

**PETITION FOR INCLUSION OF SYNTHETIC SUBSTANCE ON THE  
NATIONAL LIST OF ORGANIC SUBSTANCES ALLOWED**

**7 CFR 205.601, Synthetic Substance allowed for use in organic crop production as  
an inert ingredient.**

**NOP Contact:**

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**JUL 26 2010**

1. The substance's chemical common name:  
Methyl laurate, 111-82-0
2. The manufacturer or producers name address and telephone number:

Stepan Company  
22 W. Frontage Road  
Northfield, IL 60093

Name of Contact Representative:

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*Note: Attachment 1 a description of the Stepan Process Flow is the only document for which Stepan Company is claiming Confidential Business Information. All remaining information contained within this petition is available for public review. Stepan is claiming this information confidential as the disclosure of this information would compromise the company's ability to compete in the market place.*

3. The intended or current use of the substance:

Methyl laurate is intended to be used as an inert ingredient in larvacide products as well as agricultural products. Currently, mineral oil is used in larvacide products intended for use in ponds, pools, and other stagnant water sources to prevent the development of mosquito larva. A blend of methyl laurate and methyl myristate is a naturally derived substance which functions as an inert gradient. Methyl myristate, a component of the intended blend product is already listed as approved by the National Organic Program.

4. Method of Application and Substance Rate:

Ground and aerial applications are anticipated. The highly favorable non-target toxicity allows for aerial applications. The recommended rate is 3-5 gallons per acre.

Methyl laurate when used in conjunction with methyl myristate as an inert ingredient in a larvacide allowing for delivery of the active agent. This specific blend of methyl esters of coconut oil is used because it remains a liquid at lower temperatures thus allowing for a less temperature sensitive mosquito control system.

As an agricultural inert ingredient, the methyl laurate/ methyl myristate blend functions as a non toxic naturally derived medium to deliver active agent. As an agricultural inert ingredient, the methyl laurate/ methyl myristate blend is used on fruits, vegetables, and grains. The most common applications of the blend are corn, wheat, soybeans, and cotton.

5. The source of the substance and a detailed description of its manufacturing/ processing procedures:

Methyl laurate is made from naturally occurring edible oil, coconut. Methyl laurate is manufactured in accordance with the current good manufacturing practice regulations. The manufacture of methyl laurate involves the fractionation of coconut oil fatty acids. The raw materials used to manufacture methyl laurate are: coconut oil, methanol, and catalyst. The catalyst used is sodium methoxide.

[Attachment 1 Processing flow diagram]

“CBI”

6. A summary of any available previous review by state or private certification programs or other organizations:

The methyl esters have been evaluated by the European Oleochemical and Allied Products Group.

Attachment 2: “The Safety of Fatty Acid Methyl Esters”, APAG, The European Oleochemicals and Allied Products Group.

The European Commission- European Chemicals Bureau.

Attachment 3: IUCLID dataset: methyl laurate, European Commission- European Chemicals Bureau

The Australian Pesticides and Veterinary Medicines Authority  
Attachment 4: The Australian Pesticides and Veterinary Medicines Authority,  
Commonwealth of Australia Gazette no. APVMA 3 7 March 2006

7. Information regarding EPA, FDA, and state regulatory authority registrations:

[U.S. Federal, TSCA  
TSCA 1996 Master Testing List  
TSCA High Production Volume Chemicals: 1990, 1994, and Post-1994  
FDA/CFSAN Everything Added to Food in the United States (EAFUS) Database  
1/25/2010  
FDA 21 CFR 175.105 Food Contact: Adhesives, Substances Generally Recognized as Safe (GRAS)  
FDA 21CFR 175.125 Food Contact: Pressure Sensitive Adhesives, Substances Generally Recognized as Safe (GRAS)  
FDA 21CFR 175.300 Food Contact: Resinous and Polymeric Coatings, Substances Generally Recognized as Safe (GRAS)  
FDA 21 CFR175.320 Food Contact: Resinous and Polymeric Coatings for Polyolefin Films, Substances Generally Recognized as Safe (GRAS)  
FDA 21 CFR 176.170 Food Contact: Paper and Paperboard in Contact with Aqueous and Fatty Foods, exempt from the extractives limitations  
U.S.

U.S. Federal, Pesticides  
Inert Ingredients Permitted for use in Nonfood Use Pesticide Products  
40 CFR180.910 Inert Ingredients used pre and post harvest; exemptions from the requirement of a tolerance

U.S. State, Texas  
Texas. Effects Screening Levels ( Texas Commission on Environmental Quality, as updated October 20, 2009)]

8. CAS Registry Service:

[CAS Registry Number: 111-82-0  
CAS Registry Name: dodecanoic acid, methyl ester]

9. Physical and Chemical Properties:

[Melt Point = 4-5 °C

Boiling Point = 262°C  
Density= 0.87 g/ml at 25°C  
Freezing Point=> 230°F

LD<sub>50</sub> >20gr/kg Oral Rat Non Toxic  
LC<sub>50</sub> > 1000ml/liter at 96 hours Fish Aquatic Testing Non Toxic  
Methyl laurate is considered readily biodegradable.

Methyl laurate is included in the High Production Volume Chemical Assessment: 1990, 1994 and Post 1994 Additions. Final Report is not yet publically available.  
See Attachments 2 and 3 for additional Toxicological Information.

10. Safety Information:

Attachment 5: Sigma Aldrich MSDS for isolated methyl laurate  
Attachment 6: Stepan Product Bulletin Stepan C-42  
Attachment 7: Stepan MSDS Stepan C-42  
Attachment 8: Hazardous Substances Data Bank

11. Research Information:

A search was conducted for research information available for methyl laurate. There exists a large amount of toxicological data in the public domain however, there is not a great deal of research information in the public domain. There are two attachments which are research reviews. The first review is for mineral oil, the current petroleum based product used as an inert ingredient. The second review is for vegetable oils in general. As biodegradation is a key property for any inert ingredient these reviews were included.

Attachment 9: Biodegradation of mineral oils-A review  
Attachment 10: Biodegradation of vegetable oils: A review

12. Petition Justification Statement:

Currently, mineral oil, a petroleum distillate is use in for mosquito abatement systems. The use of methyl laurate in a blend with methyl myristate will allow for the use of a naturally derived substance of low toxicity. In addition to the benefit of sourcing from renewable resources, this substance is also low in odor and biodegrades readily.

Oils occurring in their natural state are not viable alternatives as they become viscous liquids and or solids at lower temperatures thus rendering their use as an inert ingredient in cooler conditions non-viable.

Methyl laurate is a safe alternative to prevent mosquito born illnesses such as West Nile Virus and Malaria without disrupting the surrounding ecosystem. Current systems using petroleum based, mineral oil are not as readily biodegradable.

Attachment 11: The Gillette News-Record, “ Mission: Kill Larva”, July 31<sup>st</sup>, 2008

Attachment 12: Product Label for Mineral Oil based Larvicide

Stepan 7-26-2010

Attachments:

- Attachment 1: [Process Flow Diagram] CBI
- Attachment 2: "The Safety of Fatty Acid Methyl Esters", APAG, The European Oleochemicals and Allied Products Group
- Attachment 3: IUCLID dataset: methyl laurate, European Commission- European Chemicals Bureau
- Attachment 4: The Australian Pesticides and Veterinary Medicines Authority, Commonwealth of Australia Gazette no. APVMA 3 7 March 2006
- Attachment 5: Sigma Aldrich MSDS for methyl laurate
- Attachment 6: Stepan Product Bulletin, Stepan C-42
- Attachment 7: Stepan MSDS, Stepan C-42
- Attachment 8: Hazardous Substances Data Bank
- Attachment 9: Biodegradation of mineral oils-A review
- Attachment 10: Biodegradation of vegetable oils: A review
- Attachment 11: The Gillette News-Record, "Mission: Kill Larva", July 31, 2008
- Attachment 12: Product Label for Mineral Oil based Larvicide

**Attachment 1: Process Flow Diagram**  
**“CBI deleted”**

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## The Safety of Fatty Acid Methyl Esters

**& their acceptability as immediate previous cargoes to be used in foods after further processing**



### Background

Fatty Acid Methyl Esters are used indirectly in a wide range of food, pharmaceutical, cosmetic and industrial applications. Significant volumes of these materials are shipped regularly by sea and care needs to be taken to avoid contamination with noxious materials that could effect the safety of the final product and effect the processing of the oleochemical itself. For this reason oleochemical producers ensure that when shipping by sea the immediate previous cargo is on either of the Acceptable Immediate Previous Cargo lists set up by FOSFA and NIOP. The former is recognised in principle in Directive 96/3/EC. Methyl esters themselves are on both the FOSFA and the NIOP lists and provide useful safe previous cargoes for the shipment of oils and fats intended for use in food products following further processing.

The European Oleochemicals and Allied Products Group were surprised and concerned when an SCF AD Hoc Group proposed the removal of Fatty Acid Methyl Esters from the list of Acceptable Immediate Previous Cargoes appended to Directive 96/3/EC. This group of products have generally been considered safe and have already been given Regulatory Clearance for a wide range of direct and indirect food uses. Indeed the SCF's First Report on Chemically Defined Flavouring Substances (November 1995) lists methyl esters from the butyrate to the myristate in Category 1 (substances considered safe to use), the safest of the 5 categories used. *It should be noted that Hedsets providing data on the safety of methyl esters (C6-12, CAS 67762-39-4); C10, CAS 110-42-9; C12, CAS 111-82-0; C12-18, CAS 68937-84-8; C16-18, CAS 85586-21-6) were deposit with the European Union Chemical Information Data Base, European Chemical Bureau of the European Commission, Ispra (Italy), under Council Regulations (EEC) 793/93 on the Control of Risks of Existing Chemical Substances, in 1995.*

Removal of methyl esters from the Acceptable Previous Cargo list will reduce the availability of ships meeting the new EU criteria and will lead to difficulties in overseas trade and increased freight costs for both methyl esters and for oils and fats for food use.

### The APAG Task Force set up to assess the safety of Methyl Esters

As a direct result of the Ad Hoc Group's proposal APAG set up a Task Force to assemble and evaluate the available data on the safety of methyl esters. Members of the task force were :

**Dr W Aulmann** : a Senior Toxicologist with Henkel KGaA and an expert in carcinogenicity and tumorigenicity.

**Dr D Walker** : Manager, Safety and Regulatory Matters with Procter & Gamble and having responsibility for the safety of its oleochemicals world-wide.



**Dr A Hinze** : Manager, Safety and Regulatory Matters with Unichema International (part of the Unilever organisation) and having responsibility for the safety of it's oleochemicals world-wide.

**Mr R Pearson** : Secretary General of APAG

**Ms Ch De Cooman** : Sector Group Manager, CEFIC

The task force considered information in the following areas :

1. Acute oral toxicity
2. Metabolism
3. Mutagenicity
4. Tumorigenic potential
5. Skin and Eye Irritation
6. Nutritional use
7. Regulatory Clearances already given
8. Ease of Cleaning of Ships tanks
9. Ease of Removal during the Refining Process

Each of these areas is discussed later in this position paper.

### **Conclusions from the Task Force**

- Fatty Acid Methyl Esters do not deserve classification as carcinogens and the available evidence supports the safety of these materials. Our diligent search has failed to locate any peer-reviewed research or publication which would provide a basis for classifying these materials as tumorigenic. In addition we know of no authoritative body that has so classified these materials.
- Fatty Acid Methyl Esters are relatively easy to clean from ships tanks and do not require any extra special cleaning procedure.
- Fatty Acid Methyl Esters are easily removed from oils and fats during the normal refining process.
- The safety of the fatty acid methyl esters is recognised by a number of authoritative bodies (including the US FDA, the Flavour and Extract Manufacturers Association (FEMA), US EPA, and the Scientific Committee for Foods (SCF) ). They have been approved for a wide range of direct and indirect food applications.
- Fatty Acid Methyl Esters are a normal impurity in the interesterification process with sodium methylate catalyst. About 0.3% fatty acid methyl ester is formed. This reduces to under 0.1% after refining.
- Fatty Acid Methyl Esters should be regarded as an acceptable immediate previous cargo for the shipment of oils and fats for use in foods after further processing.
- In the opinion of the task force there is no supportable evidence to support their removal from the Annex to Directive 96/3/EC.

### **Review of the data**

- a) General Introduction to Fatty Acid Methyl Esters
- b) Acute Oral Toxicity
- c) Subchronic Toxicity
- d) Metabolism
- e) Mutagenicity

- f) Tumorigenic potential
- g) Skin and Eye Irritation and skin sensitization
- h) Nutritional use of methyl esters
- i) Regulatory Clearances
- j) Cleanability of Ship's Tanks
- k) Ease of removal during the refining process

### **a) General Introduction to Fatty Acid Methyl Esters :**

Fatty acid methyl esters are aliphatic organic esters primarily prepared by the reaction of a carboxylic acid derived from natural fats and oils and methanol. The fatty acids from which they are derived, such as oleic acid and stearic acid or their simple esters are not substances that one would expect to be carcinogenic, as was acknowledged by the authors of the articles cited by RTECS which we believe to be the source of the *alleged* classification of tumerogenic. Oleic and stearic acids as their glyceryl esters, are components of all natural oils and fats, including those in the human body. These same fatty acids, in the form of their esters with aliphatic alcohols, are components of natural waxes. And the alkali metal salts of stearic and oleic acid are very familiar to us as common soap. There is nothing in the structures of the common fatty acids or esters to suggest that they might be alkylating agents, or that they have other characteristics associated with carcinogenic potential.

Commercial fatty acid methyl esters are made from naturally occurring edible fats and oils by the esterification of the refined triglycerides with methanol in the presence of a base catalyst. These 'whole cut ' esters can be subsequently processed into various alkyl range cuts by fractional distillation. Fatty acid methyl esters are used extensively as intermediates in the manufacture of detergents, emulsifiers, wetting agents, stabilisers, textile treatments, and waxes among other applications. Lesser volumes of fatty acid methyl esters are used in a variety of direct and indirect food additive applications, including the dehydration of grapes to produce raisins, synthetic flavouring agents, and in metal lubricants for metallic articles intended for food contact use. Fatty acid methyl esters are also used as intermediates in the manufacture of a variety of food ingredients. [ [Back to the top](#) ]

### **b) Acute Oral Toxicity :**

Methyl esters in the range of C8 to C18 are practically non-toxic.

Gavage studies proved methyl laurate, methyl palmitate and methyl stearate to be non-toxic to rats with LD50s exceeding the limit dose of 2000 mg/Kg body weight (IUCALID data sheet for 68937-84)-8). The acute oral toxicity of methyl caprylate to rats was investigated and found not to be harmful up to a dose of 20.5g/Kg body weight (Clayton & Clayton, 1981-1982).

Methyl myristate was also found to be not harmful to white mice following a dose of 10ml/kg body weight by gavage.

Administration of an emulsion of methyl palmitate to mice by oral intubation or intraperitoneal injection produced no alteration in organ weight or phagocytic function of the reticuloendothelial system (Di-Luzio & Blickens, 1966)

C16-18 methyl esters of fatty acids were tested on Charles River SCD rats (200-300 gms) at 100% concentration and a dose level of 20.0 ml/Kg, resulting in a mortality rate of 0/10, giving an LD50 of > 17.4g/Kg. It appears that the single fixed dose test was done, rather than the typical dosage range due to the low toxicity of the methyl ester. [ [Back to the top](#) ]

**c) Subchronic Toxicity:**

Methyl oleate was fed to 4 groups of 5 male and 5 female rats for 12 weeks as 5% of their diet. Methyl oleate caused some loss of body weight in females. Food intake and food efficiency were not altered but symptoms of essential fatty acid deficiency as seen by "scaleness of the tail", were observed in the 7<sup>th</sup> week of the study (JAOCS 35, 156-8 (1958)). Male and female rats were fed either a fat-free diet or a fat-free diet supplemented with 100mg of methyl stearate/animal/day for 12 weeks. Males fed the supplemented diet showed weight loss while no or little effect was observed in the females. Total hepatic lipid levels of male rats fed the supplemented diet were similar to those of males given the supplemented diet (J. Nutr. 87(2), 168-172 (1965)). [ [Back to the top](#) ]

**d) Metabolism:**

Fatty acid methyl esters are metabolised as would other dietary fats. Higher molecular weight aliphatic esters are readily hydrolysed to the corresponding alcohol and acid and then generally oxidised to carbon dioxide and water via well known metabolism of breakdown into two-carbon fragments which are used by the body for energy and building blocks for synthesis. During digestion, they are hydrolysed to the free fatty acids for absorption from the intestine into the blood stream aided by lipase enzymes and bile salts as demonstrated in the rat by Mattison et al (J. Nutrition 102, 1171 (1972), J. Lipid Res 13, 325 (1972)). Once formed the free fatty acid is metabolised by known oxidative processes or they are reconstituted into glyceride esters and stored in the fat depots in the body. [ [Back to the top](#) ]

**e) Mutagenicity:**

Methyl laurate, methyl palmitate and methyl stearate were devoid of any mutagenic effect in the *S. typhimurium* reversion assay (IUCALID data sheet for 68937-84-8). Cis-methyl oleate and its parent compound, oleic acid, have given negative results in Salmonella/mammalian microsome assays conducted as part of NTP's chemical screening program for mutagenicity (Environ Mutagen 8, (Suppl 7): 1-119, 1986). A Salmonella preincubation assay, which is a modification of the standard plate incorporation assay was used in the short term mutagenicity test using Salmonella strains TA1535, TA1537, TA98 and TA100 with and without Aroclor 1254-induced rat and hamster metabolic activation systems. Fatty acid methyl esters containing 6 to 20 carbon atoms were tested for possible anticlastogenic effects on busulfan, a known alkylating agent, in Chinese hamster bone marrow cells using the chromosome aberration test. All of the fatty acid methyl esters, ranging from C12 to C19, with the exception of linolenic acid methyl ester, revealed a distinct anticlastogenic effect on busulfan-induced chromosome aberrations (Renner, 1986). In view of the close relations between mutagenesis and carcinogenesis, the inhibitory effect of various fatty acids/fatty acid methyl esters on busulfan-induced chromosome damage seen above is in contradiction to the reputed evidence regarding the promoting effect on carcinogenesis of dietary fats and their simple esters. [ [Back to the top](#) ]

**f) Tumorigenic potential :**

Five investigations on the carcinogenicity of fatty acid methyl esters are reported in the literature, 3 of them are subcutaneous injection studies, one is a topical application study and one is a feeding study. They all suffer from major deficiencies. Most importantly, the only studies suggestive of a carcinogenic effect of methyl stearate by the s.c. route used a dosing vehicle now known to be carcinogenic itself. This confounds interpretation of the marginal effects observed. Other studies of fatty acid methyl esters had substantial design deficiencies, including lack of appropriate controls, and do not provide any credible evidence of carcinogenic effects. Methyl oleate may have a weak mouse skin tumour promoting activity, but many essential nutrients have also been shown to have tumour promoting activity in specific model

systems at high doses. Generally, these effects are not relevant to the conditions of human exposure. Therefore they are not appropriate for risk assessment and legal application.

Comprehensive evaluations of the tumorigenic potential of fatty acid methyl esters have been carried out by Dr Robert Binder and Dr Daniel Marsman, P&G Corporate Toxicology Dept. and by Dr Walter Aulmann, Henkel Toxicology Dept.. A compendium of their joint findings has been prepared by Dr Walter Aulmann, and is appended to this position paper. It formed the basis for the above comments.

*It is suggested that the original reference to methyl esters being classified as tumorigenic was misinterpreted. This was an extract from the Registry of Toxic Effects of Chemical Substances (RTECS) which is a compendium of toxicity data extracted from the scientific literature. All data listed in the Registry are referenced to the sources in which the data appeared. The Registry has not evaluated the data; inclusion in the Registry does not mean endorsement of the reference. Evaluation of the cited reference is the responsibility of the reader. Tumorigenic citations are classified according to the reported results of the study only to aid the reader in selecting appropriate references for in depth review and evaluation. The in depth review attached concludes that the referenced work reported in RTECS does not justify classification of methyl esters as tumorigenic. Also we know of no authoritative body that has classified these materials as tumorigenic which is noteworthy given the long course of time that has passed since the publication of the data reported in RTECS. [ [Back to the top](#) ]*

### **g) Skin and Eye Irritation and skin sensitization:**

Skin irritation: Methyl myristate, when applied undiluted in four-hour occlude patch tests, produced slight to moderate skin irritation in rabbits (Safety evaluation of the methyl esters of saturated fatty acids - Unichema International, July 1992). Methyl laurate, methyl palmitate and methyl stearate were shown to be irritating in a test according to OECD guideline No 404 (IUCLID data sheet for 68937-84-8). While the rabbit skin displayed extraordinary sensitivity to the irritation potential fatty acid methyl esters proved to be readily compatible to the human skin : in tests conducted by Procter & Gamble using human subjects, virtually no irritation was observed for C8-C10, C12-C14 and C16-C18 methyl esters applied to the skin. A 24 hours standard patch test of C16-18 methyl esters at 100% concentration resulted in an average irritation grade of 0.0. This compares to an average irritation grade of 0.1 for C12-14 methyl ester and 0.4 average irritation grade for a 4% aqueous bar soap solution tested under the same conditions (Procter & Gamble, review of the safety of methyl esters, November 1996). Thus, it can be concluded, that long chain methyl esters derived from natural fats and oils have been shown to be very mild to the human skin.

