of expressing a monooxygenase capable of terminal hydroxylation of an n-alkane.

#### Method of preparing perillyl alcohol and perillyl acetate

US 5994598 A

A process for preparing perillyl alcohol by converting beta-pinene oxide into an alcohol in an acidic reaction medium, esterifying said alcohol to produce a mixture containing perillyl acetate, and hydrolyzing said perillyl acetate to perillyl alcohol.

#### Using perillyl alcohol to kill bacteria and yeasts

US 5110832 A

A broad spectrum bactericide, which is bactericidal to bacteria and yeasts in bactericidal concentrations, is perillyl alcohol. Also a method of killing bacteria includes the treatment of bacteria with bactericidal concentrations of perillyl alcohol. The bacteria are selected from a goup consisting of Staphylococcus, Billus, Enterobacteriaceae, Streptococcus, Xanthomonas, and Mycobacteria. Also yeasts may be killed by treatment thereof with bactericidal concentrations of perillyl alcohol.

## Pharmaceutical compositions comprising deuterium-enriched perillyl alcohol, isoperillyl alcohol and derivatives thereof

WO 2013119304 A2

The present invention, provides for a deuterium-enriched monoterpene or sesquiterpene such as perillyl alcohol, or a deuterium-enriched isomer or analog of monoterpenes or sesquiterpenes, such as isoperillyl alcohol. The present invention also provides for a deuterium-enriched derivative of a monoterpene or sesquiterpene, such as a perillyl alcohol carbamate, or a deuterium-enriched derivative of an isomer or analog of a monoterpene or sesquiterpene, such as an isoperillyl alcohol carbamate. The deuterium-enriched derivative may be perillyl alcohol or isoperillyl alcohol conjugated with a therapeutic agent such as a chemotherapeutic agent. The present invention also provides for a method of treating a disease such as cancer, comprising the step of delivering to a patient a therapeutically effective amount of a deuterium-enriched compound.



## 5. L-PERILLYL ALCOHOL MARKET WORLDWIDE

## 5.1. General L-perillyl alcohol market situation, trends

Today the market for L-perillyl alcohol is dominated by manufacturers from Asia Pacific region. One of the largest manufacturing company of L-perillyl alcohol is Ruike Chemistry & Biotechnology Co., Ltd. The product is also offered by laboratory scale and custom synthesis manufacturers in different regions, including Finetech Industry Limited, CMS Chemicals (Europe), Hangzhou Sage Chemical Co., Ltd., 3Way Pharm Inc. (Asia), Santa Cruz Biotechnology, Inc., Sigma-Aldrich Corp. (North America), etc.

## 5.2. Manufacturers of L-perillyl alcohol

## **Europe**

#### **Finetech Industry Limited**

Suite 8525, 16-18 Circus Road St. John's Wood, London United Kingdom www.finetechnology-ind.com sales@finetechnology-ind.com

Finetech Industry Limited is a company in England, which specializing in developing, manufacturing and marketing fine organic compounds and intermediates for the pharmaceutical industry. Most of company's products are exported to the North America, Europe and Oceania. Company's factory, which can provide more than 20,000 products applicable in medical and chemical research, is located in China.

#### L-perillyl alcohol

Catalog number: FT-0627990

NAME: DIHYDRO CUMINYL ALCOHOL

Assay: 98%

MF: C10H16O

FW: 152.23



#### **CMS Chemicals**

7 Old Station Business Park

Compton, Berkshire, RG20 6NE, UK

Phone: +44 (0)1635 577666

Fax +44 (0)1635 579444

www.cms-chemicals.com

enquiries@cms-chemicals.com

CMS offers a wide range of fine chemicals including pyridines, bipyridines, pyrimidines, peptide coupling reagents but also includes a range of speciality and industrial chemicals. Company's catalogue offers quantities for R&D, but many are also produced in bulk. Custom synthesis is one of CMS's fastest growing business sectors. The company produces many products in its own laboratories.

#### L-perillyl alcohol

Catalog number: FP70326

#### **BIOSYNTH AG**

Rietlistr. 4, 9422 Staad

Switzerland

Tel: +41 (0)71 858 20 20

Fax: +41 (0)71 858 20 30

welcome@biosynth.ch

www.biosynth.com

BIOSYNTH AG main facilities are located in Switzerland on Lake Constance. Over the years the company has modernized and upgraded the site continuously in order to expand capacity and to comply with international regulations. Its state-of-the-art plant in Switzerland performs pilot and production runs in 50 to 3,000 liter reactors as well as small scale manufacturing, small scale API manufacturing.

L-perillyl alcohol

Catalog number: Q-201271



#### Asia

#### **RUIKE CHEMISTRY & BIOTECHNOLOGY CO.,LTD**

No. 1, Xinghong road south,

Second part of Changhongling Industrial Park,

Dali town, Nanhai region, Fushan City,

Guangdong Province, China.

Phone: +86-0757-81181831

Fax: +86-0757-81181832

528231

www.ruike-biochem.com

RUIKE CHEMISTRY & BIOTECHNOLOGY CO.,LTD by science & technology and for the environmental protection, is devoted to the development of biochemical technology, of which the mass production technology of high optical purity L-(-)-perillyl alcohol product has made it become an international pioneer. The Chief Technology Officer of the enterprise has worked before in famous colleges of America, Taiwan and Hong Kong, offered professional material and service for domestic and overseas cooperation organizations, which are highly evaluated by the market for their remarkable quality.

#### Taizhou Chemedir Biopharm-tech Co., Ltd

G02, No. 1 Avenue China Medical City, Taizhou, Jiangsu, China

Phone: +86 0523 80766898-8001 / 8003

Fax: +86 0523 80766889

sales@chemedir.com

www.chemedir.com

Taizhou Chemedir Biopharm-tech Co., Ltd is high-tech cooperation specialized in R&D, manufacturing, trading of bio-reagents, pharmaceutical intermediates, perfume & essence and other fine chemicals. It is located in Taizhou Jiangsu "China Medical City" which is the unique national level Hi-Tech Zone of medical. With the good environment, is much better for them to offer professional, perfect and prompt service to the customers all over the world.



#### **Changsha Huir (CSHR)**

Fl 20 Jindan Building Longping High-tech Park, Changsha, China

410126

Fax: 0086-731-84152788

info@phyhuir.com

www.phyhuir.com

CSHR is a professional manufacture and developer of high quality and standard botanical extracts for human health come from nature. At present, the company has adopted internationally first-tare manufacturing facilities and technology and is based on the strong R&D capability. Therefore the enterprise has core competencies. Now the factory had three first-class muti-functional production assembly, they were used to purify plant, and the assembiles are most advanced both at home and abroad. And they also had high technical force, complete detection means, and can be engaged in drawing and processing of investor's raw material business of many kinds of plants.

#### **D&C Chemicals**

Room 610, Building 15,

Jinxiang Rd 201, Pudong, Shanghai, China

Phone: +86-21-58447131

Fax: +86-21-61642470

www.dcchemicals.com

Established in 2006, D&C Chemicals is a fine organics manufacturing facility which located in Shanghai, P.R. China. D&C Chemicals provides a wide range of research chemicals and biochemicals including novel life-science reagents, reference compounds, APIs and Natural compounds for laboratory and scientific use. They are certified to the ISO 9001:2000 Standards, have a safety management system in place, and adhere to the responsible care program.

#### L-perillyl alcohol

Catalog number: DCZ-056

Purity: >99%, Standard References Grade



#### Nippon Terpene Chemicals, Inc.

NBF Hibiya Building, 14/F, 1-1-7 Uchisaiwai-cho

Chiyoda-ku, Tokyo 100-0011, Japan

Japan

Phone: (3) 3539-4133

Fax: (3) 3539-4130

www.nipponterpene.co.jp

info@nipponterpene.co.jp

Nippon Terpene Chemicals, established in 1919, has specialized in the devel- opment of monoterpenes and their derivatives to wide range of uses such as flavors and fragrances raw materials, solvents and chemicals used in the man- ufacturing of electronics devices. We are now expanding our business to include the custom synthesis of new products utilizing our know-how and man- ufacturing experience to provide high quality pharmaceutical intermediates and specialty chemicals.