Eye irritation: In a OECD 405 test the individual substances methyl laurate, methyl palmitate and methyl stearate were only slightly irritating (IUCLID data sheet for 68937-84-8). Undiluted methyl myristate was not irritant to rabbit eyes when tested using a modified Federal Hazardous Substances Labelling Act method (Safety evaluation of the methyl esters of saturated fatty acids - Unichema International, July 1992). Standard eye irritation tests were conducted on rabbits according to the Draize method by instilling 0.1 mL of C8-C10, C12-C14 and C16-C18 methyl ester at 100% concentration, non rinsed and rinsed. Based on this work C16-18 methyl esters are judged to be very mild. Slightly, readily clearing conjunctivitis was the only sign of irritation produced (Procter and Gamble, review of the safety of methyl esters, November 1996). Based on this work C8-C18 methyl esters are judged to be very mild to the eye.

Skin sensitization: Methyl esters of tallow acids did not display sensitizing effects in the guinea pig maximization assay (IUCLID data sheet for 68937-84-8). A repeated insult patch test of C16-C18 (palm methyl ester) on 68 human subjects did not induce skin sensitization (P&G unpublished data). Synopsizing these findings no indications exist for fatty acid methyl esters to have a sensitizing potential. [ [Back to the top](#) ]

## **h) Nutritional use of methyl esters:**

Methyl esters of fatty acids have been fed to experimental animals without toxic effects. Toxicity, growth and feed efficiency were tested in chickens by Reiser, et al (Agricultural and Food Chemistry 4, 798 (1956) with a conclusion that methyl esters are not toxic to poultry when included at the level of 3-15% in their feed rations as determined but their rate and efficiency of gain. Methyl esters of fatty acids have been fed to turkeys by Atkinson, et al (Poultry Science 36, 767 (1957), rats by Alfin-Slater, et al (J. Nutrition 87, 168 (1965) and to rabbits by Kritchevsky, et al (American J. Physiology 185, 279 (1956) without toxic effects.

Methyl esters of higher fatty acid methyl esters, including methyl myristate, methyl palmitate, methyl palmitoleate, methyl stearate, methyl oleate, methyl linoleate, methyl docosahexanoate, methyl ecosapentanoate and lesser amounts of the associated acid esters are cleared by the FDA as a supplementary source of fat for animal feed under 21CFR573.640. Additionally methyl esters of fatty acids derived from animal and/or vegetable fats are approved feed ingredients by the American Feed Control Officials as a fat nutrient supplement. Higher fatty acid methyl esters derived from tallow, coconut oil, palm kernel oil and palm oil, among other fats and oils have been widely used as fat supplements in animal feed over many years in the U.S. and in Europe. [ [Back to the top](#) ]

## **i) Regulatory Clearances :**

The safety of the fatty acid methyl esters is recognised by the U.S. Food and Drug Administration (FDA) who have approved, as a direct food additive, methyl esters of fatty acids produced from edible fats and oils for use in aqueous emulsions in dehydrating grapes to produce raisins (21CFR 172.225). *Residues on the raisins are approved up to 200ppm.* Additionally the lower fatty acid methyl esters, including methyl myristate and methyl laurate are approved for use as synthetic flavouring substances and adjuvants by the FDA (21CFR172.515) and by the European SCF (First report on Chemically Defined Flavouring Substances - November 1995). Methyl linolate (48%) methyl linolenate (52%) mixture has been deemed to be Generally Recognised as Safe (GRAS) by the Flavour and Extract Manufacturers' Association (FEMA).

Indirect food additive clearances include use of methyl esters of coconut fatty acid (C8-18) and methyl esters of C16-18 fatty acid derived from animal and vegetable fats and oils in surface lubricants employed in the manufacture of metallic articles that contact food (21CFR178.3910); defoaming agents used in coatings (21CFR176.200); defoaming agents used in the manufacture of paper and paper board intended for use in holding or transporting food (21CFR176.210); as a constituent of cellophane intended for food packaging (21CFR177.1200) or water-insoluble hydroxyethyl cellulose film (21CFR177.1400) and as a constituent of adhesives (21CFR175.105). C10-18 fatty acid methyl esters are cleared for use in the production of resin bonded filters intended for use in production, manufacture, processing and preparation of food.

Methyl esters of the higher fatty acids are exempted from the tolerance requirements under 21CFR182.99 for use as adjuvants for pesticide chemicals applied to growing crops or raw agricultural commodities after harvest. Additionally, the U.S. EPA has classified pesticide inert ingredients according to their toxicity to encourage the use of the least toxic inert ingredients available. Several fatty esters, including methyl myristate and methyl esters of cottonseed oil (composed of 2% methyl stearate, 17% methyl oleate, 24% methyl palmitate, and 55% methyl linoleate) are classified by the EPA in List 4B, inert ingredients for which the EPA has sufficient information to conclude that their current use patterns in pesticide products will not adversely affect public health and the environment (60FR 35396, July 7, 1995), based on the following:

- 1) These substances were reviewed by the Structure Activity Team of EPA's Office of

Pollution Prevention and Toxics and were judged to be of low concern for potential human health and/or environmental effects.

2) These substances are approved by the U.S. FDA as a direct food additive under 21CFR Part 172.

3) These inert ingredient substances were evaluated by the Office of Pesticide Program's Inert Review Group and determined to be of minimal risk.

The 4B list, which includes the methyl esters listed above, were provided to EPA's Office of Water and to FDA's Centre for Food Safety and Applied Nutrition for comment. No adverse comments were received. [ [Back to the top](#) ]

### **j) Cleanability of Ship's Tanks:**

Fatty acid methyl esters are readily cleanable from ship's deep tanks. Although not water soluble, fatty acid methyl esters are amenable to standard water blasting or detergent cleaning and do not adhere to metal surfaces any more than other fats and oils substances. Indeed fatty methyl esters have lower viscosity than the corresponding fats and oils from which they are derived and are liquids at ambient temperature. These physiochemical characteristics of fatty acid methyl esters facilitate their removal. The following comment was received from Stolt Nielsen a major international shipping company :

"With reference to your request on our procedures for the cleaning of cargo tanks after the carriage of methyl esters, and any comments on the ease of cleaning or otherwise, please note the following. Parcel Tanker operators would generally regard this product as a clean product, relatively easy to clean and remove prior to the following cargoes. It presents no problems with regard to softening or absorption into coatings or with odour. We would use a recirculation method of washing using a vegoil remover. (Details of the procedure are appended to this position paper). After washing and rinsing thoroughly the tanks are drained and hand dried and followed by an inspection of the tank, sump, manifolds and draincocks to ensure they are dry and free of all traces of washings"[ [Back to the top](#) ]

### **k) Ease of removal during the refining process :**

Fatty acid methyl esters are readily removed from edible fats and oils in the refining processes normally employed. The methyl esters are more volatile than the free fatty acids of the same carbon number and therefore can be readily removed by either physical refining or deodorisation processes. As an example, stearic acid has a boiling point of 209°C at 4mm Hg, whereas methyl stearate has a boiling point of 181°C at 4mm Hg, 28 degrees lower which indicates considerably higher volatility for the methyl ester. The lower vapour pressures are consistent for the homologous series of methyl esters versus the corresponding fatty acids (JAOCS - 56, 770A, 1979).

In the physical refining process, methyl esters can be removed in the refining/deodorising step, being removed along with the free fatty acid. In the caustic refining process, methyl esters are for the most part unaffected by the caustic at the conditions employed, but are removed in the deodorisation step along with traces of free fatty acid and odorous components.

The following comment was received from Ad Rozendaal of Unilever Research on the subject of ease of removal:

"I am somewhat surprised by the SCF proposal to remove FAME from the list of acceptable

previous cargoes. Fatty Acid Methyl Esters (FAME) are relatively easy to remove during the deodorisation or stripping stage and there is no reason to suspect that undesirable reaction products will be formed during the various refining stages. Approximate removal percentages during deodorisation/stripping are 90% at 210oC and 99% at 230°C (standard steam volumes)". He also inferred that methyl esters are produced at low levels during normal edible oil processing: "During interesterification with sodium methylate catalyst (standard dose), about 0.3% FAME is formed; after full refining under the above conditions this will be reduced to far below 0.1% which I believe is the current limit accepted by Unilever".

*In consideration of the above physicochemical and toxicological properties of the fatty acid methyl esters and the appended review regarding the alleged tumorigenic properties we consider methyl esters, including the C12 to C18 range to generally be regarded as safe as an acceptable immediate previous cargo for transport by sea of edible oils and fats intended for food use following further processing. [ [Back to the top](#) ]*

**R PEARSON**

APAG Secretary General

On behalf of the FAME Task Force

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**Attachments:**

1. Evaluation of the tumorigenic potential of fatty acid methyl esters (W Aulmann - Henkel).
2. Safety Evaluation of the Methyl Esters of saturated fatty acids (Unichema International).
3. Fax from Stolt Nielsen on the ease of cleaning of FAMEs from tanks.
4. IUCLID data sheet for 68937-84-8.
5. IUCLID data sheet for 85586-21-6.
6. Hedset Data Sheets CAS 110-42-9, 111-82-0 & 67762-39-4 . [ [Back to the top](#) ]

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**[Back to the Positions](#)**

**9<sup>th</sup> January 1997**

# I U C L I D

## D a t a s e t

Existing Chemical	Substance ID: 111-82-0
CAS No.	111-82-0
EINECS Name	methyl laurate
EINECS No.	203-911-3
Molecular Formula	C13H26O2

Dataset created by: EUROPEAN COMMISSION - European Chemicals Bureau

This dossier is a compilation based on data reported by the European Chemicals Industry following 'Council Regulation (EEC) No. 793/93 on the Evaluation and Control of the Risks of Existing Substances'. All (non-confidential) information from the single datasets, submitted in the IUCLID/HEDSET format by individual companies, was integrated to create this document.

The data have not undergone any evaluation by the European Commission.

Creation date: 18-FEB-2000

Number of Pages: 25

Chapters: all

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Flags: non-confidential



**1.0.1 OECD and Company Information**

**Name:** Henkel KGaA  
**Street:** Henkelstr. 67  
**Town:** 40589 Duesseldorf  
**Country:** Germany

**Name:** PROCTER & GAMBLE (CHEMICALS EUROPE) LTD.  
**Street:** P.O. BOX 9, HAYES GATE HOUSE, 27 UXBRIDGE ROAD  
**Town:** UB4 OJD HAYES MIDDLESEX  
**Country:** United Kingdom  
**Phone:** 44812422200  
**Telefax:** 44812422333  
**Telex:** 936310

**Name:** Unichema Chemicals Ltd.  
**Street:** Bebington, Wirral  
**Town:** L62 4UF Merseyside  
**Country:** United Kingdom

**1.0.2 Location of Production Site**

-

**1.0.3 Identity of Recipients**

-

**1.1 General Substance Information**

**Substance type:** organic  
**Physical status:** liquid

**1.1.1 Spectra**

-

**1.2 Synonyms**

CE-1218  
**Source:** Henkel KGaA Duesseldorf

CE-1290  
**Source:** Henkel KGaA Duesseldorf

CE-1295  
**Source:** Henkel KGaA Duesseldorf

CE-618  
**Source:** Henkel KGaA Duesseldorf

1. General Information

date: 18-FEB-2000  
Substance ID: 111-82-0

Degreez

**Source:** Henkel KGaA Duesseldorf

DODECANOIC ACID METHYL ESTER - METHYL ESTER CE1295

**Source:** PROCTER & GAMBLE (CHEMICALS EUROPE) LTD. HAYES MIDDLESEX

Dodecanoic acid, methyl ester

**Source:** Henkel KGaA Duesseldorf

DODECANSÄURE, METHYL-ESTER

**Source:** Henkel KGaA Duesseldorf  
Henkel KGaA Duesseldorf

DODECANSÄURE, METHYL-ESTER (ALTSTOFF)

**Source:** Henkel KGaA Duesseldorf

Dodecansäure, Methyl-ester

**Source:** Henkel KGaA Duesseldorf

DODECANSÄURE, METHYL-ESTER (ALTSTOFF)

**Source:** Henkel KGaA Duesseldorf

Dodecansäuremethyl-ester

**Source:** Henkel KGaA Duesseldorf

Emery 2296

**Source:** Henkel KGaA Duesseldorf

Estol 1502

**Source:** Henkel KGaA Duesseldorf

Kemester 9012

**Source:** Henkel KGaA Duesseldorf

Lauric acid, methyl ester

**Source:** Henkel KGaA Duesseldorf

Laurinsäure, Methyl-Ester

**Source:** Henkel KGaA Duesseldorf  
Henkel KGaA Duesseldorf

Laurinsäuremethylester

**Source:** Henkel KGaA Duesseldorf

Metholene 2296

**Source:** Henkel KGaA Duesseldorf

Methyl Dodecanoate

**Source:** Unichema Chemicals Ltd. Merseyside  
Henkel KGaA Duesseldorf

Methyl dodecylate

**Source:** Henkel KGaA Duesseldorf

Methyl laurate

**Source:** Unichema Chemicals Ltd. Merseyside

## 1. General Information

Methyl Laurate

**Source:** Henkel KGaA Duesseldorf

Methyl laurate (INCI)

**Source:** Henkel KGaA Duesseldorf

Methyl laurinate

**Source:** Henkel KGaA Duesseldorf

Methyl n-dodecanoate

**Source:** Henkel KGaA Duesseldorf

Methylaurat

**Source:** Henkel KGaA Duesseldorf

Pastell M 12

**Source:** Henkel KGaA Duesseldorf

Radia 7118

**Source:** Henkel KGaA Duesseldorf

Releez

**Source:** Henkel KGaA Duesseldorf

Stepan C40

**Source:** Henkel KGaA Duesseldorf

Uniphat A40

**Source:** Henkel KGaA Duesseldorf**1.3 Impurities**

-

**1.4 Additives**

-

**1.5 Quantity**

-

**1.6.1 Labelling**

-

**1.6.2 Classification**

-

**1.7 Use Pattern**

-

**1.7.1 Technology Production/Use**

-

**1.8 Occupational Exposure Limit Values**

Type of limit:

Limit value:

Remark: Not applicable.

Source: Unichema Chemicals Ltd. Merseyside

**1.9 Source of Exposure**

-

**1.10.1 Recommendations/Precautionary Measures**

-

**1.10.2 Emergency Measures**

-

**1.11 Packaging**

-

**1.12 Possib. of Rendering Subst. Harmless**

-

**1.13 Statements Concerning Waste**

-

**1.14.1 Water Pollution**

Classified by: KBWS (DE)  
Labelled by: KBWS (DE)  
Class of danger: 1 (weakly water polluting)  
Source: Henkel KGaA Duesseldorf  
Henkel KGaA Duesseldorf

(1)

Classified by: KBWS (DE)  
Labelled by:  
Class of danger: 1 (weakly water polluting)  
Remark: German Commission for the Assessment of Water Polluting  
Substances (Datasheet No. 834)  
Source: Transfer program  
Henkel KGaA Duesseldorf

**1.14.2 Major Accident Hazards**

**Legislation:** Stoerfallverordnung (DE)  
**Substance listed:** no  
**Source:** Henkel KGaA Duesseldorf  
Henkel KGaA Duesseldorf

**1.14.3 Air Pollution**

-

**1.15 Additional Remarks**

**Remark:** Can cause irritation when in contact with eyes.  
Unlikely to be harmful unless excessive amount swallowed.  
Vapour of the heated product can cause irritation when  
inhaled.  
**Source:** Unichema Chemicals Ltd. Merseyside  
**Test substance:** ESTOL 1502 and ESTOL 1507

(2)

**Source:** Henkel KGaA Duesseldorf

**Remark:** The Methyl esters of saturated fatty acids are acceptable  
materials based on toxicological data. They have a long  
history of safe use in the chemical industry.  
**Source:** Henkel KGaA Duesseldorf

(3)

**1.16 Last Literature Search**

-

**1.17 Reviews**

-

**1.18 Listings e.g. Chemical Inventories**

-

**2.1 Melting Point**

Value: = 5 degree C  
Source: Henkel KGaA Duesseldorf  
Henkel KGaA Duesseldorf (4)

Value: >= 6 degree C  
Decomposition: no  
Sublimation: no  
Method: other  
Year: 1961  
GLP: no data  
Source: PROCTER & GAMBLE (CHEMICALS EUROPE) LTD. HAYES MIDDLESEX (5)

**2.2 Boiling Point**

Value: > 204.4 degree C at 1013.08 hPa  
Decomposition: no  
Method: other  
GLP: no data  
Remark: NO METHOD CITED - CONFIRMED BY PLANT EXPERIENCE :  
DISTILLATION TO BE DONE AT > 260 dC.  
Source: PROCTER & GAMBLE (CHEMICALS EUROPE) LTD. HAYES MIDDLESEX

Value: ca. 250 degree C  
Source: Henkel KGaA Duesseldorf  
Henkel KGaA Duesseldorf (6)

**2.3 Density**

Type: density  
Value: = .8695 g/cm<sup>3</sup> at 20 degree C  
Source: Henkel KGaA Duesseldorf  
Henkel KGaA Duesseldorf (7)

Type: density  
Value: ca. .87 g/cm<sup>3</sup> at 20 degree C  
Source: Henkel KGaA Duesseldorf  
Henkel KGaA Duesseldorf (6)

Type: relative density  
Value: ca. .866 at 25 degree C  
Method: other  
GLP: no data  
Source: PROCTER & GAMBLE (CHEMICALS EUROPE) LTD. HAYES MIDDLESEX (8)

**2.3.1 Granulometry**

-

**2.4 Vapour Pressure**

**Value:** < 1.333 hPa at 22.2 degree C  
**Method:** other (measured)  
**GLP:** no data  
**Source:** PROCTER & GAMBLE (CHEMICALS EUROPE) LTD. HAYES MIDDLESEX (9)

**Value:** = 1.33 hPa at 87.8 degree C  
**Source:** Henkel KGaA Duesseldorf  
Henkel KGaA Duesseldorf (4)

**Value:** = 2.66 hPa at 102.8 degree C  
**Source:** Henkel KGaA Duesseldorf  
Henkel KGaA Duesseldorf (7)

**2.5 Partition Coefficient**

**log Pow:** = 5.43  
**Method:** other (calculated): Leo, Hansch: Version CLOGP 3.3  
**Year:**  
**Source:** Henkel KGaA Duesseldorf  
Henkel KGaA Duesseldorf (10)

**log Pow:** = 6.02  
**Method:** other (measured): using HPLC/MS  
**Year:**  
**Source:** Henkel KGaA Duesseldorf  
Henkel KGaA Duesseldorf (10)

**2.6.1 Water Solubility**

**Qualitative:** of very low solubility  
**Remark:** ACCORDING TO CRC HANDBOOK ; "INSOLUBLE"  
**Source:** PROCTER & GAMBLE (CHEMICALS EUROPE) LTD. HAYES MIDDLESEX

**Qualitative:** not soluble  
**Source:** Henkel KGaA Duesseldorf  
Henkel KGaA Duesseldorf (6)

**2.6.2 Surface Tension**

-

**2.7 Flash Point**

**Value:** ca. 115.6 degree C  
**Type:** closed cup  
**Method:** other  
**Year:**  
**GLP:** no data  
**Source:** PROCTER & GAMBLE (CHEMICALS EUROPE) LTD. HAYES MIDDLESEX  
**Test condition:** PENSKI-MARTENS CLOSED CUP - ASTM D93-62

**Value:** ca. 130 degree C  
**Type:** open cup  
**Method:** other: DIN ISO 2592  
**Year:**  
**Source:** Henkel KGaA Duesseldorf  
Henkel KGaA Duesseldorf

(6)

**2.8 Auto Flammability**

-

**2.9 Flammability**

**Result:** non flammable  
**Method:** other  
**GLP:** no data  
**Source:** PROCTER & GAMBLE (CHEMICALS EUROPE) LTD. HAYES MIDDLESEX

(11)

**2.10 Explosive Properties**

-

**2.11 Oxidizing Properties**

-

**2.12 Additional Remarks**

**Remark:** Solidification point: 4 degr. C  
**Source:** Henkel KGaA Duesseldorf  
Henkel KGaA Duesseldorf

(6)



**3.1.1 Photodegradation**

-

**3.1.2 Stability in Water**

-

**3.1.3 Stability in Soil**

-

**3.2 Monitoring Data (Environment)**

-

**3.3.1 Transport between Environmental Compartments**

-

**3.3.2 Distribution**

-

**3.4 Mode of Degradation in Actual Use**

**Remark:** HYDROLYSIS OF THE METHYL ESTER TO FORM THE FATTY ACID AND METHANOL  
**Source:** PROCTER & GAMBLE (CHEMICALS EUROPE) LTD. HAYES MIDDLESEX

**3.5 Biodegradation**

**Type:** aerobic  
**Inoculum:** other: sewage treatment plant effluent/biological stage  
**Concentration:** 2 mg/l  
**Degradation:** 100 - 69 % after 30 day  
**Result:** readily biodegradable  
**Method:** Directive 84/449/EEC, C.6 "Biotic degradation - closed bottle test"  
**Year:** **GLP:**  
**Test substance:** other TS  
**Remark:** Original experimental data: ungenügender Rest O2 5ppm 28T  
Abbauergebnisse > 100% / Bewertung unter Vorbehalt..  
**Source:** Henkel KGaA Duesseldorf  
**Test condition:** #1: 2 mg/l referring to Active Substance: 100% with  
parameter % BSB/CSB  
#2: 5 mg/l referring to Active Substance: 69% with parameter  
% BSB/CSB  
**Test substance:** Analogy; data taken from CASRN 85566-27-4 <Fatty acids,  
C12-16, Me esters>.

(12) (13) (14)

3. Environmental Fate and Pathways

date: 18-FEB-2000  
Substance ID: 111-82-0

**Type:** aerobic  
**Inoculum:** other: municipal sewage treatment plant effluent  
**Concentration:** 2 mg/l related to Test substance  
**Degradation:** 100 % after 30 day  
**Result:** readily biodegradable  
**Method:** OECD Guide-line 301 D "Ready Biodegradability: Closed Bottle Test"  
**Year:** 1981 **GLP:** no  
**Test substance:** other TS  
**Source:** Henkel KGaA Duesseldorf  
Henkel KGaA Duesseldorf  
**Test substance:** Analogy! C12-14 fatty acids, methylester

(15)

**Type:**  
**Inoculum:**  
**Method:**  
**Year:** **GLP:**  
**Test substance:**  
**Remark:** KNOWN TO BE BIODEGRADABLE - NO SPECIFIC PROCTER & GAMBLE  
STUDY DATA AVAILABLE  
**Source:** PROCTER & GAMBLE (CHEMICALS EUROPE) LTD. HAYES MIDDLESEX

**3.6 BOD5, COD or BOD5/COD Ratio**

-

**3.7 Bioaccumulation**

-

**3.8 Additional Remarks**

-

**AQUATIC ORGANISMS****4.1 Acute/Prolonged Toxicity to Fish**

**Type:** static  
**Species:** Lepomis macrochirus (Fish, fresh water)  
**Exposure period:** 96 hour(s)  
**Unit:** mg/l **Analytical monitoring:** yes  
**LC50:** > 1000  
**Method:** other  
**Year:** 1975 **GLP:**  
**Test substance:**  
**Remark:** NO SOLVENT USED - MATERIAL ADDED BY DIRECT WEIGHING  
PROCTER & GAMBLE STUDY PERFORMED BY UNION CARBIDE  
ENVIRONMENTAL SERVICES (1979)  
**Source:** PROCTER & GAMBLE (CHEMICALS EUROPE) LTD. HAYES MIDDLESEX (16)

**Type:** static  
**Species:** Leuciscus idus (Fish, fresh water)  
**Exposure period:** 48 hour(s)  
**Unit:** mg/l **Analytical monitoring:**  
**LC0:** 1000  
**LC50:** 1700  
**LC100:** 3000  
**Method:** other: Bestimmung der Wirkung von Wasserinhaltsstoffen auf  
Fische, DIN 38412 Teil 15  
**Year:** **GLP:** no  
**Test substance:** as prescribed by 1.1 - 1.4  
**Source:** Henkel KGaA Duesseldorf  
Henkel KGaA Duesseldorf  
**Test condition:** Poorly soluble test substance treated with Ultraturax for  
10 min prior to test. (17)

**Type:**  
**Species:** Leuciscus idus (Fish, fresh water)  
**Exposure period:** 48 hour(s)  
**Unit:** mg/l **Analytical monitoring:**  
**LC0:** 1000  
**LC50:** 1700  
**LC100:** 3000  
**Method:** other: DIN 38412, Teil 15 (Golden orfe, acute toxicity test)  
**Year:** **GLP:**  
**Test substance:** as prescribed by 1.1 - 1.4  
**Remark:** Related to: Test substance  
**Source:** Henkel KGaA Duesseldorf  
**Test substance:** Active Matter = 98 % (18) (19)

**4.2 Acute Toxicity to Aquatic Invertebrates**

-

**4.3 Toxicity to Aquatic Plants e.g. Algae**

**Species:** Scenedesmus subspicatus (Algae)  
**Endpoint:**  
**Exposure period:** 96 hour(s)  
**Unit:** mg/l **Analytical monitoring:**  
**EC0:** .3  
**EC50:** 1.5  
**Method:** other: DIN 38412, Teil 9 (Algal growth inhibition test)  
**Year:** **GLP:**  
**Test substance:** as prescribed by 1.1 - 1.4  
**Method:** Method conforms with OECD Guide-line 201  
**Remark:** ErC50(24-72h) = 2,6 mg/l. Validierung mit ähnlichen  
 Substanzen erforderlich!  
 Related to: Test substance  
**Source:** Henkel KGaA Duesseldorf  
**Test substance:** Active Matter = 98 %

(20) (21)

**4.4 Toxicity to Microorganisms e.g. Bacteria**

**Type:** aquatic  
**Species:** domestic sewage  
**Exposure period:** 3 day  
**Unit:** mg/l **Analytical monitoring:** yes  
**:** > 10000  
**Method:** other  
**Year:** **GLP:** no data  
**Test substance:** as prescribed by 1.1 - 1.4  
**Source:** PROCTER & GAMBLE (CHEMICALS EUROPE) LTD. HAYES MIDDLESEX  
**Test condition:** INOCULUM = SETTLED DOMESTIC SEWAGE STORED AT 20 dC FOR 24 -  
 36 HOURS.

END-POINT = THRESHOLD INHIBITION LEVEL - CONCENTRATION AT WHICH A DEPRESSED BIOLOGICAL OXIDATION IS FIRST DETECTED

(22)

**Type:** aquatic  
**Species:** Pseudomonas putida (Bacteria)  
**Exposure period:** 16 hour(s)  
**Unit:** mg/l **Analytical monitoring:**  
**EC0:** > 10000  
**Method:** other: DIN 38412 Teil 8: "Bestimmung der Hemmwirkung von Wasserinhaltsstoffen auf Bakterien." (cell multiplication inhibition test)  
**Year:** **GLP:** no  
**Test substance:** as prescribed by 1.1 - 1.4  
**Remark:** 10000 mg/l was highest concentration tested.  
**Source:** Henkel KGaA Duesseldorf

(17)

## 4. Ecotoxicity

date: 18-FEB-2000  
Substance ID: 111-82-0

**Type:** aquatic  
**Species:** Pseudomonas putida (Bacteria)  
**Exposure period:** 30 minute(s)  
**Unit:** mg/l **Analytical monitoring:**  
**EC0:** > 10000  
**Method:** other: Pseudomonas-Atmungs-Hemmtest, DIN 38412 Teil 27, in Vorbereitung, "Bestimmung der Hemmwirkung von Abwasser auf die Sauerstoffzehrung von Pseudomonas putida."  
**Year:** **GLP:** no  
**Test substance:** as prescribed by 1.1 - 1.4  
**Remark:** 10000 mg/l was highest concentration tested.  
**Source:** Henkel KGaA Duesseldorf  
 Henkel KGaA Duesseldorf

(17)

**Type:** aquatic  
**Species:** Pseudomonas putida (Bacteria)  
**Exposure period:** 16 hour(s)  
**Unit:** mg/l **Analytical monitoring:**  
**EC0:** > 10000  
**Method:** other: Pseudomonas-Zellvermehrungs-Hemmtest, DIN 38412 Teil 8, zum Gelbdruck verabschiedet, "Bestimmung der Hemmwirkung von Wasserinhaltsstoffen auf Bakterien."  
**Year:** **GLP:** no  
**Test substance:** as prescribed by 1.1 - 1.4  
**Remark:** 10000 mg/l was highest concentration tested.  
**Source:** Henkel KGaA Duesseldorf  
 Henkel KGaA Duesseldorf

(17)

**Type:**  
**Species:** Pseudomonas putida (Bacteria)  
**Exposure period:** 30 minute(s)  
**Unit:** mg/l **Analytical monitoring:**  
**EC0:** 10000  
**Method:** other: DIN 38412, Teil 27 (Bacterial oxygen consumption test)  
**Year:** **GLP:**  
**Test substance:** as prescribed by 1.1 - 1.4  
**Method:** Method conforms with OECD Guide-line 209  
**Remark:** LC0/EC0 entspricht der höchsten Prüfkonzentration  
 Related to: Test substance  
**Source:** Henkel KGaA Duesseldorf  
**Test substance:** Active Matter = 98 %

(23) (19)

**Type:**  
**Species:** Pseudomonas putida (Bacteria)  
**Exposure period:** 16 hour(s)  
**Unit:** mg/l **Analytical monitoring:**  
**EC0:** 10000  
**Method:** other: DIN 38412, Teil 8 (Bacterial cell growth inhibition test)  
**Year:** **GLP:**  
**Test substance:** as prescribed by 1.1 - 1.4  
**Remark:** LC0/EC0 entspricht der höchsten Prüfkonzentration  
 Related to: Test substance  
**Source:** Henkel KGaA Duesseldorf  
**Test substance:** Active Matter = 98 %

(24) (19)

**4.5 Chronic Toxicity to Aquatic Organisms****4.5.1 Chronic Toxicity to Fish**

-

**4.5.2 Chronic Toxicity to Aquatic Invertebrates**

-

**TERRESTRIAL ORGANISMS****4.6.1 Toxicity to Soil Dwelling Organisms**

**Type:**  
**Species:** other: Heliothis virescens  
**Endpoint:** mortality  
**Exposure period:** 12 day  
**Unit:** other: % dietary level  
**LC50:** = .15  
**Method:** other: Antibiotic effects  
**Year:** **GLP:** no data  
**Test substance:** as prescribed by 1.1 - 1.4  
**Source:** Henkel KGaA Duesseldorf

(25)

**Type:**  
**Species:** other: Heliothis zea  
**Endpoint:** mortality  
**Exposure period:** 14 day  
**Unit:** other: % dietary level  
**LC50:** = .14  
**Method:** other: Antibiotic effects  
**Year:** **GLP:** no data  
**Test substance:** as prescribed by 1.1 - 1.4  
**Source:** Henkel KGaA Duesseldorf

(25)

**Type:**  
**Species:** other: Pectinophora gossypiella  
**Endpoint:** mortality  
**Exposure period:** 14 day  
**Unit:** other: % dietary level  
**LC50:** = .12  
**Method:** other: Antibiotic effects  
**Year:** **GLP:** no data  
**Test substance:** as prescribed by 1.1 - 1.4  
**Source:** Henkel KGaA Duesseldorf

(25)

#### 4.6.2 Toxicity to Terrestrial Plants

**Species:** other terrestrial plant: Nicotiana tabaccum  
**Endpoint:** other: inhibition of axillary bud growth  
**Expos. period:**  
**Unit:**  
**Method:** other: see Test Condition  
**Year:** **GLP:** no data  
**Test substance:**  
**Remark:** Dodecanoic acid methylester inhibited bud growth by ca. 95 %  
 parameter: % inhibition of axillary bud growth (average from  
 200 plants of 4 types of field-grown tobacco); data  
 extracted from graph  
**Source:** Henkel KGaA Duesseldorf  
**Test condition:** test compound was emulsified in water and wetting agent  
 (chemical nature not stated); plants were sprayed with  
 different concentrations (0.1 - 0.4 M = 20 - 40 ml);  
 axillary buds wilted and dried within 30-60 min.

(26)

**Species:** other terrestrial plant: Nicotiana tabaccum  
**Endpoint:** other: inhibition of axillary bud growth  
**Expos. period:**  
**Unit:**  
**Method:** other: see freetext Test Condition  
**Year:** **GLP:** no data  
**Test substance:**  
**Remark:** Dodecanoic acid methylester inhibited bud growth by ca. 95 %  
 parameter: % inhibition of axillary bud growth (average from  
 200 plants of 4 types of field-grown tobacco); data  
 extracted from graph  
**Source:** Henkel KGaA Duesseldorf  
 Henkel KGaA Duesseldorf  
**Test condition:** test compound was emulsified in water and wetting agent  
 (chemical nature not stated); plants were sprayed with  
 different concentrations (0.1 - 0.4 M = 20 - 40 ml);  
 axillary buds wilted and dried within 30-60 min.

(26)

#### 4.6.3 Toxicity to other Non-Mamm. Terrestrial Species

-

**4.7 Biological Effects Monitoring**

-

**4.8 Biotransformation and Kinetics**

-

**4.9 Additional Remarks**

-



**5.1 Acute Toxicity****5.1.1 Acute Oral Toxicity**

Type: LD50  
Species: rat  
Sex:  
Number of  
Animals:  
Vehicle:  
Value: > 20000 mg/kg bw  
Method: other  
Year: 1981 GLP: yes  
Test substance: as prescribed by 1.1 - 1.4  
Remark: DIARRHEA WAS THE ONLY OVERT SYMPTOM OF TOXICITY  
Source: PROCTER & GAMBLE (CHEMICALS EUROPE) LTD. HAYES MIDDLESEX (27)

Type: LD50  
Species: rat  
Sex:  
Number of  
Animals:  
Vehicle:  
Value: > 2000 mg/kg bw  
Method:  
Year: GLP:  
Test substance:  
Remark: Limit-Test; strain: Wistar  
Source: Henkel KGaA Duesseldorf  
Henkel KGaA Duesseldorf (28)

Type: LD50  
Species: rat  
Sex:  
Number of  
Animals:  
Vehicle:  
Value: > 2000 mg/kg bw  
Method: Directive 84/449/EEC, B.1 "Acute toxicity (oral)"  
Year: GLP: yes  
Test substance: as prescribed by 1.1 - 1.4  
Remark: Limit-Test; strain: Wistar  
Source: Henkel KGaA Duesseldorf (29)

**5.1.2 Acute Inhalation Toxicity**

-

**5.1.3 Acute Dermal Toxicity**

-

**5.1.4 Acute Toxicity, other Routes**

-

**5.2 Corrosiveness and Irritation****5.2.1 Skin Irritation**

Species: rabbit  
Concentration:

Exposure:  
Exposure Time:  
Number of  
Animals:

PDII:  
Result: slightly irritating  
EC classificat.: not irritating  
Method: other  
Year: 1981 GLP: yes  
Test substance: as prescribed by 1.1 - 1.4  
Source: PROCTER & GAMBLE (CHEMICALS EUROPE) LTD. HAYES MIDDLESEX  
Test substance: UNDILUTED

(30)

Species: rabbit  
Concentration:

Exposure:  
Exposure Time:  
Number of  
Animals:

PDII:  
Result: highly irritating  
EC classificat.: irritating  
Method: Directive 84/449/EEC, B.4 "Acute toxicity (skin irritation)"  
Year: 1984 GLP: yes  
Test substance: as prescribed by 1.1 - 1.4  
Source: Henkel KGaA Duesseldorf  
Henkel KGaA Duesseldorf

(31) (32)

Species: rabbit  
Concentration:

Exposure:  
Exposure Time:  
Number of  
Animals:

PDII:  
Result: highly irritating  
EC classificat.: irritating  
Method: Directive 84/449/EEC, B.4 "Acute toxicity (skin irritation)"  
Year: 1984 GLP: yes  
Test substance: as prescribed by 1.1 - 1.4  
Source: Henkel KGaA Duesseldorf

(33) (34)

5. Toxicity

date: 18-FEB-2000  
Substance ID: 111-82-0

Species: rabbit  
Concentration:  
  
Exposure:  
Exposure Time:  
Number of  
Animals:  
PDII:  
Result: moderately irritating  
EC classificat.: not irritating  
Method: OECD Guide-line 404 "Acute Dermal Irritation/Corrosion"  
Year: 1981 GLP: yes  
Test substance: as prescribed by 1.1 - 1.4  
Remark: Primary Irritation Index: 3.89  
Source: Henkel KGaA Duesseldorf

(35)

Species: human  
Concentration:  
  
Exposure:  
Exposure Time:  
Number of  
Animals:  
PDII:  
Result: not irritating  
EC classificat.: not irritating  
Method: other: open Epicutan-test according to Burckhardt  
Year: 1964 GLP: yes  
Test substance: as prescribed by 1.1 - 1.4  
Source: Henkel KGaA Duesseldorf  
Henkel KGaA Duesseldorf

(36)

Species: human  
Concentration:  
  
Exposure:  
Exposure Time:  
Number of  
Animals:  
PDII:  
Result: not irritating  
EC classificat.: not irritating  
Method: other: open Epicutan-test according to Burckhardt  
Year: 1964 GLP: yes  
Test substance: as prescribed by 1.1 - 1.4  
Source: Henkel KGaA Duesseldorf

(37)

**5.2.2 Eye Irritation**

**Species:** rabbit  
**Concentration:**  
**Dose:**  
**Exposure Time:**  
**Comment:**  
**Number of Animals:**  
**Result:** not irritating  
**EC classificat.:** not irritating  
**Method:** Draize Test  
**Year:** 1959 **GLP:** yes  
**Test substance:** as prescribed by 1.1 - 1.4  
**Source:** PROCTER & GAMBLE (CHEMICALS EUROPE) LTD. HAYES MIDDLESEX  
**Test substance:** 0.1 ML UNDILUTED

**Species:** rabbit  
**Concentration:**  
**Dose:**  
**Exposure Time:**  
**Comment:**  
**Number of Animals:**  
**Result:** slightly irritating  
**EC classificat.:** not irritating  
**Method:** OECD Guide-line 405 "Acute Eye Irritation/Corrosion"  
**Year:** **GLP:**  
**Test substance:**  
**Source:** Henkel KGaA Duesseldorf  
Henkel KGaA Duesseldorf

(38)

**Species:** rabbit  
**Concentration:**  
**Dose:**  
**Exposure Time:**  
**Comment:**  
**Number of Animals:**  
**Result:** slightly irritating  
**EC classificat.:** not irritating  
**Method:** OECD Guide-line 405 "Acute Eye Irritation/Corrosion"  
**Year:** **GLP:**  
**Test substance:**  
**Remark:** Fatty acid methyl esters are unusual in this respect that they are more irritating to the skin than to the eye.  
**Source:** Henkel KGaA Duesseldorf

(39)

**5.3 Sensitization**

Type:  
 Species: guinea pig  
 Number of  
 Animals:  
 Vehicle:  
 Result: not sensitizing  
 Classification:  
 Method:  
 Year:  
 Test substance: as prescribed by 1.1 - 1.4  
 Source: Henkel KGaA Duesseldorf

GLP:

(40)

**5.4 Repeated Dose Toxicity**

Species:  
 Strain:  
 Route of admin.:  
 Exposure period:  
 Frequency of  
 treatment:  
 Post. obs.  
 period:  
 Doses:  
 Control Group:  
 Method:  
 Year:

Sex:

GLP:

Test substance:  
 Remark: METHYL ESTERS OF HIGHER FATTY ACIDS ARE CLEARED AS A  
 SUPPLEMENTARY SOURCE OF FAT FOR ANIMAL FEED BY THE US FDA  
 (21CFR 573.640).  
 NUMEROUS FEEDING STUDIES PUBLISHED.  
 Source: PROCTER & GAMBLE (CHEMICALS EUROPE) LTD. HAYES MIDDLESEX

**5.5 Genetic Toxicity 'in Vitro'**

Type: Ames test  
 System of  
 testing: Salmonella typhimurium  
 Concentration: 8, 40, 200, 1000 and 5000 ug/plate  
 Metabolic  
 activation: with and without  
 Result: negative  
 Method: OECD Guide-line 471 "Genetic Toxicology: Salmonella  
 typhimurium Reverse Mutation Assay"  
 Year: 1983  
 Test substance: as prescribed by 1.1 - 1.4  
 Source: Henkel KGaA Duesseldorf

GLP: yes

(41)

## NOTICE

### **Methyl Laurate, Methyl Linoleate, Methyl Oleate, Methyl Myristate, Methyl Palmitate, Methyl Pentadecanoate, Methyl Stearate, Dimethyl Azelate, Dimethyl Pimelate**

The Australian Pesticides and Veterinary Medicines Authority (APVMA) has before it an application for the approval of the following new active constituents for use in veterinary chemical products: Methyl Laurate, Methyl Linoleate, Methyl Oleate, Methyl Myristate, Methyl Palmitate, Methyl Pentadecanoate, Methyl Stearate, Dimethyl Azelate and Dimethyl Pimelate. Methyl Laurate, Methyl Linoleate, Methyl Oleate, Methyl Myristate, Methyl Palmitate, Methyl Pentadecanoate Methyl Stearate, Dimethyl Azelate and Dimethyl Pimelate may be used in combination as synthetic analogue of feline facial pheromones.