### L-perillyl alcohol

Description: Colorless or pale yellow clear liquid 85% up

Odor: Mild floral

#### J&K Chemical Ltd.

AEF 18/F Building D, Majesty Garden,

6 Bei-Si-Huan-Zhong Road, Beijing, CH 100029, China

Phone: +86-(10)-8284-8833

Fax: +86-(10)-8284-9933

www.jkchemical.com

jkinfo@jkchemical.com

J&K was established in 1992 with bases in Sweden and China and is now a leading manufacturer and market developer of ultrafine materials. The Group has operations with fast worldwide extending, and employs a team of highly skilled and experienced scientists and engineers.

J&K has two research institutes where bench work produces serial molecules in quantities from 10 mg to hundred kg. Production processes can be transferred to manufacturing facilities equipped with multi-purpose reactors for large scale production. The reactors range in size from 500ml to 3,000 litres and are made from stainless steel or glass-lined.

#### L-perillyl alcohol

Product name: Dihydro cuminyl alcohol, 85%

Catalog number: 246485

Purity: 85%

Boiling Point: 119-121 °C / 760 mmHg

Flash Point: 110 °C (C.C)



Refractive Index: 1.5010 (n20/D)

Density: 0.96 g/mL (25 °C)

Optical activity: -88 (C=1, MeOH)

#### Haihang Industry Co., Ltd.

2/F, East Tower, Bldg 12, No. 2 Qilihe Road

Jinan, P.R. China

Phone: +86-531-88032799

Fax: +86-531-85821093

www.haihangchem.com

export001@haihangchem.com

Haihang Industry Co., Ltd., established in 2000, is a leading producer and supplier of chemicals industry in China. Haihang Industry Co., Ltd. develops, produces and distributes high quality pharmaceutical chemicals, special chemicals and other fine chemicals.

With the expanding of the market, Haihang occupies a stable share in domestic and foreign market. Company's products are popular all over the world. Haihang Industry Co., Ltd. even has established long-term companionship with some world famous pharmaceutical and chemical corporations.

#### Hangzhou Sage Chemical Co., Ltd.

RM501 Tower A, New Youth Plaza, NO.8

Jia Shan Road, Hangzhou, Zhejiang 310014, China

Phone: +86-(571)-86818502

Fax: +86-(571)-86818503

www.sagechem.com

will@sagechem.com

Hangzhou Sage Chemical Co., Ltd., is a well-established and continuously growing high-tech company engaging in researching, manufacturing and marketing high quality pharmaceutical, agrochemical and dyestuff intermediates, fluorochemicals, intermediates of high performance materials and etc. The company's laboratories and manufacture plants are located in the Zhejiang and Jiangsu.

The company also provides services for toll and contract manufacturing activities with pilot and commercial scale.

L-perillyl alcohol

Catalog number: SGC190086



#### 3Way Pharm Inc.

Room C334, No. 128, Xiangyin Road,

Yangpu District, Shanghai 200433, China

Phone: +86-(21)-35322592

Fax: +86-(21)-35322292

www.3wpharm.com

sales3@wpharm.com

Established in April 2008, 3Way Pharm Inc. (Shanghai) is a leading intermediates and Active Pharmaceutical Ingredients (API) manufacturing and services company. It is fully equipped with state of the art databases and analytical instruments to ensure research and product quality. 3Way Pharm also undertakes custom synthesis and contract manufacturing.

#### L-perillyl alcohol

Catalog number: SWOT-87438

Name: DIHYDROCUMINYLALCOHOL



#### **North America**

#### Santa Cruz Biotechnology, Inc.

2145 Delaware Ave

Santa Cruz, CA. 95060, USA

Phone: 800-457-3801 / +1 -831-457-3800

Fax: +1-831-457-3801

www.scbt.com scbt@scbt.com

Santa Cruz Biotechnology, Inc. focuses on the development of research antibodies. The company offers conjugated primary, tumor suppressors/apoptosis, cell cycle protein, transcription regulator, homeodomain protein, steroid and membrane receptor, kinase and phosphatase, growth factor and hormone and etc. It also provides phospho-specific, fusion protein tag, biologically active, and secondary antibodies, as well as chemicals, laboratory supplies, multicolor flow cytometry systems, and expression vectors.

#### L-perillyl alcohol

Product name: (-)-Perillyl Alcohol

Purity: ≥90%

Catalog number: sc-205798; sc-205798A

Physical State: Liquid

Solubility: Soluble in ethanol, and acetone. Insoluble in water.