In accordance with section 12 of the Agvet Code, the APVMA invites any person to submit a relevant written submission as to whether the applications for approvals of Methyl Laurate, Methyl Linoleate, Methyl Oleate, Methyl Myristate, Methyl Palmitate, Methyl Pentadecanoate, Methyl Stearate, Dimethyl Azelate and Dimethyl Pimelate should be granted. Submissions should state the grounds on which they are based. Such grounds should relate only to the matters that the APVMA is required to take into account in deciding whether to grant the approval. Comments must be received by the APVMA within 28 days of the date of this Gazette.

#### **Particulars of Active Constituent**

Common Name: Methyl Laurate  
IUPAC Name: Methyl dodecanoate  
CAS Number: 111-82-0  
Molecular Formula:  $C_{13}H_{26}O_2$   
Molecular Weight: 214.35

Common Name: Methyl Linoleate  
IUPAC Name: Methyl cis, cis-9,12-octadeca-dienoate  
CAS Number: 112-63-0  
Molecular Formula:  $C_{19}H_{34}O_2$   
Molecular Weight: 294.47

Common Name: Methyl Oleate  
IUPAC Name: Methyl (Z)-9-octadecenoate  
CAS Number: 112-62-9  
Molecular Formula:  $C_{19}H_{36}O_2$   
Molecular Weight: 296.49

Common Name: Methyl Myristate  
IUPAC Name: Methyl tetradecanoate  
CAS Number: 124-10-7  
Molecular Formula:  $C_{15}H_{30}O_2$   
Molecular Weight: 242.40

Common Name: Methyl Palmitate  
IUPAC Name: Methyl hexadecanoate  
CAS Number: 112-39-0  
Molecular Formula:  $C_{17}H_{34}O_2$   
Molecular Weight: 270.45

Common Name: Methyl Pentadecanoate  
IUPAC Name: Methyl Pentadecanoate  
CAS Number: 7132-64-1  
Molecular Formula:  $C_{16}H_{32}O_2$   
Molecular Weight: 256.42

Common Name: Methyl Stearate  
IUPAC Name: Methyl octadecanoate  
CAS Number: 112-61-8  
Molecular Formula:  $C_{19}H_{38}O_2$   
Molecular Weight: 298.5

Common Name: Dimethyl Azelate  
IUPAC Name: dimethyl nonanedioate  
CAS Number: 1732-10-1  
Molecular Formula:  $C_{11}H_{20}O_4$   
Molecular Weight: 216.74

Common Name: Dimethyl Pimelate  
IUPAC Name: dimethyl heptanedioate  
CAS Number: 1732-08-7  
Molecular Formula:  $C_9H_{16}O_4$

**Summary of the APVMA's Evaluation of Methyl Laurate, Methyl Linoleate, Methyl Oleate, Methyl Myristate, Methyl Palmitate, Methyl Pentadecanoate, Methyl Stearate, Dimethyl Azelate and Dimethyl Pimelate**

The Chemistry and Residues Program of the APVMA has evaluated the Chemistry aspects of Methyl Laurate, Methyl Linoleate, Methyl Oleate, Methyl Myristate, Methyl Palmitate, Methyl Pentadecanoate, Methyl Stearate, Dimethyl Azelate and Dimethyl Pimelate active constituents (manufacturing process, quality control procedures, batch analysis results and analytical methods) and found them to be acceptable.

Methyl Laurate, Methyl Linoleate, Methyl Oleate, Methyl Myristate, Methyl Palmitate, Methyl Pentadecanoate, Methyl Stearate, Dimethyl Azelate and Dimethyl Pimelate are not subject to an accepted pharmacopeia monograph.

The Office of Chemical Safety (OCS) of the Department of Health and Ageing has considered the toxicological aspects of Methyl Laurate, Methyl Linoleate, Methyl Oleate, Methyl Myristate, Methyl Palmitate, Methyl Pentadecanoate, Methyl Stearate, Dimethyl Azelate and Dimethyl Pimelate, and advised that there are no toxicological objections to the approval of these chemicals.

The APVMA accepts the findings and recommendations of its advisers on these criteria.

The APVMA is satisfied that the proposed importation and use of Methyl Laurate, Methyl Linoleate, Methyl Oleate, Methyl Myristate, Methyl Palmitate, Methyl Pentadecanoate, Methyl Stearate, Dimethyl Azelate and Dimethyl Pimelate would not be an unde toxicological hazard to the safety of people exposed to it during its handling and use.

Written Submissions on the APVMA's proposal to grant approval for Methyl Laurate, Methyl Linoleate, Methyl Oleate, Methyl Myristate, Methyl Palmitate, Methyl Pentadecanoate, Methyl Stearate, Dimethyl Azelate and Dimethyl Pimelate should be addressed in writing to

Dr Paul Sethi  
Chemistry Manager  
Chemistry and Residues Program  
Australian Pesticides and Veterinary Medicines Authority  
PO Box E240  
KINGSTON ACT 2604

Phone: (02) 6272 3987

Fax: (02) 6272 3551



**SIGMA-ALDRICH****Material Safety Data Sheet**Version 3.0  
Revision Date 09/25/2008  
Print Date 06/07/2010**1. PRODUCT AND COMPANY IDENTIFICATION**

Product name : Methyl laurate

Product Number : 234591  
Brand : Aldrich

Company : Sigma-Aldrich  
3050 Spruce Street  
SAINT LOUIS MO 63103  
USA

Telephone : +18003255832  
Fax : +18003255052  
Emergency Phone # : (314) 776-6555

**2. COMPOSITION/INFORMATION ON INGREDIENTS**

Synonyms : Methyl dodecanoate  
Lauric acid methyl ester

Formula :  $C_{13}H_{26}O_2$   
Molecular Weight : 214.34 g/mol

CAS-No.	EC-No.	Index-No.	Concentration
<b>Methyl laurate</b>			
111-82-0	203-911-3	-	-

**3. HAZARDS IDENTIFICATION****Emergency Overview****OSHA Hazards**

No known OSHA hazards

**HMIS Classification**

Health Hazard: 0

Flammability: 0

Physical hazards: 0

**NFPA Rating**

Health Hazard: 0

Fire: 0

Reactivity Hazard: 0

**Potential Health Effects**

**Inhalation** May be harmful if inhaled. May cause respiratory tract irritation.

**Skin** May be harmful if absorbed through skin. May cause skin irritation.

**Eyes** May cause eye irritation.

**Ingestion**

May be harmful if swallowed.

**4. FIRST AID MEASURES****If inhaled**

If breathed in, move person into fresh air. If not breathing give artificial respiration

**In case of skin contact**

Wash off with soap and plenty of water.

**In case of eye contact**

Flush eyes with water as a precaution.

**If swallowed**

Never give anything by mouth to an unconscious person. Rinse mouth with water.

**5. FIRE-FIGHTING MEASURES****Flammable properties**

Flash point &gt; 113.00 °C (&gt; 235.40 °F) - closed cup

Ignition temperature no data available

**Suitable extinguishing media**

Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide.

**Special protective equipment for fire-fighters**

Wear self contained breathing apparatus for fire fighting if necessary.

**6. ACCIDENTAL RELEASE MEASURES****Personal precautions**

Avoid breathing vapors, mist or gas.

**Environmental precautions**

Do not let product enter drains.

**Methods for cleaning up**

Keep in suitable, closed containers for disposal.

**7. HANDLING AND STORAGE****Handling**

Normal measures for preventive fire protection.

**Storage**

Keep container tightly closed in a dry and well-ventilated place.

**8. EXPOSURE CONTROLS/PERSONAL PROTECTION**

Contains no substances with occupational exposure limit values.

**Personal protective equipment****Respiratory protection**

Respiratory protection is not required. Where protection is desired, use multi-purpose combination (US) or type ABEK (EN 14387) respirator cartridges. Use respirators and components tested and approved under appropriate government standards such as NIOSH (US) or CEN (EU).

**Hand protection**

For prolonged or repeated contact use protective gloves.

**Eye protection**

Safety glasses

**Hygiene measures**

General industrial hygiene practice.

**9. PHYSICAL AND CHEMICAL PROPERTIES****Appearance**

Form liquid, clear

Colour colourless

**Safety data**

pH no data available

Melting point 4 - 5 °C (39 - 41 °F)

Boiling point 262 °C (504 °F) at 1,021 hPa (766 mmHg)

Flash point &gt; 113.00 °C (&gt; 235.40 °F) - closed cup

Ignition temperature no data available

Lower explosion limit no data available

Upper explosion limit no data available

Density 0.87 g/mL at 25 °C (77 °F)

Water solubility no data available

**10. STABILITY AND REACTIVITY****Storage stability**

Stable under recommended storage conditions.

**Materials to avoid**

Strong oxidizing agents, Strong bases

**Hazardous decomposition products**

Hazardous decomposition products formed under fire conditions. - Carbon oxides

**11. TOXICOLOGICAL INFORMATION****Acute toxicity**

no data available

**Irritation and corrosion**

no data available

**Sensitisation**

no data available

**Chronic exposure**

IARC: No component of this product present at levels greater than or equal to 0.1% is identified as probable, possible or confirmed human carcinogen by IARC.

ACGIH: No component of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by ACGIH.

**SARA 313 Components**

SARA 313: This material does not contain any chemical components with known CAS numbers that exceed the threshold (De Minimis) reporting levels established by SARA Title III, Section 313.

**SARA 311/312 Hazards**

No SARA Hazards

**Massachusetts Right To Know Components**

No components are subject to the Massachusetts Right to Know Act.

**Pennsylvania Right To Know Components**

	CAS-No.	Revision Date
Methyl laurate	111-82-0	

**New Jersey Right To Know Components**

	CAS-No.	Revision Date
Methyl laurate	111-82-0	

**California Prop. 65 Components**

This product does not contain any chemicals known to State of California to cause cancer, birth, or any other reproductive defects.

**16. OTHER INFORMATION****Further information**

Copyright 2008 Sigma-Aldrich Co. License granted to make unlimited paper copies for internal use only. The above information is believed to be correct but does not purport to be all inclusive and shall be used only as a guide. The information in this document is based on the present state of our knowledge and is applicable to the product with regard to appropriate safety precautions. It does not represent any guarantee of the properties of the product. Sigma-Aldrich Co., shall not be held liable for any damage resulting from handling or from contact with the above product. See reverse side of invoice or packing slip for additional terms and conditions of sale.



Product Bulletin

AGRICULTURE

<b>Product Name</b>	<b>STEPAN® C-42</b>																																		
<b>Chemical Description</b>	STEPAN C-42 is a Methyl Laurate/Methyl Myristate ester blend derived from vegetable oils.																																		
<b>CAS Registry No.</b>	111-82-0 & 124-10-7																																		
<b>Composition</b>	<table border="0"> <tr> <td>C<sub>10</sub> or lower, % .....</td> <td>1</td> </tr> <tr> <td>C<sub>12</sub> (Methyl Laurate), % .....</td> <td>72</td> </tr> <tr> <td>C<sub>14</sub> (Methyl Myristate), % .....</td> <td>26</td> </tr> <tr> <td>C<sub>16</sub> or higher, % .....</td> <td>1</td> </tr> </table>	C <sub>10</sub> or lower, % .....	1	C <sub>12</sub> (Methyl Laurate), % .....	72	C <sub>14</sub> (Methyl Myristate), % .....	26	C <sub>16</sub> or higher, % .....	1																										
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<b>Applications</b>	STEPAN C-42 can be used as a solvent, cosolvent, crop oil, or carrier oil in agricultural applications.																																		
<b>Typical Properties</b>	<table border="0"> <tr> <td>Appearance at 25°C .....</td> <td>Clear Liquid</td> </tr> <tr> <td>Moisture, % .....</td> <td>0.1 max.</td> </tr> <tr> <td>Color, Gardner .....</td> <td>1 max.</td> </tr> <tr> <td>Acid Number .....</td> <td>0.6 max.</td> </tr> <tr> <td>Saponification Value .....</td> <td>253</td> </tr> <tr> <td>Iodine Number .....</td> <td>0.3 max.</td> </tr> <tr> <td>Melting Point, °C (°F) .....</td> <td>-5 (23)</td> </tr> <tr> <td>Boiling Point, °C (°F) .....</td> <td>&gt;260 (&gt;500)</td> </tr> <tr> <td>Flash Point, PMCC °C (°F) .....</td> <td>&gt;93 (&gt;201)</td> </tr> <tr> <td>Density, g/ml (lbs/U.S. gal) .....</td> <td>0.87 (7.3)</td> </tr> <tr> <td>Viscosity at 25°C, cps .....</td> <td>7</td> </tr> <tr> <td>RVOC, U.S. EPA, % (Methyl Ester, &lt;C12) .....</td> <td>22</td> </tr> <tr> <td>Solubility</td> <td></td> </tr> <tr> <td>    Water .....</td> <td>Insoluble</td> </tr> <tr> <td>    Methanol .....</td> <td>Soluble</td> </tr> <tr> <td>    Kerosene .....</td> <td>Soluble</td> </tr> <tr> <td>    Xylene .....</td> <td>Soluble</td> </tr> </table>	Appearance at 25°C .....	Clear Liquid	Moisture, % .....	0.1 max.	Color, Gardner .....	1 max.	Acid Number .....	0.6 max.	Saponification Value .....	253	Iodine Number .....	0.3 max.	Melting Point, °C (°F) .....	-5 (23)	Boiling Point, °C (°F) .....	>260 (>500)	Flash Point, PMCC °C (°F) .....	>93 (>201)	Density, g/ml (lbs/U.S. gal) .....	0.87 (7.3)	Viscosity at 25°C, cps .....	7	RVOC, U.S. EPA, % (Methyl Ester, <C12) .....	22	Solubility		Water .....	Insoluble	Methanol .....	Soluble	Kerosene .....	Soluble	Xylene .....	Soluble
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Methanol .....	Soluble																																		
Kerosene .....	Soluble																																		
Xylene .....	Soluble																																		
<b>Biodegradability</b>	This product is readily biodegradable. Additional information is available upon request.																																		
<b>Toxicity</b>	STEPAN C-42 is practically non-toxic orally (LD <sub>50</sub> > 5g/kg) and causes slight skin and eye irritation.																																		
<b>Storage &amp; Handling</b>	<p>Normal safety precautions (i.e gloves and safety goggles) should be employed when handling STEPAN C-42. Contact with the eyes and prolonged contact with the skin should be avoided. Wash thoroughly after using the material.</p> <p><u>Standard Packaging:</u> STEPAN C-42 is made to order in bulk or 55 gallon drums (net weight 390 lb/177 kg).</p>																																		

STEPAN® is a registered trademark of Stepan Company.



## MATERIAL SAFETY DATA SHEET

### 1. Chemical Product & Company Identification

**Material name** STEPAN C-42  
**Version #** 08  
**Revision date** 01-13-2010  
**Product code** 0742  
**Chemical class** Methyl esters  
**Manufacturer** Stepan Company  
 22 West Frontage Road  
 Northfield, IL 60093 USA  
  
**Emergency** Medical 800-228-5635  
 Chemtrec 800-424-9300  
 Chemtrec Int'l 703-527-3887  
  
**General information** General (847) 446-7500

### 2. Hazards Identification

**Emergency overview** Contact with eyes may cause irritation. Contact with skin may cause irritation. May cause irritation of respiratory tract.

**Potential health effects**

- Eyes** Contact with eyes may cause irritation.
- Skin** This product may cause irritation to the skin.
- Inhalation** Inhalation of vapors or mists of the product may be irritating to the respiratory system.
- Ingestion** Ingestion of large amounts may produce gastrointestinal disturbances including irritation, nausea, and diarrhea.

### 3. Composition / Information on Ingredients

Components	CAS #	Percent
Methyl Laurate	111-82-0	70 - 75
Methyl myristate	124-10-7	25 - 30

### 4. First Aid Measures

**First aid procedures**

- Eye contact** Immediately flush eyes with plenty of water for at least 15 minutes. If irritation persists get medical attention.
- Skin contact** For skin contact flush with large amounts of water. Immediately take off all contaminated clothing. If irritation persists get medical attention. Wash clothing separately before reuse.
- Inhalation** If symptoms are experienced, remove source of contamination or move victim to fresh air. If symptoms persist, get medical attention. If the affected person is not breathing, apply artificial respiration. If breathing is difficult, give oxygen. Get medical attention immediately.
- Ingestion** If ingestion of a large amount does occur, seek medical attention. Do NOT induce vomiting.

### 5. Fire Fighting Measures

**Flammable properties** Porous material such as rags, paper, insulation, or organic clay may spontaneously combust when wetted with this material.

**Extinguishing media**

- Suitable extinguishing media** Water fog. Foam. Dry chemical powder. Carbon dioxide (CO<sub>2</sub>).

**Protection of firefighters**

- Protective equipment and precautions for firefighters** As in any fire, wear self-contained breathing apparatus pressure-demand, MSHA/NIOSH (approved or equivalent) and full protective gear.

## 6. Accidental Release Measures

<b>Personal precautions</b>	Isolate area. Keep unnecessary personnel away. Stay upwind. Keep out of low areas. Ventilate closed spaces before entering.
<b>Environmental precautions</b>	Prevent further leakage or spillage if safe to do so.
<b>Methods for containment</b>	Prevent entry into waterways, sewers, basements or confined areas.
<b>Methods for cleaning up</b>	Eliminate ignition sources including sources of electrical, static or frictional sparks. Wear appropriate protective equipment and clothing during clean-up.  Small Spills: Use a non-combustible material like vermiculite, sand or earth to soak up the product and place into a container for later disposal.  Large Spills: Dike far ahead of liquid spill for later disposal.

## 7. Handling and Storage

<b>Handling</b>	Avoid contact with skin and eyes. Wash hands thoroughly after handling.
<b>Storage</b>	Store in cool place. Keep in a well-ventilated place. Do not handle or store near an open flame, heat or other sources of ignition. Prevent electrostatic charge build-up by using common bonding and grounding techniques.

## 8. Exposure Controls / Personal Protection

<b>Engineering controls</b>	Use general ventilation. Local exhaust is suggested for use, where possible, in enclosed or confined spaces.
<b>Personal protective equipment</b>	
<b>General</b>	Eye wash fountain and emergency showers are recommended.
<b>Eye / face protection</b>	Wear chemical goggles. Face-shield.
<b>Skin protection</b>	Wear suitable protective clothing. Use impervious gloves.
<b>Respiratory protection</b>	If ventilation is not sufficient to effectively prevent buildup of aerosols or vapors, appropriate NIOSH/MSHA respiratory protection must be provided.

## 9. Physical & Chemical Properties

<b>Physical state</b>	Liquid.
<b>Form</b>	Liquid.
<b>Boiling point</b>	525.2 °F (274 °C)
<b>Flash point</b>	> 201 °F (> 93.9 °C) PMCC
<b>Evaporation rate</b>	Estimated slower than ethyl ether.
<b>Vapor pressure</b>	0.0163 torr, 25 C
<b>Vapor density</b>	Estimated heavier than air.
<b>Specific gravity</b>	0.8653 g/ml @ 25 C
<b>Solubility (water)</b>	Insoluble
<b>RVOC</b>	0 %
<b>Viscosity</b>	2 cps @ 25 C

## 10. Stability & Reactivity

<b>Chemical stability</b>	Stable at normal conditions.
<b>Conditions to avoid</b>	Heat, flames and sparks.
<b>Incompatible materials</b>	This product may react with strong alkalis. Strong oxidizing agents
<b>Hazardous decomposition products</b>	Alcohols
<b>Possibility of hazardous reactions</b>	Will not occur.