Storage: Store at 4° C

Melting Point: 11.12 °C (Predicted)

Boiling Point: 119-121 °C (lit.) at 11 mmHg

Density: 0.96 g/mL at 20 °C Refractive Index: n20D 1.50

#### Sigma-Aldrich Corp.

3050 Spruce St.

St. Louis, MO 63103, USA

Phone: (800) 521-8956

Fax: (800) 325-5052

www.sigmaaldrich.com

Sigma-Aldrich Corporation, together with its subsidiaries, develops, manufactures, purchases, and distributes a range of chemicals, biochemicals, and equipment worldwide. The company offers biological buffers, cell culture reagents, biochemicals, chemicals, solvents, and other



reagents and kits. It also sells organic chemicals, analytical reagents, chromatography and other laboratory consumables, reference materials, and high-purity products.

#### L-perillyl alcohol

Catalog number: 218391

Appearance (Color): Colorless to Pale Yellow

Appearance (Form): Liquid

Infrared spectrum: Conforms to Structure

Refractive index at 20 ° C: 1.499 - 1.503

Optical Rotation c = 1%; In Methanol: -90.00 - -86.00 deg

Purity (GC): ≥ 95.5 %

Color Test: ≤ 200 APHA

Catalog number: W266418

Appearance (Color): Colorless to Yellow

Appearance (Form): Liquid

Refractive index at 20 ° C: 1.499 - 1.503

Infrared spectrum: Conforms to Structure

Purity (GC): ≥ 95.00 %

Specific Rotation C=1%, Methanol: -90.0 - -86.0 °

Arsenic (As):  $\leq$  3 ppm

Cadmium (Cd): ≤ 1 ppm

Mercury (Hg): ≤1 ppm

Lead (Pb):  $\leq$  10 ppm

#### **BOC Sciences**

45-16 Ramsey Road, Shirley, NY 11967, USA

Phone: 1-631-504-6093

Fax: 1-631-614-7828

info@bocsci.com

www.bocsci.com

BOC Sciences is the chemistry division of Creative Dynamics Inc. headquartered in New York, USA. The company leverages its wide spectrum of business in the fields of development, manufacturing, marketing, and distribution to help its clients make best-informed decisions. BOC Sciences' complete suite of CRO services spans the entire molecule development pipeline including contract research for target identification, building blocks, compound synthesis, biochemical and cellular analysis, preclinical animal tests, and clinical studies.

#### L-perillyl alcohol

Catalog number: 536-59-4

Product Name: Dihydrocuminyl alcohol



Density: 0.96

Appearance: clear colorless to light yellow liquid



## 5.3. Suppliers of L-perillyl alcohol

## **Europe**

#### **Ambinter**

c/o Greenpharma

3, allée du titane 45100 Orléans,

France

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Fax: +33 238 259 965

Email: contact@ambinter.com

Web: www.ambinter.com

#### Carl Roth GmbH + Co. KG

Germany

Phone: 0800/5699-000

Fax: 0721/5606-149

E-Mail: bestellungen@carlroth.de

Web: www.carlroth.com

#### **Chemical Point UG**

Gleißentalstrasse 16

82041 Deisenhofen

Germany

Phone: +49 (89) 41 61 599 - 30

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#### **CHEMOS GmbH**

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Web: www.chemos-group.com

#### Labotest

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#### **Cymit Quimica S.L.**

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Barcelona 08020

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Fax: +34 93 414 49 79

Email: info@ cymitquimica.com

Web: www.cymitquimica.com

#### Carbosynth

8 & 9 Old Station Business Park

Compton, Berkshire

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Email: sales@carbosynth.com

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### **Fluorochem Ltd**

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Hadfield Derbyshire

SK13 1QH United Kingdom

Phone: (01457) 868921 (4 lines)

Fax: (01457) 869360/860927

E-mail: vernam@fluorochem.co.uk

Web: www.fluorochem.co.uk



#### **Asia**

#### **Advanced Technology & Industrial Co., Ltd.**

Unit B, 1/F., Cheong Shing Bldg.,

17 Walnut St., Tai Kok Tsui, Kln, Hong Kong

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E-Mail: sales@advtechind.com

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#### **Angene International Limited**