## 11. Toxicological Information

Not available.

## 12. Ecological Information

Not available.

### 13. Disposal Considerations

**Disposal instructions** Dispose in accordance with all applicable regulations. All wastes must be handled in accordance with local, state and federal regulations. Regulations vary.

### 14. Transport Information

**Notes** Refer to bill of lading or container label for DOT or other transportation hazard classification, if any.

### 15. Regulatory Information

**Reportable Quantity** There is no calculable reportable quantity (RQ) for this product.

#### CERCLA (Superfund) reportable quantity

None

#### Superfund Amendments and Reauthorization Act of 1986 (SARA)

**Section 302 extremely hazardous substance** No

**Section 311 hazardous chemical** No

#### Inventory status

Country(s) or region	Inventory name	On inventory (yes/no)*
Australia	Australian Inventory of Chemical Substances (AICS)	Yes
Canada	Domestic Substances List (DSL)	Yes
Canada	Non-Domestic Substances List (NDSL)	No
China	Inventory of Existing Chemical Substances in China (IECSC)	Yes
Europe	European Inventory of New and Existing Chemicals (EINECS)	Yes
Europe	European List of Notified Chemical Substances (ELINCS)	No
Japan	Inventory of Existing and New Chemical Substances (ENCS)	Yes
Korea	Existing Chemicals List (ECL)	Yes
New Zealand	New Zealand Inventory	No
Philippines	Philippine Inventory of Chemicals and Chemical Substances (PICCS)	Yes
United States & Puerto Rico	Toxic Substances Control Act (TSCA) Inventory	Yes

A "Yes" indicates that all components of this product comply with the inventory requirements administered by the governing country(s)

### 16. Other Information

**Further information** HMIS® is a registered trade and service mark of the NPCA.

**HMIS® ratings**  
Health: 1  
Flammability: 1  
Physical hazard: 0  
Personal protection: X

**NFPA ratings**  
Health: 1  
Flammability: 1  
Instability: 0

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**Issue date** 01-13-2010



**HSDB® - Hazardous Substances Data Bank****Name Of Substance:**

METHYL DODECANOATE

**CAS Registry Number:**

111-82-0

**Section 0 - Administrative Information**

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**Hazardous Substances Databank Number: 5550****Last Revision Date**

20030214

**Review Date**

Reviewed by SRP on 5/20/1999

**Update History**

Complete Update on 02/14/2003, 1 field added/edited/deleted.  
Complete Update on 11/08/2002, 1 field added/edited/deleted.  
Complete Update on 08/06/2002, 1 field added/edited/deleted.  
Complete Update on 01/14/2002, 1 field added/edited/deleted.  
Complete Update on 08/09/2001, 1 field added/edited/deleted.  
Complete Update on 05/15/2001, 1 field added/edited/deleted.  
Complete Update on 06/12/2000, 1 field added/edited/deleted.  
Complete Update on 02/08/2000, 1 field added/edited/deleted.  
Complete Update on 02/02/2000, 1 field added/edited/deleted.  
Complete Update on 09/21/1999, 1 field added/edited/deleted.  
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Complete Update on 03/10/1998, 1 field added/edited/deleted.  
Complete Update on 11/01/1997, 1 field added/edited/deleted.  
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Complete Update on 01/05/1995, 1 field added/edited/deleted.

Complete Update on 04/04/1994, 1 field added/edited/deleted.

Field update on 01/08/1993, 1 field added/edited/deleted.

Complete Update on 10/10/1990, 1 field added/edited/deleted.

Complete Update on 04/16/1990, 1 field added/edited/deleted.

Field update on 03/06/1990, 1 field added/edited/deleted.

Complete Update on 01/16/1985

## Section 1 - Substance Identification

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### Name Of Substance:

METHYL DODECANOATE

### CAS Registry Number:

111-82-0

### Synonyms

DODECANOIC ACID, METHYL ESTER \*\*PEER REVIEWED\*\*

FEMA NUMBER 2715

*Furia, T.E. (ed.). CRC Handbook of Food Additives. 2nd ed. Cleveland: The Chemical Rubber Co., 1972., p. 893*

*Peer Reviewed*

LAURIC ACID, METHYL ESTER \*\*PEER REVIEWED\*\*

METHYLENE 2296 \*\*PEER REVIEWED\*\*

METHYL N-DODECANOATE \*\*PEER REVIEWED\*\*

METHYL DODECYLATE \*\*PEER REVIEWED\*\*

**<< METHYL >> << LAURATE >> \*\*PEER REVIEWED\*\***

METHYL LAURINATE \*\*PEER REVIEWED\*\*

UNIPHAT A40 \*\*PEER REVIEWED\*\*

### Molecular Formula:

C13-H26-O2 \*\*PEER REVIEWED\*\*

## Section 2 - Manufacturing/Use Information

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### Methods of Manufacturing

BY PROLONGED BOILING OF LAURIC ACID WITH METHANOL IN THE PRESENCE OF SULFURIC ACID.

*Fenaroli's Handbook of Flavor Ingredients. Volume 2. Edited, translated, and revised by T.E. Furia and N. Bellanca. 2nd ed. Cleveland: The Chemical Rubber Co., 1975., p. 378*

*Peer Reviewed*

### Formulations/Preparations

Grades: 69%, 74%, 90%, 96%, 99.8%

Lewis, R.J., Sr (Ed.). *Hawley's Condensed Chemical Dictionary*. 12th ed. New York, NY: Van Nostrand Rheinhold Co., 1993, p. 772

Peer Reviewed

### Manufacturers

Henkel Corp., Hq, The Triad, Suite 200, 2200 Renaissance Blvd., Gulph Mills, PA 19406, (610) 270-8100; Chemicals Group, 5051 Este Creek Dr., Cincinnati, OH 45232-1446, (513) 482-3000; Production site: City of Commerce, CA 90040

SRI. 1998 *Directory of Chemical Producers -United States of America*. SRI International, Menlo Park, CA. 1998., p. 753

Peer Reviewed

The Proctor and Gamble Company, Hq, 301 East Sixth Street, PO Box 599, Cincinnati, OH 45201, (513) 983-5607; Production site: Sacramento, CA 95828

SRI. 1998 *Directory of Chemical Producers -United States of America*. SRI International, Menlo Park, CA. 1998., p. 753

Peer Reviewed

Stepan Company, Hq, 22 West Frontage Rd., Northfield, IL 60093, (800) 745-STEP

SRI. 1998 *Directory of Chemical Producers -United States of America*. SRI International, Menlo Park, CA. 1998., p. 753

Peer Reviewed

Unichema North America, Hq, 4650 South Racine Ave, Chicago, IL 60609, (773) 376-9000; Production site: Chicago, IL 60609

SRI. 1998 *Directory of Chemical Producers -United States of America*. SRI International, Menlo Park, CA. 1998., p. 753

Peer Reviewed

### Other Manufacturing Information

Method of purification: vacuum fractional distillation.

Lewis, R.J., Sr (Ed.). *Hawley's Condensed Chemical Dictionary*. 12th ed. New York, NY: Van Nostrand Rheinhold Co., 1993, p. 772

Peer Reviewed

NON-ALCOHOLIC BEVERAGES 0.50-5.0 PPM; ICE CREAM, ICES, ETC 0.50-5.0 PPM; CANDY 0.02-0.50 PPM; BAKED GOODS 1.0 PPM.

Fenaroli's *Handbook of Flavor Ingredients*. Volume 2. Edited, translated, and revised by T.E. Furia and N. Bellanca. 2nd ed. Cleveland: The Chemical Rubber Co., 1975., p. 378

Peer Reviewed

USEFUL IN FATTY FLAVORS, COCONUT, NUT.

Furia, T.E. (ed.). *CRC Handbook of Food Additives*. 2nd ed. Volume 2. Boca Raton, Florida: CRC Press, Inc., 1980., p. 288

Peer Reviewed

### Major Uses

Intermediate for detergents, emulsifiers, wetting agents, stabilizers, lubricants, plasticizers, textiles, flavoring

Lewis, R.J., Sr (Ed.). *Hawley's Condensed Chemical Dictionary*. 12th ed. New York, NY: Van Nostrand Rheinhold Co., 1993, p. 772

Peer Reviewed

CHEM INT-EG, FOR ALKANOLAMIDES, FATTY ALCOHOLS & ACIDS \*\*PEER REVIEWED\*\*

FLAVORING AGENT, EG, IN BAKED GOODS & ICE CREAM \*\*PEER REVIEWED\*\*

## Section 3 - Chemical and Physical Properties

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### Color/Form

#### COLORLESS LIQUID

*Fenaroli's Handbook of Flavor Ingredients. Volume 2. Edited, translated, and revised by T.E. Furia and N. Bellanca. 2nd ed. Cleveland: The Chemical Rubber Co., 1975., p. 378*

Peer Reviewed

#### Water-white liquid

*Lewis, R.J., Sr (Ed.). Hawley's Condensed Chemical Dictionary. 12th ed. New York, NY: Van Nostrand Rheinhold Co., 1993, p. 772*

Peer Reviewed

### Odor

#### FATTY, FLORAL ODOR REMINISCENT OF WINE

*Fenaroli's Handbook of Flavor Ingredients. Volume 2. Edited, translated, and revised by T.E. Furia and N. Bellanca. 2nd ed. Cleveland: The Chemical Rubber Co., 1975., p. 378*

Peer Reviewed

#### OILY, WINEY, FATTY ODOR

*Furia, T.E. (ed.). CRC Handbook of Food Additives. 2nd ed. Volume 2. Boca Raton, Florida: CRC Press, Inc., 1980., p. 288*

Peer Reviewed

### Taste

#### FATTY TASTE

*Furia, T.E. (ed.). CRC Handbook of Food Additives. 2nd ed. Volume 2. Boca Raton, Florida: CRC Press, Inc., 1980., p. 288*

Peer Reviewed

### Boiling Point

267 deg C

*Lide, D.R. (ed.). CRC Handbook of Chemistry and Physics. 76th ed. Boca Raton, FL: CRC Press Inc., 1995-1996., p. 3-148*

Peer Reviewed

### Melting Point

5.2 deg C

*Lide, D.R. (ed.). CRC Handbook of Chemistry and Physics. 76th ed. Boca Raton, FL: CRC Press Inc., 1995-1996., p. 3-148*

Peer Reviewed

### Molecular Weight

214.35

*Lide, D.R. (ed.). CRC Handbook of Chemistry and Physics. 76th ed. Boca Raton, FL: CRC Press Inc., 1995-1996., p. 3-148*

Peer Reviewed

### Density/Specific Gravity

0.8702 @ 20 deg C/4 deg C

*Lide, D.R. (ed.). CRC Handbook of Chemistry and Physics. 76th ed. Boca Raton, FL: CRC Press Inc., 1995-1996., p. 3-148*

*Peer Reviewed*

### **Octanol/Water Partition Coefficient**

log Kow= 5.41

***Krop HB et al; Chemosphere 34: 107-19 (1997)***

*Peer Reviewed*

### **Solubilities**

Insol in water; miscible with ethyl alcohol, ether, acetone

*Lide, D.R. (ed.). CRC Handbook of Chemistry and Physics. 76th ed. Boca Raton, FL: CRC Press Inc., 1995-1996., p. 3-148*

*Peer Reviewed*

SOL IN MOST COMMON ORGANIC SOLVENTS

*Fenaroli's Handbook of Flavor Ingredients. Volume 2. Edited, translated, and revised by T.E. Furia and N. Bellanca. 2nd ed. Cleveland: The Chemical Rubber Co., 1975., p. 378*

*Peer Reviewed*

### **Spectral Properties**

Index of refraction: 1.4301 @ 25 deg C/D

*Lewis, R.J., Sr (Ed.). Hawley's Condensed Chemical Dictionary. 12th ed. New York, NY: Van Nostrand Rheinhold Co., 1993, p. 772*

*Peer Reviewed*

index of refraction: 1.4319 @ 20 deg C/D

*Lide, D.R. (ed.). CRC Handbook of Chemistry and Physics. 76th ed. Boca Raton, FL: CRC Press Inc., 1995-1996., p. 3-148*

*Peer Reviewed*

IR: 2086 (Coblentz Society Spectral Collection)

*Weast, R.C. and M.J. Astle. CRC Handbook of Data on Organic Compounds. Volumes I and II. Boca Raton, FL: CRC Press Inc. 1985., p. V1 811*

*QC Reviewed*

NMR: 125 (Sadler Research Laboratories Spectral Collection)

*Weast, R.C. and M.J. Astle. CRC Handbook of Data on Organic Compounds. Volumes I and II. Boca Raton, FL: CRC Press Inc. 1985., p. V1 811*

*QC Reviewed*

MASS: 1528 (Atlas of Mass Spectral Data, John Wiley & Sons, New York)

*Weast, R.C. and M.J. Astle. CRC Handbook of Data on Organic Compounds. Volumes I and II. Boca Raton, FL: CRC Press Inc. 1985., p. V1 811*

*QC Reviewed*

### **Vapor Pressure**

4.11X10<sup>-3</sup> mm Hg @ 25 deg C

*Daubert, T.E., R.P. Danner. Physical and Thermodynamic Properties of Pure Chemicals Data Compilation. Washington, D.C.: Taylor and Francis, 1989.*

*Peer Reviewed*

## Section 4 - Safety and Handling

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### Decomposition

When heated to decomposition it emits acrid smoke and irritating vapors.

*Lewis, R.J. Sax's Dangerous Properties of Industrial Materials. 9th ed. Volumes 1-3. New York, NY: Van Nostrand Reinhold, 1996., p. 2256*  
*Peer Reviewed*

### Disposal Methods

SRP: At the time of review, criteria for land treatment or burial (sanitary landfill) disposal practices are subject to significant revision. Prior to implementing land disposal of waste residue (including waste sludge), consult with environmental regulatory agencies for guidance on acceptable disposal practices.

**\*\*PEER REVIEWED\*\***

## Section 5 - Toxicity/Biomedical Effects

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### Non-Human Toxicity Excerpts

USING DEPRESSED GROWTH RESPONSE AS A CRITERION, THE EFFECTS OF METHYL ESTERS OF FATTY ACIDS OF CHAIN LENGTH 4 TO 18 CARBONS ON ESSENTIAL FATTY ACID DEFICIENCY WERE STUDIED. HIGH MORTALITY WAS OBSERVED IN RATS FED << METHYL >> << LAURATE >>. IT ACCENTUATED THE ESSENTIAL FATTY ACID DEFICIENCY BECAUSE SUPPLEMENTATION RESULTED IN AN INCR ACCUMULATION OF HEPATIC CHOLESTEROL ESTERS.

*ALFIN-SLATER RB ET AL; J NUTR 87 (2): 168 (1965)*

*Peer Reviewed*

INTRAVENOUS INJECTION OF 1.2 MG << METHYL >> << LAURATE >> PRODUCED IMMEDIATE DEATH IN MICE.

*DI-LUZIO NR, BLICKENS DA; J RETICULOENDOTHEL SOC 3 (3): 250 (1966)*

*Peer Reviewed*

### Interactions

Linear saturated fatty acid methyl esters were comitogenic with lectins for mouse lymphocytes, the degree of comitogenicity being strongly dependent on the length of the acyl group, and maximal for methyl tetradecanoate. Lesser effects were found for analogs with 10, 12, or 16 acyl carbon atoms, whereas those with fewer than 10 or more than 16 were inactive. /Methyl esters/

**Baxter CS, Fish LA; Biochemical and Biophysical Research Communication 103 (1): 168-74**

**(1981)**

*Peer Reviewed*

## Section 6 - Pharmacology

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### Therapeutic Uses

EXPTL USE: << METHYL >> << LAURATE >> (5 MG) GIVEN DAILY FOR 5 DAYS TO MICE IMPLANTED IP WITH 106 EHRLICH ASCITES TUMOR CELLS PROLONGED SURVIVAL.

*KATO A ET AL; CANCER RES 31 (5): 501 (1971)*

*Peer Reviewed*

## Section 7 - Environmental Fate/Exposure Potential

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## Environmental Fate/Exposure Summary

Methyl dodecanoate's production and use as a synthetic intermediate and flavoring agent may result in its release to the environment through various waste streams. If released to air, a vapor pressure of 0.0041 mm Hg at 25 deg C indicates methyl dodecanoate will exist solely as a vapor in the ambient atmosphere. Vapor-phase methyl dodecanoate will be degraded in the atmosphere by reaction with photochemically-produced hydroxyl radicals; the half-life for this reaction in air is estimated to be 29 hours. If released to soil, methyl dodecanoate is expected to have low mobility based upon an estimated Koc of 1,600. Volatilization from moist soil surfaces is expected to be an important fate process based upon an estimated Henry's Law constant of 0.003 atm-cu m/mole. However, adsorption to soil is expected to attenuate volatilization. Methyl dodecanoate is expected to rapidly biodegrade in aerobic soils by analogy to other structurally similar long-chain fatty acid esters. If released into water, methyl dodecanoate is expected to adsorb to suspended solids and sediment in the water column based upon the estimated Koc. Methyl dodecanoate is expected to rapidly biodegrade in aerobic waters by analogy to other structurally similar long-chain fatty acid esters. Volatilization from water surfaces is expected to be an important fate process based upon this compound's estimated Henry's Law constant. Estimated volatilization half-lives for a model river and model lake are 5 hours and 6 days, respectively. However, volatilization from water surfaces is expected to be attenuated by adsorption to suspended solids and sediment in the water column. The volatilization half-life from a model pond is estimated to be about 56 hours ignoring adsorption; when considering maximum adsorption the volatilization half-life increases to 14 days. An estimated BCF of 290 suggests the potential for bioconcentration in aquatic organisms is high. An estimated base-catalyzed second-order hydrolysis rate constant of 0.030 L/mole-sec corresponds to half-lives of 7.3 years and 270 days at pH values of 7 and 8, respectively. Occupational exposure to methyl dodecanoate may occur through inhalation and dermal contact with this compound at workplaces where methyl dodecanoate is produced or used. The general population may be exposed to methyl dodecanoate due to its use as a flavoring. (SRC) \*\*PEER REVIEWED\*\*

## Natural Occurring Sources

REPORTED FOUND IN ORRIS ABSOLUTE.

*Fenaroli's Handbook of Flavor Ingredients. Volume 2. Edited, translated, and revised by T.E. Furia and N. Bellanca. 2nd ed. Cleveland: The Chemical Rubber Co., 1975., p. 378*  
Peer Reviewed

## Artificial Sources

Methyl dodecanoate's production and use as a synthetic intermediate and flavoring(1) may result in its release to the environment through various waste streams(SRC).

(1) Lewis RJ; *Hawley's Condensed Chemical Dictionary. 12th Ed. NY,NY: Van Nostrand Reinhold Company (1993)*  
Peer Reviewed

## Environmental Fate

TERRESTRIAL FATE: Based on a classification scheme(1), an estimated Koc value of 1,600(SRC), determined from a structure estimation method(2), indicates that methyl dodecanoate is expected to be immobile in soil(SRC). Volatilization of methyl dodecanoate from moist soil surfaces is expected to be an important fate process(SRC) given an estimated Henry's Law constant of 0.003 atm-cu m/mole(SRC), using a fragment constant estimation method(3). However, adsorption to soil is expected to attenuate volatilization(SRC). Methyl dodecanoate is not expected to volatilize from dry soil surfaces(SRC) based upon a vapor pressure of 0.004 mm Hg(4). Methyl dodecanoate is expected to rapidly biodegrade in aerobic soils by analogy to structurally similar long-chain fatty acid esters(5-7).