4/F Silvercord Center Tower 130 Canton Rd,KL, Hong Kong

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Email: sales@angenechemical.com

Web: www.angenechemical.com

#### **AN PharmaTech Co Ltd**

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China

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Fax: 86(21)33321566

Email: sales@anpharma.net Anpharma@163.com

Web: www.anpharma.net

#### **BeiJing Hwrk Chemicals Limited**

China

Phone: 010-57411839; 020-31335234

Fax: 010-87653215; 021-55236763

Email: ales@hwrkchemical.com

Web: www.hwrkchemical.com

#### **Beijing Ouhe Technology Co., Ltd**

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Phone: +86-10-4006331231; +86-10-51280831; +86-10-82967028

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Email: sales@ouhechem.com



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#### **Bide Pharmatech Ltd.**

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#### **Chengdu Herbpurify Co.Ltd.**

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gaoxin, District, Chengdu City,

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#### **Finetech Industry Limited**

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#### **Health Chemicals Co., Ltd.**

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Web: http://healthchemicals.com



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Web: www.macklin.cn

## **Wuhan 3B Scientific Corporation**

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Fax: 86 27 88063656

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Web: www.yickvic.com

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Fax: 03-3358-5973

Email: ttcltky@nifty.com



#### **North America**

#### **ACC Corporation**

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E-mail: info@acccorooration.com

Web: acccorporation.com

#### **ALB Materials Inc**

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#### **Alfa Chemistry**

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Email: info@alfa-chemistry.com

Web: www.alfa-chemistry.com

#### Ark Pharm, Inc.

1840 Industrial Drive, Suite 120

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Email: sales@arkpharminc.com

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#### **Aurum Pharmatech LLC**

P.O. Box 504

Howell, NJ 07731

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Email: sales@aurumpharmatech.com

Web: www.aurumpharmatech.com

#### **Enamine LLC**

Princeton Corporate Plaza

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## Penta Manufacturing Company, LLC

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E-mail: sales@pentamfg.com

Web: www.pentamfg.com

## 5.4. L-perillyl alcohol market forecast

Market for L-perillyl alcohol is expected to continue growing in the coming years. With the increasing demand from its end use sectors (cancer treatment) L-perillyl alcohol is expected to gain the market.



## 6. L-PERILLYL ALCOHOL MARKET PRICES

L-perillyl alcohol market prices range, depending on source, grade and purity, from  $\pm$ USD 300 per kg to more than  $\pm$ USD 2000 per kg.

## 6.1. L-perillyl alcohol prices in Europe

Table 1. L-perillyl alcohol prices in European market

| Company                 | Country     | Quantity and Price  |
|-------------------------|-------------|---------------------|
| Carl Roth GmbH + Co. KG | Germany     | 96%                 |
|                         |             | EUR 72.50 / 5 ml    |
| Labotest                | Germany     | USD 37.00 / 5 mg    |
|                         |             | USD 69.00 / 25 mg   |
|                         |             | USD 145.00 / 100 mg |
| Biomol GmbH             | Germany     | >85%                |
|                         |             | EUR 123.00 / 10 g   |
|                         |             | EUR 366.00 / 50 g   |
| SIGMA-RBI               | Switzerland | 96% (Aldrich)       |
|                         |             | EUR 60.50 / 10 g    |
|                         |             | EUR 206.00 / 50 g   |
|                         |             | ≥95%, FG (Aldrich)  |
|                         |             | EUR 106.00 / 100 g  |
|                         |             | EUR 606.00 / 1 kg   |
|                         |             | EUR 2,739.00 / 5 kg |
| Fluorochem Ltd.         | UK          | 95%                 |
|                         |             | EUR 22.39 / 5 g     |
|                         |             | EUR 36.88 / 10 g    |
|                         |             | EUR 72.45 / 25 g    |