(1) Swann RL et al; *Res Rev 85: 17-28 (1983)* (2) Meylan WM et al; *Environ Sci Technol 26: 1560-67 (1992)* (3) Meylan WM, Howard PH; *Environ Toxicol Chem 10: 1283-93 (1991)* (4) Daubert TE, Danner RP; *Physical and Thermodynamic Properties of Pure Chemicals: Data Compilation. Design Inst*

*Phys Prop Data, Amer Inst Chem Eng NY, NY: Hemisphere Pub Corp (1989) (5) Malaney GW, Gerhold RM; Proc 17th Ind Waste Conf Purdue Univ Ext Ser 112: 249-57 (1962) (6) Kawasaki M; Ecotox*

**Environ Safety 4: 444-54 (1980)** (7) Freitag D et al; *Environmental Hazard Profile - Test Results as Related to Structures and Translation into the Environment: QSAR in Environmental Toxicology pp. 111-136 (1984)*  
Peer Reviewed

AQUATIC FATE: Based on a classification scheme(1), an estimated Koc value of 1,600(SRC), determined from a structure estimation method(2), indicates that methyl dodecanoate is expected to adsorb to suspended solids and sediment in water(SRC). Volatilization from water surfaces is expected(3) based upon an estimated Henry's Law constant of 0.003 atm-cu m/mole(SRC), developed using a fragment constant estimation method(4). Volatilization half-lives for a model river and model lake are 5 hours and 6 days, respectively(SRC), using an estimation method(3). However, volatilization from water surfaces is expected to be attenuated by adsorption to suspended solids and sediment in the water column(SRC). The volatilization half-life from a model pond is estimated to be about 56 hours ignoring adsorption; when considering maximum adsorption the volatilization half-life increases to 14 days(5). According to a classification scheme(6), an estimated BCF of 290(SRC) from its log Kow of 5.41(12) and a regression-derived equation(7), suggests the potential for bioconcentration in aquatic organisms is high although it may be lower than that indicated due to the expected rapid metabolism rate for this compound(9). Methyl dodecanoate is expected to rapidly biodegrade in aerobic soils by analogy to structurally similar long-chain fatty acid esters(8-10). An estimated base-catalyzed second-order hydrolysis rate constant of 0.030 L/mole-sec(9,SRC) corresponds to half-lives of 7.3 years and 270 days at pH values of 7 and 8, respectively(11).

(1) Swann RL et al; *Res Rev 85: 17-28 (1983)* (2) Meylan WM et al; *Environ Sci Technol 26: 1560-67 (1992)* (3) Lyman WJ et al; *Handbook of Chemical Property Estimation Methods. Washington, DC: Amer Chem Soc pp. 4-9, 5-4, 5-10, 15-1 to 15-29 (1990)* (4) Meylan WM, Howard PH; *Environ Toxicol Chem 10: 1283-93 (1991)* (5) USEPA; *EXAMS II Computer Simulation (1987)* (6) Franke C et al; *Chemosphere 29: 1501-14 (1994)* (7) Meylan WM et al; *Environ Toxicol Chem 18: 664-72 (1999)* (8) Malaney GW, Gerhold RM; *Proc 17th Ind Waste Conf Purdue Univ Ext Ser 112: 249-57 (1962)* (9) Kawasaki M; *Ecotox Environ Safety 4: 444-54 (1980)* (10) Freitag D et al; *Environmental Hazard Profile - Test Results as Related to Structures and Translation into the Environment: QSAR in Environmental Toxicology pp. 111-136 (1984)* (11) Mill T et al; *Environmental Fate and Exposure Studies Development of a PC-SAR for Hydrolysis: Esters, Alkyl Halides and Epoxides. EPA Contract No. 68-02-4254. Menlo Park, CA: SRI International (1987)* (12) **Krop HB et al; Chemosphere 34: 107-**

## **19 (1997)**

Peer Reviewed

ATMOSPHERIC FATE: According to a model of gas/particle partitioning of semivolatile organic compounds in the atmosphere(1), methyl dodecanoate, which has a vapor pressure of 0.0041 mm Hg at 25 deg C(2), will exist in solely as a vapor in the ambient atmosphere. Vapor-phase methyl dodecanoate is degraded in the atmosphere by reaction with photochemically-produced hydroxyl radicals(SRC); the half-life for this reaction in air is estimated to be 29 hours(SRC) from its estimated rate constant of  $1.3 \times 10^{-11}$  cu cm/molecule-sec at 25 deg C(3).

(1) **Bidleman TF; Environ Sci Technol 22: 361-367 (1988)** (2) Daubert TE, Danner RP; *Physical and Thermodynamic Properties of Pure Chemicals: Data Compilation. Design Inst Phys Prop Data, Amer Inst Chem Eng NY, NY: Hemisphere Pub Corp (1989)* (3) Meylan WM, Howard PH; *Chemosphere 26: 2293-99 (1993)*  
Peer Reviewed

## **Biodegradation**

AEROBIC: By analogy to chemically similar long chain fatty acid esters that were rapidly degraded by mixed sewage sludge(1-3), methyl dodecanoate is expected to rapidly biodegrade under aerobic conditions(SRC).

(1) Malaney GW, Gerhold RM; *Proc 17th Ind Waste Conf Purdue Univ Ext Ser 112: 249-57 (1962)* (2)



**Kawasaki M; Ecotox Environ Safety 4: 444-54 (1980)** (3) Freitag D et al; *Environmental Hazard Profile - Test Results as Related to Structures and Translation into the Environment: QSAR in Environmental Toxicology* pp. 111-136 (1984)  
Peer Reviewed

### Abiotic Degredation

The rate constant for the vapor-phase reaction of methyl dodecanoate with photochemically-produced hydroxyl radicals has been estimated as  $1.3 \times 10^{-11}$  cu cm/molecule-sec at 25 deg C(SRC) using a structure estimation method(1). This corresponds to an atmospheric half-life of about 29 hours at an atmospheric concentration of  $5 \times 10^5$  hydroxyl radicals per cu cm(1). A base-catalyzed second-order hydrolysis rate constant of 0.030 L/mole-sec(SRC) was estimated using a structure estimation method(2); this corresponds to half-lives of 7.3 years and 270 days at pH values of 7 and 8, respectively(2). Methyl dodecanoate is not expected to directly photolyze due to the lack of absorption in the environmental UV spectrum(3).

(1) Meylan WM, Howard PH; *Chemosphere* 26: 2293-99 (1993) (2) Mill T et al; *Environmental Fate and Exposure Studies Development of a PC-SAR for Hydrolysis: Esters, Alkyl Halides and Epoxides*. EPA Contract No. 68-02-4254. Menlo Park, CA: SRI International (1987) (3) Lyman WJ et al; *Handbook of Chemical Property Estimation Methods*. Washington, DC: Amer Chem Soc pp. 7-4, 7-5 (1990)  
Peer Reviewed

### Bioconcentration

An estimated BCF of 290 was calculated for methyl dodecanoate(SRC) using a log Kow of 5.41(1) and a regression-derived equation(2). According to a classification scheme(3), the estimated BCF suggests the potential for bioconcentration in aquatic organisms is high. However, bioconcentration studies on compounds which are structurally similar(4,5) suggests that bioconcentration may be lower than that indicated by the regression-derived equation due to the ability of aquatic organisms to readily metabolize this class of compounds(SRC).

(1) Krop HB et al; *Chemosphere* 34: 107-19 (1997) (2) Meylan WM et al; *Environ Toxicol Chem* 18:

664-72 (1999) (3) **Franke C et al; Chemosphere 29: 1501-14 (1994)** (4) *Chemicals Inspection and Testing Institute; Biodegradation and Bioaccumulation Data of Existing Chemicals Based on the CSCL Japan*. Japan Chemical Industry Ecology - Toxicology and Information Center. ISBN 4-89074-101-1. pp. 3-9 (1992) (5) Freitag D et al; *Environmental Hazard Profile - Test Results as Related to Structures and Translation into the Environment: QSAR in Environmental Toxicology* pp. 111-136 (1984)  
Peer Reviewed

### Soil Adsorption/Mobility

Using a structure estimation method based on molecular connectivity indices(1), the Koc for methyl dodecanoate can be estimated to be about 1600(SRC). According to a classification scheme(2), this estimated Koc value suggests that methyl dodecanoate is expected to have low mobility in soil.

(1) **Meylan WM et al; Environ Sci Technol 26: 1560-67 (1992)** (2) Swann RL et al; *Res Rev* 85: 17-28 (1983)  
Peer Reviewed

### Volatilization from Water/Soil

The Henry's Law constant for methyl dodecanoate is estimated as 0.003 atm-cu m/mole(SRC) using a fragment constant estimation method(1). This Henry's Law constant indicates that methyl

dodecanoate is expected to volatilize from water surfaces(2). Based on this Henry's Law constant, the volatilization half-life from a model river (1 m deep, flowing 1 m/sec, wind velocity of 3 m/sec)(2) is estimated as approximately 5 hours(SRC). The volatilization half-life from a model lake (1 m deep, flowing 0.05 m/sec, wind velocity of 0.5 m/sec)(2) is estimated as approximately 6 days(SRC). The volatilization half-life from a model pond 2 m deep is estimated to be about 56 hours ignoring adsorption; when considering maximum adsorption the volatilization half-life increases to 14 days(3). Methyl dodecanoate's Henry's Law constant(1) indicates that volatilization from moist soil surfaces may occur although adsorption is expected to attenuate this process(SRC). Methyl dodecanoate is not expected to volatilize from dry soil surfaces(SRC) based upon a vapor pressure of 0.0041 mm Hg(4).  
(1) Meylan WM, Howard PH; *Environ Toxicol Chem* 10: 1283-93 (1991) (2) Lyman WJ et al; *Handbook of Chemical Property Estimation Methods*. Washington,DC: Amer Chem Soc pp. 15-1 to 15-29 (1990) (3) USEPA; *EXAMS II Computer Simulation* (1987) (4) Daubert TE, Danner RP; *Physical and Thermodynamic Properties of Pure Chemicals: Data Compilation. Design Inst Phys Prop Data, Amer Inst Chem Eng NY,NY: Hemisphere Pub Corp*(1989)  
Peer Reviewed

### **Water Concentrations**

SURFACE WATER: In a survey of 14 heavily industrialized river basins in the United States (240 sites), 1975-76, 7 samples were found to contain methyl dodecanoate, detection limit not provided(1). Water samples collected from Spirit Lake shortly after the eruption of Mount Saint Helens, 1980, contained methyl dodecanoate, concentration and detection limit not provided(2). Methyl dodecanoate was also detected in trace quantities in samples from the River Lee, UK(3).  
(1) Ewing BB et al; *Monitoring to Detect Previously Unrecognized Pollutants in Surface Waters USEPA-*

*560/6-77-015 p. 75* (1977) (2) **McKnight DM et al; *Org Geochem* 4: 85-92 (1982)** (3)  
*Waggott A; Chem Water Reuse* 2: 55-9 (1981)  
Peer Reviewed

### **Sediment/Soil Concentrations**

SOIL: Methyl dodecanoate was qualitatively detected in soil samples from Southern Alberta, Canada, in strata associated with the Mazama volcano eruption which occurred approximately 7000 years ago(1).  
(1) Dormaar JF; *Can J Earth Sci* 20: 859-65 (1983)  
Peer Reviewed

### **Probable Routes of Human Exposure**

NIOSH (NOES Survey 1981-1983) has statistically estimated that 34,133 workers (75 of these are female) are potentially exposed to methyl dodecanoate in the US(1). Occupational exposure to methyl dodecanoate may occur through inhalation and dermal contact with this compound at workplaces where methyl dodecanoate is produced or used(SRC). The general population may be exposed to methyl dodecanoate via inhalation of ambient air, ingestion of food and drinking water, and dermal contact with this compound and other consumer products containing methyl dodecanoate(SRC). The general population may also be exposed to methyl dodecanoate due to its use as a flavoring(2).  
(1) NIOSH; *National Occupational Exposure Survey (NOES)* (1983) (2) Lewis RJ; *Hawley's Condensed Chemical Dictionary. 12th Ed. NY,NY: Van Nostrand Reinhold Company* (1993)  
Peer Reviewed

## **Section 8 - Exposure Standards and Regulations**

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### **FDA Requirements**

<< Methyl >> << laurate >> is a food additive permitted for direct addition to food for human consumption as a synthetic flavoring substance and adjuvant in accordance with the following

conditions: a) they are used in the minimum quantity required to produce their intended effect, and otherwise in accordance with all the principles of good manufacturing practice, and 2) they consist of one or more of the following, used alone or in combination with flavoring substances and adjuvants generally recognized as safe in food, prior-sanctioned for such use, or regulated by an appropriate section in this part.

*21 CFR 172.515 (4/1/98)*

*Peer Reviewed*

## **Section 9 - Monitoring and Analysis Methods**

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### **Analytic Laboratory Methods**

DETERMINATION OF FATTY ACIDS IN FATS AND OILS BY GAS CHROMATOGRAPHY.

***BANNON CD ET AL; J CHROMATOGR 247 (1): 71 (1982)***

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## Review

# Biodegradation of mineral oils – A review

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**The uses of the various kinds of mineral oils in various industrial situations have made them an indispensable ingredient of the industrialization and development that has characterized the past century. Recent focus on health, safety and the preservation of the environment has turned the searchlight to the effects of mineral oils on the environment when they are accidentally spilled, or intentionally disposed of. Biodegradation, which provides an indication of the persistence of a particular substance in the environment, is the yardstick for assessing the eco friendliness of substances. Due to the poor biodegradation rates observable for mineral oils, various methods of bioremediation are currently being researched, with the isolation of various microbial species with the ability to use up mineral oils as a carbon and energy source. Ultimately, vegetable oil based hydraulic fluids will come to the fore as a suitable and more environmentally friendly solution to the demand for hydraulic fluids.**

**Key words:** Lubricant, environmental, transformer oil, additives.

## INTRODUCTION

Crude oils are naturally occurring, exceedingly complex mixtures, which consist predominantly of hydrocarbons, and contain sulfur, nitrogen, oxygen and metals as minor constituents. The petroleum industry, which holds a prime position in the modern world economy, is, in the main, centered on crude oil. The economic importance of crude oil is to be found in the numerous possible products obtainable from crude oil through refining – the uses of these products in the modern industrialized world justify the resources committed to its exploration and production. Motor fuels, domestic fuels, industrial fuels for heating and power generation as well lubricants are among the products derivable from crude oil.

The class of petroleum products known as mineral oils can be generally understood to include a variety of products which go by different names such as white oils, lubricating oils, light fuel oils, residual fuel oils, as well as transformer and cable oils (Gary and Handwerk, 2001). These various products have been applied ever since the discovery of crude oil. The recent worldwide emphasis on environmental preservation now raises questions which concern the long term effects of the use, accidental spills

and intentional disposal of industrial products such as mineral oils. Pressure is mounting to use more environmentally friendly products, especially in ecologically sensitive situations (Lea, 2005). Hence the biodegradability of mineral oils is of interest to a great many researchers, seeing that the environmental persistence of possibly toxic constituents of these mineral oils is fast becoming unacceptable.

## THE IDENTITY AND ORIGIN OF MINERAL OILS

The term "mineral oils" tends to be non-specific, and its usage in the literature could give rise to some confusion as it may be found to refer to various substances. However in this context, it is taken to refer to all oils which are made from dewaxed paraffin-based crude oils which are blended with additives to impart particular properties for specific uses. This classification is as against other oils such as Organophosphate esters and polyalphaolefin fluids ([www.atsdr.cdc.gov](http://www.atsdr.cdc.gov), 2008). Mineral oils include lubricant base oils (obtained from petroleum) and products derived from them ([www.ntp.niehs.nih.gov](http://www.ntp.niehs.nih.gov), 2003). Hence, their origin is petroleum – they are formulated from base petroleum stocks with about 10 – 25% additives. These additives consist of antioxidants and metal deactivators, detergents, dispersants, corro-

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sion inhibitors, rust inhibitors, amongst others (Farrington and Slater, 1997). The carbon number distribution and by extension the viscosity in mineral oil hydraulic fluids varies depending upon the anticipated application of the fluid. Generally however, C15 to C50 is a reasonably all encompassing range. Also, the higher the carbon number, the higher the viscosity of the fluid in question ([www.atsdr.cdc.gov](http://www.atsdr.cdc.gov), 2008).

Mineral oils are composed of straight and branched chain paraffinic, naphthenic, and aromatic hydrocarbons with 15 or more carbons in a complex mixture. Generally, the physical properties of mineral oils depend on their composition in terms of carbon number distribution, and this is defined by the source of crude oil. Accordingly, these physical properties vary widely: boiling points generally range from 300 to 600°C, while specific gravities range from 0.820 for light paraffinic base/ process oils to just over 1.0 for high aromatic base/process oils. They are all generally insoluble in water and alcohol, but are soluble in benzene, chloroform, ether, carbon disulphide, and petroleum ether ([www.ntp.niehs.nih.gov](http://www.ntp.niehs.nih.gov), 2003).

In most crude oil refineries, lubricating oil base stocks are obtained from the heavy vacuum gas oil fraction and reduced crude from paraffinic or naphthenic base crude oils. Reduced crude (bottoms from the atmospheric distillation unit) is processed in a propane deasphalting unit where asphaltenes are removed; following which it is processed in a blocked operation with the vacuum gas oils to give rise to lubricating oils base stocks, which form the basis for the wide range of mineral oils. Further details on the origin of mineral oils can be provided: the vacuum gas oils and deasphalted reduced crude stocks are first solvent extracted to remove the aromatic compounds and the dewaxed to improve the pour point. Then they are treated with special clays or high severity hydrotreating to improve their color and stability before they are blended into lubricating oils (Gary and Handwerk, 2001).

## USES OF MINERAL OILS

The first centers of large scale production of mineral oils were located in Pennsylvania and Baku. Generally, there has been an explosion of mineral oil based products globally over the last century due to the increasing demands of industrialization (Lea, 2005). Numerous useful products are obtainable from mineral base oils for numerous applications, and these are outlined below.

The uses of mineral oils includes applications such as engine oils, automotive and industrial gear oils, transmission fluids, hydraulic fluids, circulating and hydraulic oils, bearing oils and machine oils. Other uses are as machine-tool oils, compressor and refrigerator oils, textile machine oils, air tool oils, steam engine oils, metal-working oils, rust prevention oils transformer oils and so on and so forth ([www.ntp.niehs.nih.gov](http://www.ntp.niehs.nih.gov), 2003). The list is almost endless, indicating that over the last century, it is

correct to say that mineral oil has been exploited to the full since its early discovery (Lea, 2005). Another use is found for mineral oils in medical applications, for we have oils that are known as medicinal white oils, which are essentially mixtures of highly refined paraffinic and naphthenic liquid hydrocarbons obtained from mineral crude oils through various refining steps including distillation, extraction and crystallization, with subsequent purification by acid and catalytic hydro treatment. They have medicinal applications – they have been taken orally as laxatives, and as used in many skin care products, as a suspending and levigating agent in sulfur based ointments, and in livestock vaccines ([www.wikipedia.org](http://www.wikipedia.org), 2008). White mineral oils are also applied as release agents as well as glazing agents

## THE COMPOSITION OF MINERAL OILS - ADDITIVES

It must be noted that apart from base petroleum stocks, mineral oils in their commercial applications contain about 10 – 25% of substances known as additives (Farrington and Slater., 1997). These additives are necessary to impart properties that are considered appropriate to specific applications. These additives thus constitute a very important part of the composition of mineral oils ([www.atsdr.cdc.gov](http://www.atsdr.cdc.gov), 2008), and include amongst others: "extreme pressure additives, which help prevent surface damage under severe loading (organic sulfur-, phosphorus-, and chlorine-containing compounds); anti-wear additives, which prevent wearing under light loads (fatty acids and derivatives, organophosphate esters); corrosion inhibitors, which prevent corrosion by oxygen and water (fatty acids, sulfonates, and salts of fatty acids); oxidation inhibitors, which inhibit oxidation of the hydraulic fluid (phenols, amines, and sulfides); defoam-ers, which prevent foam formation (silicone oils); viscosity index improvers, which reduce the dependence of viscosity on temperature (polyalphaolefins, polymethacrylates, and polyalkylstyrenes); pour point depressants, which lower the pour point temperature (polymethacrylates and condensation products); demulsifiers, which allow separation of oil and water (ionogenic and non-ionogenic polar compounds); and dispersants, which prevent unwanted deposits (sulfonates and amides)" ([www.atsdr.cdc.gov](http://www.atsdr.cdc.gov), 2008). The chemical nature and production methods of these additives are generally unknown as they are closely guarded trade secrets.

## THERMAL STABILITY OF MINERAL OILS

The term "thermal stability, when used in reference to lubricating oils may be defined as the resistance posed by the lubricant to either molecular breakdown, or some form of rearrangement at elevated temperatures in the absence of oxygen (Booser, 1984). It is a well observed fact that all oils will start to decompose even in the ab-

sence of oxygen when they are heated above a certain temperature. When heated, mineral oils break down to yield basically methane, ethane and ethylene (Stachowiak and Batchelor, 2005). More moles of methane are liberated than of ethane and ethylene (Booser, 1984).