Valuation basis: EXW if other is not specified



## 6.2. L-perillyl alcohol prices in Asia

Table 2. L-perillyl alcohol prices in Asian market

| Company                                      | Country | Quantity and Price             |
|--|---------|--------------------------------|
| Changsha Huir Biological-tech                | China   | 98%                            |
| Co., Ltd                                     | O.I.I.a | USD 2338 / kg                  |
|  |         | FOB China                      |
| Shanghai Macklin Co.,ltd                     | China   | 90%                            |
|  | Ja      | USD 33.00 / 5 g                |
|  |         | USD 78.17 / 25 g               |
|  |         | USD 213.00 / 100 g             |
| Shanghai taitan technology                   | China   | USD 38.33 / 5 g                |
| Co.,ltd                                      |         | USD 115.00 / 25 g              |
|  |         | USD 330.00 / 100 g             |
| Taizhou Chemedir Biopharm-<br>tech. Co., Ltd | China   | USD 340.00 / kg                |
|  | China   | USD 25 00 / 20 mm              |
| Chengdu Herbpurify CO.,LTD                   | China   | USD 25.00 / 20 mg              |
| DC Chemicals                                 | China   | >99%,Standard References Grade |
|  |         | USD 280.00 / 20 mg             |
| Bide pharmatech LTD.                         | China   | USD 10.83 / 1 g                |
|  |         | USD 48.75 / 10 g               |
|  |         | USD 243.75 / 100 g             |
| J & K SCIENTIFIC LTD.                        | China   | 85%                            |
|  |         | USD 39.00 / 10 g               |
|  |         | USD 111.00 / 50 g              |
| BeiJing Hwrk Chemicals Limted                | China   | 98%                            |
|  |         | USD 141.49 / 100 g             |
|  |         | USD 585.14 / 1 kg              |
|  |         | 90%                            |
|  |         | USD 300.92 / 100 g             |
| Adamas Reagent, Ltd.                         | China   | 90%+, RG                       |
|  |         | USD 34.95 / 5 g                |
|  |         | USD 104.86 / 25 g              |
|  |         | USD 300.92 / 100 g             |

Valuation basis: EXW if other is not specified



## 6.3. L-perillyl alcohol prices in North America

 Table 3.
 L-perillyl Alcohol prices in North American market

| Company                                  | Country | Quantity and Price |
|--|---------|--------------------|
| Aurum Pharmatech LLC                     | USA     | 96%                |
|  |         | USD 135.00 / 1 g   |
|  |         | USD 156.93 / 2.5 g |
|  |         | USD 197.43 / 5 g   |
|  |         | USD 268.31 / 10 g  |
| Enamine Ltd                              | USA     | USD 20.00 / 1 g    |
|  |         | USD 57.00 / 5 g    |
|  |         | USD 99.00 / 10 g   |
| Ark Pharm, Inc.                          | USA     | USD 21.00 / 5 g    |
|  |         | USD 35.00 / 10 g   |
|  |         | USD 70.00 / 25 g   |
| American Custom Chemicals<br>Corporation | USA     | USD 569.40 / 1 g   |
|  |         | USD 770.44 / 5 g   |
| Santa Cruz Biotechnology, Inc            | USA     | USD 154.00 / 10 g  |
|  |         | USD 462.00 / 50 g  |
| LKT Laboratories                         | USA     | USD 83.10 / 10 g   |
|  |         | USD 247.10 / 50 g  |

Valuation basis: FOB if other is not specified



## 7. L-PERILLYL ALCOHOL END-USE SECTOR

## 7.1. L-perillyl alcohol market by application sphere

The major part of L-perillyl alcohol is used in cancer treatment, fragrances and perfumes and food flavoring applications.

## 7.2. L-perillyl alcohol downstream markets trends and prospects

#### Cancer treatment

Around 14 million new cases of cancer are revealed annually, and it's estimated that over the next 20 years the number of new cases will increase by about 70%. Nowadays dozens of treatment options for cancer exist. Among the most common types of cancer treatment there are:

- Surgery. Surgery is considered to be one of the most efficient cures, especially in the case when cancer has not metastasized and has not spread to other parts of the body. Surgery is the oldest known treatment for cancer. Moreover surgery is used not only to treat, but also to diagnose and sometimes even prevent cancer.
- Chemotherapy. Chemotherapy is the treatment of cancer with one or more cytotoxic antineoplastic drugs. The efficacy of chemotherapy treatment depends on the type and the stage of cancer. Moreover chemotherapy may be useful to reduce symptoms like pain or to reduce the size of an inoperable tumor in the hope that surgery will be possible in the future. Though it is an effective treatment, chemotherapy often causes side effects.
- Radiation Therapy. Radiation therapy is the use of high-energy x-rays or other particles to kill cancer cells. It is one of the most common treatments for cancer, either by itself or in combination with other forms of treatment.
- Immunotherapy. Immunotherapy is a type of cancer treatment that uses the body's immune system to fight cancer. There are several types of immunotherapy, including monoclonal antibodies, non-specific immunotherapies, and cancer vaccines.
- Hormone therapy. Hormone therapy implies any manipulating the body's hormones, including injection hormones and drugs. Another method of hormone therapy is removal of hormone glands to kill or prevent further cancer cells growth.
- Targeted Treatment. Targeted Treatment is a new and fast developing type of treatment that targets a cancer's specific genes, proteins, without damaging normal cells. There are 2 main forms of targeted drugs: Monoclonal antibody drugs and Small-molecule drugs.

At present cancer treatment is improving, among the alternative cancer treatments there are Palliative care, Hyperthermia, Stem Cell Transplant, Photodynamic Therapy, etc. Many more cancer treatment therapies are being developed. A particular cancer treatment choice depends on the type and stage of cancer, possible side effects, and the patient's preferences and overall health.



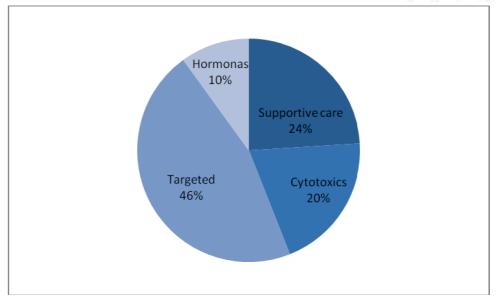


Figure 1. Global cancer treatment methods, 2014.

#### Fragrances and perfumes

The global perfume and fragrance market volume is expected to exceed \$45.5 billion by 2018, driven mainly be emerging markets.

Premium fragrances segment dominates in developed regions (Europe, North America), while mass fragrances segment has stronger position in developing ones, such as Asia Pacific and Latin America. Brazil is the world's biggest fragrance market. It has recently overcome the United States first in value.

Today perfume market is very crowded and requires a certain level of technology and expertise to produce product that will be attractive to customers. Women's fragrances continue to dominate the market, with a maximum number of product launches and innovations. However, men's fragrance shows growing trend too.

#### Food flavors

Today North America is the largest food flavor consumer, followed by Asia Pacific and Europe regions. The market is growing at about 5-5.5% per year. In near future it is Asia Pacific which will show the highest growth rates. The global food flavor market is expected to reach \$14 billion by 2018.

The market is expected to grow fueled by process of migration and formation of multicultural society, growth in international travel, wider choice in supermarkets, opening of ethnic food restaurants and food deliveries, etc. Today many consumers are more willing to try something new - and flavors provide endless opportunities there. But still, chocolate, strawberry, hazelnut, etc. remain its leading positions on the market.

Increasing consumer preferences towards the use of more natural and eco-friendly products are forcing flavors manufacturers to change strategies. Flavors from natural ingredients are expected to gain popularity on the market.



## 7.3. L-perillyl alcohol consumers globally

## Flavorings, for the food industry

#### **Europe**

#### **APOGEI Ltd**

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Fax: +380 44 5733542

#### **KARBOKOM Private Business**

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Tel: +380 66 6700010

#### **BEELIGHT Ltd**

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## Gusto Zakład Produkcyjno-Handlowo-Usługowy

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# Jar Jaskulski Aromaty

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### **CODA TRADE d.o.o.**

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#### KEMIN CENTRAL EUROPE s.r.o.

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Fax: +41 44 924 27 77



### **Landolt Hauser AG**

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### **INDUKERN CHEMIE AG**

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# G.E.I., SpA (Gruppo Essenziero Italiano)

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Fax: +39 011 887865

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# **DuPont Nutrition Biosciences ApS**

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Fax: +44 1427 811805

#### **Kershaws Frozen Foods**

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Scarisbrick

Southport, Merseyside PR8 5LD

United Kingdom

Tel: +44 1704 530767

Fax: +44 1704 536067

# **Nutrition Supplies**

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Co Cork

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Fax: +49 4193 995580



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Page 52 BAC Reports (C)



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Page 54 BAC Reports (C)



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