Thermal stability of crude oil products, which includes the class of compounds known as mineral oils, determines their use and applicability in crude oil industry (Rychla et al., 2001). The improvement of the thermal stability of mineral oils is achieved right from the refining process. It is known that organonitrogen molecules are largely responsible for poor color and stability of base oils; hence the finishing processes undertaken during refining must necessarily involve operations which are effective for removing organonitrogen molecules (Mortier and Orszulik, 1997). Thermal stability may not be improved via the means of additives; rather, usually, additives used with lubricant base stocks have lower thermal stability than the base stocks themselves (Stachowiak and Batchelor, 2005). Thermal stability is also dependent on the length of usage (Karacan et al., 1999). Carbon to carbon single bonds are the most vulnerable points for thermal breakdown. Hence fluids such as mineral oils which are constituted of a substantial percentage of C-C single bonds exhibit a thermal stability of about 650 to 700°F. Synthetic oils, in general, exhibit better thermal stability than mineral oils (Stachowiak and Batchelor, 2005).

## ENVIRONMENTAL AND HEALTH CONCERNS WITH MINERAL OILS

In terms of environmental effects of mineral oils, each type of crude oil or refined product has distinct physical properties which affect the way the oil spreads and breaks down, and ultimately determines the hazard it may pose to marine and human life, and the likelihood that it would pose a threat to natural and manmade resources. Mineral oils are persistent and present a greater remediation challenge than lighter petroleum products (www.epa.gov, 2008).

This prospective hazard is recognized by many regulatory bodies; the Michigan Department of Environmental Quality for instance stipulates that used oils in liquid form cannot be disposed of by any of the following means:

- Dumped down drains or sewers or into surface or ground water
- Disposed of in land fills
- Burned in municipal solid waste incinerators or other incinerators without energy recovery or
- Used as dust control or weed control.

Under this regulation, used oil refers to petroleum-based products which are used as lubricating agents or in other protective applications.

The United States' Environmental Protection Agency

has laid down guidelines which stipulate that accessible oil be recovered in the event of a spill, and all contaminated soil be removed. This is expensive business; for instance a municipal electric utility in Iowa, USA spent over \$20 000 on spill remediation for a mere 20 gallon spill of PCB-contaminated transformer oil (www.safetransformers.org, 2008). Additionally, the EPA also requires that no visible oil sheen be evident downstream from facilities close to waterways. Another regulation requires that point discharges into waterways should not exceed 10 ppm of mineral-based oils (US Army Corps and Engineers, 1999)

As earlier stated, these various stringent regulations are as a result of the fact that mineral oils are generally recognized to cause pollution of soil and water when spilled accidentally or when disposed of, affecting plant and animal life. They cannot be regarded as readily biodegradable, and hence their harmful effects often persist in the environment (Cliff Lea), "Mineral-oil-based lubricating oils, greases, and hydraulic fluids....are usually toxic and not readily biodegradable, because of these characteristics, if these materials escape to the environment, the impacts tend to be cumulative and consequently harmful to plant, fish and wildlife" (US Army Corps and Engineers, 1999). The overall environmental hazard of lubricants and other mineral oils is not entirely determined by the mineral oil based base fluids, but more so on the several additives used in hydraulic fluids which contribute substantially to the toxicity of the spill. This increased toxicity is coupled with the physical effect of staining essential organs of animal life in aquatic environments (Broekhuizen et al., 2003). Additionally, by means of spills and improper disposal of mineral oils, the general population is potentially exposed to unused and used mineral oils which are present as environmental pollutants. Such exposure to untreated and mildly treated mineral oils has been linked to cancer (www.ntp.niehs.nih.gov, 2003).

## THE BIODEGRADATION OF MINERAL OILS

The notion of biodegradability conveys the meaning of the breaking down of complex, and possibly toxic material into simple and common forms, in which the elements carbon, hydrogen and oxygen exist or are simply associated. Whenever any substance is placed in the environment, it begins to undergo degradation due to the action of relevant substrate utilizing microorganisms. Every substance, irrespective of its complexity and toxicity is subject to this process. When used in the present context, it is referenced to a time frame. That is, for a given substance to be referred to as biodegradable, a specific time limit must be used as a reference (wisere Renewables.com, 2006).

By definition, biodegradation is the chemical transformation of a substance caused by organisms or their enzymes. There are two major types of biodegradation –

**Table 1.** Ultimate Biodegradability Test (wiserenewables.com, 2006).

Ultimate Biodegradation tests: Test title	Measurements	Sponsoring organization
D5864, test method for the aerobic aquatic biodegradation of lubricants	Theoretical CO <sub>2</sub> (%)	ASTM
9429:1990, Technical corrigendum 1, water quality-evaluation in an aqueous medium of the "ultimate" biodegradation of organic compounds-method by analysis of released carbon dioxide	Theoretical CO <sub>2</sub> (%)	ISO
301B, CO <sub>2</sub> evolution test (modified Sturm test)	Theoretical CO <sub>2</sub> (%)	OECD
Aerobic aquatic biodegradation test	Theoretical CO <sub>2</sub> (%)	US EPA
C.4-C: Carbon dioxide (CO <sub>2</sub> ) evolution	Theoretical CO <sub>2</sub> (%)	EUC
L-33-A-934, biodegradability of two-stroke cycle outboard engine oils in CH <sub>2</sub> groups water (formerly L-33-T-82)	Loss of extractable (%)	CEC

Primary Biodegradation, which refers to the modification of a substance by microorganisms such that a change is caused in some specific measurable property of the substance (US Army Corps and Engineers, 1999). When the term primary biodegradation is used it refers to minimal transformation that alters the physical characteristics of a compound while leaving the molecule largely intact. Intermediary metabolites produced may however be more toxic than the original substrate (wiserenewables.com, 2006). Thus mineralization is the true aim. When this happens it is referred to as ultimate or complete biodegradation; which is the degradation achieved when a substance is totally utilized by microorganisms resulting in the production of carbon dioxide, methane, water, mineral salts, and new microbial cellular constituents (US Army Corps and Engineers, 1999).

Various methods exist for the testing of biodegradability of substances. Table 1 below indicates a number of tests amongst others for ultimate biodegradability in aerobic aquatic environments indicating their sponsoring organizations (Bioblend, 2008)

Biodegradability is assessed by following certain parameters which are considered to be indicative of the consumption of the test substance by microorganisms, or the production of simple basic compounds which indicate the mineralization of the test substance. Hence there are various biodegradability testing methods which measure the amount of carbon dioxide (or methane, for anaerobic cases) produced during a specified period; there are those which measure the loss of dissolved organic carbon for substances which are water soluble; those that measure the loss of hydrocarbon infrared bands (Bioblend, 2008); and there are yet others which measure the uptake of oxygen by the activities of microorganisms (the Biochemical Oxygen Demand, BOD).

However, when the reference is specifically to lubricants, there are 2 major methods of biodegradability testing, and these are outlined in brief below:

1. ASTM test method D 5864 determines lubricant biodegradation. This test determines the rate and extent of aerobic aquatic biodegradation of lubricants when exposed to an inoculum under laboratory

conditions. The inoculum may be the activated sewage-sludge from a domestic sewage-treatment plant, or it may be derived from soil or natural surface waters, or any combination of the three sources. The degree of biodegradability is measured by calculating the rate of conversion of the lubricant to CO<sub>2</sub>. A lubricant, hydraulic fluid or grease is classified as readily biodegradable when 60% or more of the test material carbon is converted to CO<sub>2</sub> in 28 days, as determined using this test method.

2. The most established test methods used by the lubricant industry for evaluating the biodegradability of their products are Method CEC-L-33-A-94 developed by the Coordinating European Council (CEC); Method OECD 301B, the Modified Sturm Test, developed by the Organization for Economic Cooperation and Development (OECD); and Method EPA 560/6-82-003, number CG-2000, the Shake Flask Test, adapted by the U.S. Environmental Protection Agency (EPA). These tests also determine the rate and extent of aerobic aquatic biodegradation under laboratory conditions. The Modified Sturm Test and Shake Flask Test also calculate the rate of conversion of the lubricant to CO<sub>2</sub>. The CEC test measures the disappearance of the lubricant by analyzing test material at various incubation times through infrared spectroscopy. Laboratory tests have shown that the degradation rates may vary widely among the various test methods indicated above (US Army Corps of Engineers, 1999).

Biodegradability tests based on the CEC method described above has certain trends which indicate that mineral oils, along with alkylated benzenes and polyalkeleneglycols among others, generally have poor biodegradability: between 0 – 40%. Specifically, mineral oil biodegradability varies from 15 – 35% as conducted by the CEC biodegradability test (wiserenewables, 2006).

## BIOREMEDIATION – THE CHALLENGE

Consequent on the poor biodegradability of mineral oils, remediation activities are required when spills occur. It

has been demonstrated that a variety of contaminants can be degraded by microbes, and that such biological processes are cost and clean-up effective, especially when compared to conventional pump and treat processes applied for the remediation of contaminated groundwater. Clean up efforts carried out by Biopract between 1997 and 2000 in Berlin for a 500 m<sup>2</sup> area, 10 m deep region contaminated by cable insulating oil. Bio-remediation techniques were applied and an impressive biodegradation rate of 86% in a thousand days was recorded (Zittwitz et al., 2000).

A similar study to demonstrate the potentials of bioremediation of contaminated soils was carried out in Boucherville, Quebec, where a transformer oil spill had been recorded. The summary of the results is that on bioremediation, the site recorded a removal rate of 72% within 48 weeks (Biogenie, 1995).

In keeping with recorded successes on bioremediation efforts, research to optimize the process is ongoing with the isolation of strains of microorganisms which are found to have hydrocarbon degradative capabilities. Such microorganisms have enzyme systems which degrade and utilize oils as sources of carbon and hydrogen. In research carried out by Nwaogu et al. (2008) diesel oil was used as a source for the isolation of certain bacteria strains including *Bacillus subtilis*, and *Bacillus cereus*, which are found to possess hydrocarbon degrading capability (Nwaogu et al., 2008). Yet other studies have identified strains belonging to genus *Bacillus* as having impressive biodegradative ability, utilizing crude oil as the sole source of carbon and energy even under stressed environmental conditions (Khalida et al., 2006). Further studies carried out by Muratovba and Turkovskaia (2001) similarly isolated a series of microbial associations capable of degrading various petroleum oils, emulsions, and crude oil. Oil product degradation by these microbial associations was identified to be most efficient during aerobic flow cultivation. Under these conditions, oils were degraded by about 92%; also, certain parameters such as the brand of oil, the concentration of the oil, its degree of emulsification and aeration were found to have an effect on the microbial degradation of the oil (Muratovba et al., 2001). In another related study, surfactants belonging to the fatty acid-acylated amino acids were found to accelerate the microbial degradation of mineral oils.

The faster, more complete degradation of mineral oils is identified as being caused solely by interfacial activity (Riis et al., 2000).

## CONCLUSION

Mineral oils are very important products in the industrialized 21<sup>st</sup> century with such numerous applications that they may presently be described as indispensable. However, increasing environmental awareness has placed the spotlight on the persistence of the harmful

components of mineral oils in the environment, and their cumulative effects on ecosystems, especially in the light of their established poor biodegradability. Spills are inevitable, and the development of bioremediation processes utilizing isolated hydrocarbon degrading bacteria has gone a long way in improving the efficiency of spill cleanup. The poor biodegradability of mineral oils, coupled with the fact that remediation efforts always tend to be expensive has made the option of the development of environmentally friendly oils based primarily on vegetable oils an attractive one. The future will bring with it the improvement of the efficiency of biobased fluids in various applications, leading to the widespread use of these products; a situation which will no doubt be in the best interests of the global ecosystem to which we belong.

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## Review

# Biodegradation of vegetable oils: A review

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**Vegetable oils have traditionally been applied in food uses, but recent trends suggest their economic usefulness as industrial fluids. Increasing crude oil prices and emphasis on the development of renewable, environmentally friendly industrial fluids have brought vegetable oils to a place of prominence. Biodegradability provides an indication of the persistence of any particular substance in the environment and is the yardstick for assessing the eco friendliness of substances. The superior biodegradation of vegetable oils in comparison with mineral based oils has been demonstrated severally, leaving scientists with the lone challenge of finding economic and safe means to improve their working efficiency in terms of their poor oxidative stability and high pour points.**

**Keywords:** Biodegradability, oxidative stability, environment, eco friendliness, renewable.

## INTRODUCTION

The use of fats and oils by man dates back to antiquity. Their chemical composition and specific properties have allowed them to find use as foods, fuels and lubricants. Their sources are numerous, encompassing vegetable, animal, and marine sources. As it is with all matter, their usefulness to man is determined by their chemical nature; and all fats and oils have certain characteristics in common.

Fats and oils are naturally occurring substances which consist predominantly of mixtures of fatty acid esters of the trihydroxy alcohol or glycerol (Nwobi et al., 2006). Different fats and oils come about due to the fact that there are numerous fatty acids of various kinds and these can be combined in an infinite number of ways on the hydroxyl centers of glycerol. Moreover, the physical properties of fats and oils are dependent on the nature of fatty acids involved in the ester. Hence the traditional distinction of fats as solids and oils as liquids arises from the fact that due to the different chemical structures of the different fatty acids combined in the esters, the bonding forces in existence vary in strength resulting in different melting points. These differences are manifested in different chain lengths, the presence or otherwise of unsaturation as well as geometric conformations.

The present emphasis on conservation and environmental friendliness has brought about renewed interest in the use of these "natural oils" for non edible purposes. Their established superiority in terms of biodegradability

(Charley, 1970), when compared with mineral oils, as well as the fact that they are renewable and generally non toxic has focused attention on technologies that would enhance their usefulness as bio fuels and industrial lubricants (Honary, 2004). There are also concerns as to what to expect in case of vegetable oil spills. This is the subject of some researchers (Zhengkai et al., 2001, Li et al., 2005) including the process of remediating such spills (Wincele et al., 2004). This paper examines the extent of work that has been carried out on the biodegradability of vegetable oils.

## VEGETABLE OILS - GENERAL PROPERTIES

Vegetable oils are obtained from oil containing seeds, fruits, or nuts by different pressing methods, solvent extraction or a combination of these (Bennion, 1995). Crude oils obtained are subjected to a number of refining processes, both physical and chemical. These are detailed in various texts and articles (Bennion, 1995; Fennema, 1985).

There are numerous vegetable oils derived from various sources. These include the popular vegetable oils: the foremost oilseed oils - soybean, cottonseed, pea-nuts and sunflower oils; and others such as palm oil, palm kernel oil, coconut oil, castor oil, rapeseed oil and others. They also include the less commonly known oils such as rice bran oil, tiger nut oil, patua oil, koème oil, niger seed oil, piririma oil and numerous others. Their yields, different compositions and by extension their physical and chemical properties determine their usefulness in various applications aside edible uses.

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Cottonseed oil was developed over a century ago as a byproduct of the cotton industry (Bennion, 1995). Its processing includes the use of hydraulic pressing, screw pressing and solvent extraction (Wolf, 1978). It is classified as a polyunsaturated oil, with palmitic acid consisting 20 – 25%, stearic acid 2 – 7 %, oleic acid 18 – 30% and linoleic acid 40 – 55% (Fennema, 1985). Its primary uses are food related – as salad oil, for frying, for margarine manufacture and for manufacturing shortenings used in cakes and biscuits.

Palm oil, olive oil, cottonseed oil, peanut oil, and sunflower oil amongst others are classed as Oleic – Linoleic acid oils seeing that they contain a relatively high proportion of unsaturated fatty acids, such as the monounsaturated oleic acid and the polyunsaturated linoleic acid (Dunn, 2005), (Gertz et al., 2000). They are characterized by a high ratio of polyunsaturated fatty acids to saturated fatty acids. They thus, have relatively low melting points and are liquid at room temperature. Iodine values, saponification values, specific compositions and melting points in addition to other physical properties have been determined and are widely available in the literature. (Williams, 1966; Oyediji and Oderinde, 2006).

Other oils fall under various classes such as the erucic acid oils which are like the oleic linoleic acid oils except that their predominant unsaturated fatty acid is erucic acid ( $C_{22}$ ). Rapeseed and mustard seed oil are important oils in this class. Canola oil is a type of rapeseed oil with reduced erucic acid content (Applewhite, 1978). It is a stable oil used in salad dressings, margarine and shortenings. Soybean oil is an important oil with numerous increasing applications in the modern day world. It is classed as a linolenic acid oil since it contains the more highly unsaturated linolenic acid. Other oils include castor oil (a hydroxy-acid oil) which contains glycerides of ricinoleic acid (Erhan et al, 2006). Also worthy of note is that coconut oil, which unlike most vegetable oils is solid at room temperature due to its high proportion of saturated fatty acids (92%) particularly lauric acid. Due to its almost homogenous composition, coconut oil has a fairly sharp melting point, unlike other fats and oils which melt over a range (Bennion, 1995). Oils from several sources are the subject of recent researches. Examples include corn oil (Sanchez, 2008); *camelina sativa* oil (Abramovic and Abram, 2005); Palmarosa oil (Mohanan et al, 2007) and Cineole oil (Rodriguez, 2006).

## INDUSTRIAL USES OF VEGETABLE OILS

The application of vegetable oils and animal fats for industrial purposes and specifically lubrication has been in practice for many years. Inherent disadvantages and the availability of inexpensive options have however brought about low utilization of vegetable oils for industrial lubrication (Honary, 2004). When applied in the science of tribology, vegetable oils fall under the class known as fixed oils (Gunther, 1971). They are so named because

they do not volatilize without decomposing. Prior to recent developments, vegetable and animal oils in tribology have functioned mainly as additives to mineral lubricating oil formulations, although in some cases they are applied exclusively, or in blends.

For instance, tallow (acidless) has been used as an emulsifying agent for steam cylinder oils, while castor, peanut and rapeseed oils have been used in blends with mineral oils to improve lubrication performance. Palm oil has been used in isolation as a fluxing dip in the tin plating of steel, while olive oil has applications as a yarn lubricant (Gunther, 1971).

Reasons for the use of vegetable oils in the science of lubrication abound. Their superior lubricity and emulsifying characteristics increase their desirability as additives to the cheaper but less effective mineral oil based lubricants. Their superior lubricity in industrial and machinery lubrication sometimes even necessitates the addition of friction materials in tractor transmissions in order to reduce clutch slippage (Honary, 2004).

Other advantages that encourage the use of vegetable oils include their relatively low viscosity-temperature variation; that is their high viscosity indices, which are about twice those of mineral oils (Honary, 2004).

Additionally, they have low volatilities as manifested by their high flash points. (Honary, 2004) Significantly, they are environmentally friendly: renewable, non toxic and biodegradable (Howell, 2007). In summary, engine lubricants formulated from vegetable oils have the following advantages deriving from the base stock chemistry:

- i. Higher Lubricity resulting in lower friction losses, and hence more power and better fuel economy.
- ii. Lower volatility resulting in decreased exhaust emissions.
- iii. Higher viscosity indices.
- iv. Higher shear stability.
- v. Higher detergency eliminating the need for detergent additives.
- vi. Higher dispersancy.
- vii. Rapid biodegradation and hence decreased environmental / toxicological hazards. (Erhan and Perez, 2002).

In a comparison of palm oil and mineral based lubricants, palm oil based lubricants were found to be more effective in reducing the hydrocarbon and carbon monoxide emission levels, among other things (Masjuki et al., 1999).

Vegetable oils have also been identified as having a lot of potential as alternative diesel engine fuels (Kayisoglu et al., 2006). This is supported by an interest in a cleaner environment, as well as the increasing cost of mineral deposit based energy (Howell, 2007). Based on availability to meet demand, soybean, peanut and sunflower oils have been identified as the most promising fuel sources (Kayisoglu et al., 2006). When used as a fuel, the term "biodiesel" is applicable.

Biodiesel is defined strictly as "...the mono alkyl ester

(usually methyl ester) of renewable fats and oils..." (Howell, 2007). It consists primarily of long chain fatty acid esters, produced by the transesterification reaction of vegetable oils with short chain alcohols. Distinct advantages of biodiesel include a high flash point of over 100°C, excellent lubricity, a BTU content comparable to that of petro diesel, and virtually no sulfur or aromatic content. Above all, biodiesel is non-toxic and biodegradable (Howell, 2007).

Results from investigating performance of vegetable oils in blends with diesel indicate that blending up to 25% biodiesel (sunflower) with mineral diesel has no adverse effect on performance. (Kayisoglu et al., 2006).

Vegetable oils have also been applied as transformer coolant oils and have been found to conform to all industry standards with performances and cost profiles comparable to the conventional mineral oils applied in transformer cooling (ABB Inc., 2002; McShane, 2002). Transformer oil products have been produced from soybean oils as well as castor oils (Honary, 2004).

The major disadvantage militating against the use of vegetable oils in industrial applications is its oxidative stability. This factor has been most researched (Bahrudin et al., 2008; Nedyalka, 2001) particular as biodiesel (Kapilani et al., 2009). Several proposals on how to tackle this problem have been investigated (Anderson, 2007). Ways of evaluating the oxidative stability of oils have occupied several authors (Tan et al., 2001; International organization for Standards, 1996; Gertz et al., 2000). Several oils have been proposed for industrial uses primarily due to their recognized high oxidative stability compared to other oils (Brimberg and Afaf, 1994). Ghazalia et al. (2006) investigated the effect of light on the stability of palm olein. Others have investigated the stability of these oils when anti oxidants are added (Nedyalka, 2001; Gordon and Lenka, 1995; Schober and Mittelbach, 2004; Ruger et al., 2002).

## BIODEGRADATION AND ITS MEASUREMENT

### Biodegradation

Is the process by which organic substances are broken down by the enzymes produced by living organisms. The term is often used in relation to ecology, waste management and environmental remediation (bioremediation). Organic material can be degraded aerobically, with oxygen or anaerobically, without oxygen. A term related to biodegradation is biomineralisation, in which organic matter is converted into minerals (Diaz, 2008).

By definition, biodegradation is the chemical transformation of a substance caused by organisms or their enzymes. There are two major types of biodegradation – Primary Biodegradation, which refers to the modification of a substance by microorganisms such that a change is caused in some specific measurable property of the substance (US Army Corps of Engineers, 1999). When the term primary biodegradation is used it refers to

minimal transformation that alters the physical characteristics of a compound while leaving the molecule largely intact. Intermediary metabolites produced may however be more toxic than the original substrate (wiserenewables.com, 2006). Thus mineralization is the true aim. When this happens it is referred to as Ultimate or Complete Biodegradation; which is the degradation achieved when a substance is totally utilized by microorganisms resulting in the production of carbon dioxide, methane, water, mineral salts, and new microbial cellular constituents (US Army Corps of Engineers, 1999).

Various methods exist for the testing of biodegradability of substances. Biodegradability is assessed by following certain parameters which are considered to be indicative of the consumption of the test substance by microorganisms, or the production of simple basic compounds which indicate the mineralization of the test substance. Hence there are various biodegradability testing methods which measure the amount of carbon dioxide (or methane, for anaerobic cases) produced during a specified period; there are those which measure the loss of dissolved organic carbon for substances which are water soluble; those that measure the loss of hydrocarbon infrared bands (bioblend, 2008); and there are yet others which measure the uptake of oxygen by the activities of microorganisms (the Biochemical Oxygen Demand, BOD).

However, when the reference is specifically to lubricants, there are 2 major methods of biodegradability testing, and these are outlined in brief below:

1. ASTM test method D 5864 determines lubricant biodegradation. This test determines the rate and extent of aerobic aquatic biodegradation of lubricants when exposed to an inoculum under laboratory conditions. The inoculum may be the activated sewage-sludge from a domestic sewage-treatment plant, or it may be derived from soil or natural surface waters, or any combination of the three sources. The degree of biodegradability is measured by calculating the rate of conversion of the lubricant to CO<sub>2</sub>. A lubricant, hydraulic fluid or grease is classified as readily biodegradable when 60% or more of the test material carbon is converted to CO<sub>2</sub> in 28 days, as determined using this test method.
2. The most established test methods used by the lubricant industry for evaluating the biodegradability of their products are Method CEC-L-33-A-94 developed by the Coordinating European Council (CEC); Method OEC D 301B, the Modified Sturm Test, developed by the Organization for Economic Cooperation and Development (OECD); and Method EPA 560/6-82-003, number CG-2000, the Shake Flask Test, adapted by the U.S. Environmental Protection Agency (EPA). These tests also determine the rate and extent of aerobic aquatic biodegradation under laboratory conditions. The Modified Sturm Test and Shake Flask Test also calculate the rate of conversion of the lubricant to CO<sub>2</sub>. The CEC test measures the disappearance of the lubricant by analyzing test

material at various incubation times through infrared spectroscopy. Laboratory tests have shown that the degradation rates may vary widely among the various test methods indicated above (US Army Corps of Engineers, 1999).

Biodegradability tests based on the CEC method described above has certain trends which indicate that mineral oils, along with alkylated benzenes and polyalkylene glycols among others, generally have poor biodegradability: between 0 – 40%. Specifically, mineral oil biodegradability varies from 15 – 35% as conducted by the CEC biodegradability test (Wiserenewables, 2006).

### **BIODEGRADATION CHARACTERISTICS OF VEGETABLE OILS**

The notion of biodegradability conveys the meaning of the breaking down of complex, and possibly toxic material into simple and common forms, in which the elements carbon, hydrogen and oxygen exist or are simply associated. Whenever any substance is placed in the environment, it begins to undergo degradation due to the action of relevant substrate utilizing microorganisms. Every substance, irrespective of its complexity and toxicity is subject to this process. When used in the present context, it is referenced to a time frame. That is, for a given substance to be referred to as biodegradable, a specific time limit must be used as a reference (wiserenewables.com, 2006).

According to the California advertising statute, a manufacturer cannot claim his product is biodegradable unless it has the proven capability to decompose in the most common environment where the product may be disposed within three years through natural biological processes into nontoxic carbonaceous soil, water, carbon dioxide or methane (wiserenewables.com, 2006). Biodegradation is important for the natural and industrial cycling of environmental chemicals. Government regulators and industries are always interested in the fate of industrial chemicals and waste products when discarded to the environment, either intentionally or unintentionally. This is because toxic substances in the environment eventually affect the ecosystem and humans adversely (Wackett et al., 1999).

Lipids (fats, oils and greases) form a major part of domestic and industrial waste – hence they contribute their fair share towards environmental pollution. Sources include waste water from the edible oil refinery, slaughter houses and dairy products. These waste products are responsible for clogging sewer networks and unsettling the balance of waste water treatment plants (Saifudin et al., 2006).

The first step in the degradation of vegetable based oils is the enzyme-catalyzed cleavage of the ester bond to fatty acids. The enzymes which catalyze this biodegradation reaction include esterases and lipases and these are synthesized by a wide range of microorganisms

(Broekhuizen et al., 2003). "Lipases are hydrophobic proteins that catalyze the cleavage of carboxyl ester bonds in tri-, di-, and monoacylglycerols (the major constituents of animal, plant and microbial fats and oils)" (Saifudin et al., 2006). Due to their degradative effects, lipases are applied in remediation efforts to degrade lipid rich waste. Drawbacks however include thermal instability of the enzyme and the high cost of the single use of the enzyme (Saifudin et al., 2006). Following the first step of degradation, both saturated and unsaturated fatty acids biodegrade via a process of  $\beta$ -oxidation.

Indeed, the biodegradation of materials also is dependent on the nature of the environment, as documented by Kaakinen et al. (2007) where pH adjustments of soils, for instance was found to have a noticeable effect on the biodegradation of certain compounds (Kaakinen et al., 2007). Microbial communities are also prone to adapt to a substrate when it is a regular contaminant that is, increases in rates of transformation of hydrocarbons associated with oil contaminated environments has been identified and documented (Khalida et al., 2006). Modified strains of bacteria emerge which are characterized by the ability to degrade the substances which induce the modification (Mansee et al., 2004; Abrashev et al., 2002). However, biodegradability primarily is a function of the chemical nature of the substance in question.

That natural and vegetable oils are biodegradable is not in doubt. "Vegetable oils and synthetic esters have a much better biodegradation capacity than mineral oil under aerobic as well as anaerobic conditions" (Broekhuizen et al, 2003). Tests carried out severally indicate that vegetable oils undergo about 70-100% biodegradation in a period of 28 days.

In a specific comparative study carried out by Mecurio et al. (2003), Vegetable-Derived Lubricants were established to be in fact more biodegradable than comparable Mineral-Derived Lubricants in the presence of tropical mangrove or coral reef microbial communities (Mecurio et al., 2003); while some others have examined the biodegradation of vegetable oils under spill conditions (Pereira et al., 1998; Campo et al., 2007; Al-Darbi et al., 2005). Several authors have examined the biodegradability and oxidative stability of industrial fluids obtained from vegetable oils. These include; as methyl esters (Demirba, 2009); as hydraulic fluids (Abdalla and Patel, 2006; Petyuk et al., 2004); an lubricant (Fernando and Hanna, 2002) and as dielectric fluid (McShane, 2002).

### **Conclusion**

The biodegradability of vegetable oils is the strongest point in the case for their industrial use. In the light of more concerns about the environmental impact of the use of industrial fuels and lubricants, they offer in theory the most plausible solution to the issue of obtaining renewable and eco friendly lubricants and fuels. With established biodegradabilities in the range of 70 – 100%,

their eco friendliness is not in doubt. The challenge is the improvement of their performance in industrial uses; specifically with reference to their oxidative stabilities and pour points which in general leave much to be desired. Improvements are inevitable and are already being recorded with increasing research directed in these areas.

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# NEWS-RECORD

The Gillette

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## Mission: Kill larvae

*Aerial strike is unleashing an experimental soybean-based larvicide*

By ANDREW K. ROGERS

News-Record Staff Writer

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As the glowing red sun rose Wednesday morning over a pond on state property by Gliven Road, a helicopter swooped down, out of the sky and unleashed a swirling spray onto the shallow waters below.

**Its mission:** Kill the mosquito larvae before they hatch.

The aerial strike, which dropped 50 gallons of larvicide over 13 acres on both the pond and neighboring Brown Lake, was a test run for an experimental bio-based mosquito control tactic known as minimal field methyl soyate. The larvicide, made from soybeans, is a safer

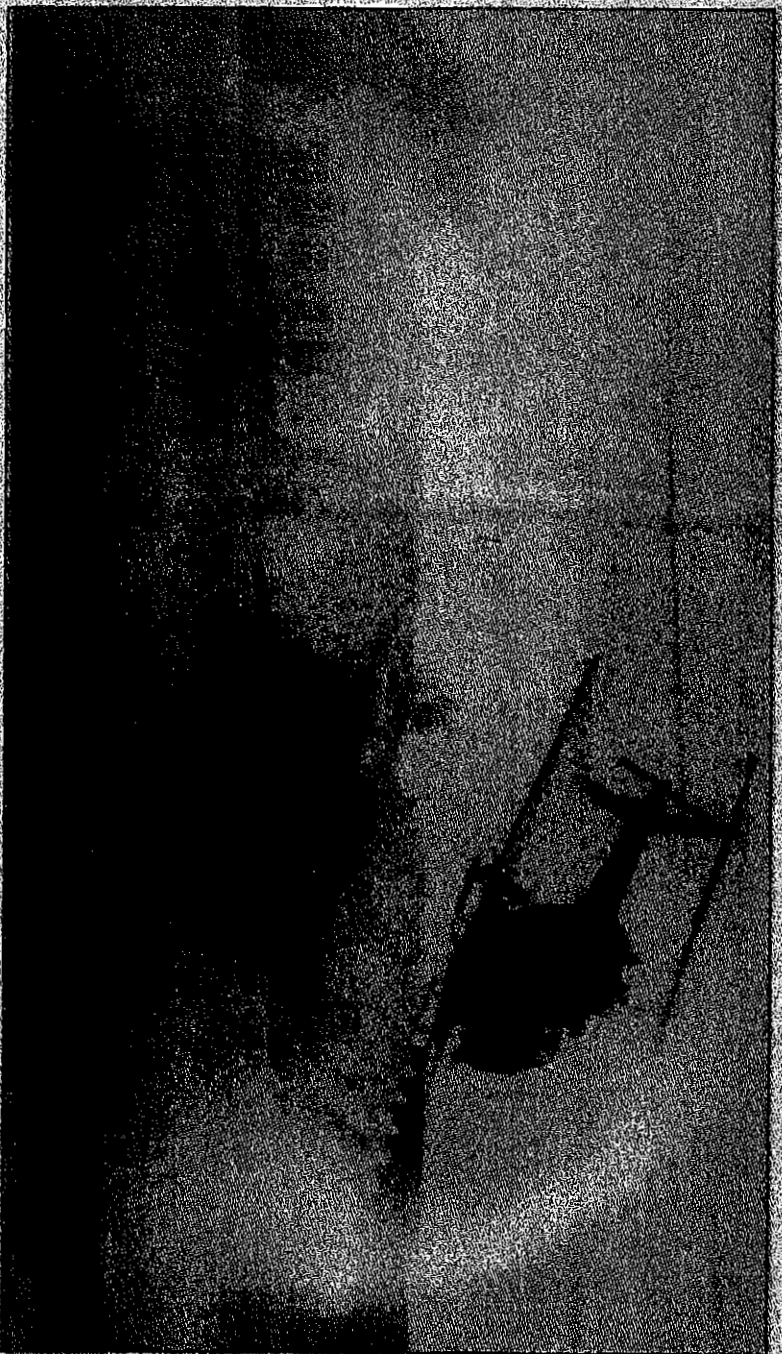
See MOSQUITOS on page 4

### SOYBEAN

#### FACTS

- Leading export for U.S. in the United States.
- More than 600,000 soybean farmers in the nation.
- It is used to make ink, paints, adhesives, plastics, solvents and washing machine parts.
- Edamame, cooked soybeans, is a favorite snack around the world.





## SOY BOMB

A heliopter sprays emulsified methyl soyate over the "state swamp" early Wednesday morning. The emulsified methyl soyate is an experimental bio-based larvicide made primarily from soybeans, which is used to kill mosquito larvae.

New Record photo by Steve Gesele

# Mosquitoes: 'Everyone is excited about killing mosquitoes'

Continued from page A1

cheaper and more environmentally friendly alternative to fighting mosquitoes, including those carrying West Nile virus, said Avon Young, toxicologist and United Soybean Board senior consultant.

Many larvicides are petroleum-based chemicals that can hurt other animals and wildlife.

The use of oil in Young's larvicide is more cost-effective than insecticides that target mosquitoes by suffocating larvae.

Larvae float near the top of shallow water and have needles that stick out of the water to gather air to breathe like a snorkel. When the soybean oil coats the top of the water, the larvae needles suck in the oil, and then the little suckers drown, Young said.

Young already has tested the larvicide in ground

experiments on coal-bed methane water and at the wastewater treatment around the county.

Before he could indicate the soybean experiment, Young had to get the Wyoming Department of Agriculture's approval. Allen Mooney, director of the Campbell County West and Best Department, was interested in a better way to control mosquitoes in the county.

Young said he got Young's

idea. Young and Mooney tested the water Thursday by dipping cups around the shallow edge of a swamp on Kliver Road and counting the amount of larvae they caught. They decided to target the areas of the pond with the highest concentration of mosquitoes near the road construction on Kliver Road. With the blessing of John Kliver, who leases the land, the test was ready to take flight.

As Young and Mooney watched the test run, he

sniffed the air as the oil fell to the surface. "Ah, smells like McDonald's french fries," Young said.

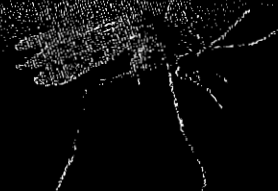
Robert Clegem, the top entomologist in the Department of Defense and professor at University of Maryland, came to Campbell County to examine the experiment. He said he will examine the larvae and will check the results.

It's nice to have a bio-based larvicide rather than a petroleum-based one," Clegem said.

The tests will return to both ponds Thursday to check for dead larvae. If the oil works, Young will try to take his soybean larvicide to the market. He hopes the larvicide will not only take off, but that it will promote the production of soybeans in the county.

Everyone is excited about killing mosquitoes," Young said.

# Mosquito Larvicide



TRUSTED SINCE 1926



FOR USE ON SEWAGE AND DRAINAGE DITCHES, CATCH BASINS, SALT MARSHES, SWAMPS AND STAGNANT WATER POOLS.

KILLS LARVAE AND PUPA STAGES OF MOSQUITOES

30069

<b>Mosquito Larvicide</b>	<b>55 Gallons</b>
<b>FIRST AID</b>	
Have the product container or label with you when calling a poison control center or doctor, or going for treatment. You may also contact the National Pesticide Information Center at 1-800-858-7378 for emergency medical treatment information.	
<b>If Inhaled:</b>	<ul style="list-style-type: none"> <li>• Move person to fresh air.</li> <li>• If person is not breathing, call 911 or an ambulance, then give artificial respiration, preferably by mouth-to-mouth, if possible.</li> <li>• Call a poison control center or doctor for further treatment advice.</li> </ul>
<b>If Swallowed:</b>	<ul style="list-style-type: none"> <li>• Call poison control center or doctor immediately for treatment advice.</li> <li>• Do not give any liquid to a person.</li> <li>• Do not induce vomiting unless told to do so by the poison control center or doctor.</li> <li>• Do not give anything by mouth to an unconscious person.</li> </ul>
<b>Note to Physician:</b> Contains mineral oil -- vomiting may cause aspiration pneumonia.	
<b>PRECAUTIONARY STATEMENTS</b>	
<b>HAZARDS TO HUMANS AND DOMESTIC ANIMALS</b>	
<b>CAUTION:</b> Harmful if inhaled or swallowed. Avoid breathing spray mist. Remove contaminated clothing and wash clothing before reuse. Wash thoroughly with soap and water after handling.	
<b>ENVIRONMENTAL HAZARDS</b>	
Do not apply directly to water, except as directed for use on this label. Do not contaminate water by cleaning of equipment or disposal of equipment washwaters.	
<b>DIRECTIONS FOR USE</b>	
It is a violation of Federal law to use this product in a manner inconsistent with its labeling.	
<b>STORAGE AND DISPOSAL</b>	
Do not contaminate water, food or feed by storage or disposal.	
<b>Pesticide Storage:</b> Store and transport in an upright position. Store in original container in a cool, dry area.	
<b>Pesticide Disposal:</b> Wastes resulting from the use of this product may be disposed of on site or at an approved waste disposal facility.	
<b>Container Disposal (plastic containers):</b> Triple rinse, or equivalent. Then offer for recycling or reconditioning, or puncture and dispose of in a sanitary landfill, or incineration, or if allowed by state and local authorities by burning. If burned, stay out of smoke.	
<b>Container Disposal (metal containers):</b> Triple rinse, or equivalent. Then offer for recycling or reconditioning, or puncture and dispose of in a sanitary landfill, or by other procedures approved by state and local authorities.	
Bonide® Mosquito Larvicide can be used all season long; does not depend on life cycle timing for effectiveness. It kills by suffocation and mosquitoes do not develop resistance. The last application of the season is as effective as the first. Does not smear or deface the environment with dark oily films or residues.	
<b>GROUND APPLICATION:</b> One to five gallons per acre (3 to 15 fl. oz. per 1,000 sq. ft.) depending on water surface conditions and vegetative density. Use 1 to 2½ gallons per acre (3 to 7½ fl. oz. per 1,000 sq. ft.) if trees are in green tip stage and vegetative cover is light and water is essentially clean. To penetrate heavier or denser vegetative cover, or if water is substantially polluted, use 2½ to 5 gallons per acre (7½ to 15 fl. oz. per 1,000 sq. ft.). An average rate of 2½ to 3 gallons per acre (approximately 1 quart to 5,000 sq. ft. - 50' x 100' area, 7½ to 9 fl. oz. per 1,000 sq. ft., or 2 to 4 teaspoons per 100 sq. ft. - 10' x 10' area) of water surface covers most conditions.	
<b>AERIAL APPLICATION:</b> Two to four gallons per acre for salt marshes and swamps. Adjust for vegetation or surface conditions. Average rate of 3 gallons per acre (36 gallons per 100 ft. swath mile) covers most conditions.	
Apply to leave a thin film over surface of breeding areas. Include treatment of drainage ditches, catch basins, stagnant pools, open sewage basins to improve overall control. Since high pressures or high velocities are not needed, lighter less expensive equipment can be effectively used. Since mosquitoes can hatch in 5 - 7 days of warm weather, any stagnant water expected to be exposed for that period or longer should be treated.	
For information on pesticide products (including health concerns, medical emergencies, or pesticide incidents), call the National Pesticide Information Center at 1-800-858-7378.	
Buyer's Guarantee Limited to Label Claims.	
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