201-16566A

HIGH PRODUCTION VOLUME (HPV) CHEMICAL CHALLENGE PROGRAM

EXPOSURE AND USE DATA

For

CASHEW NUT SHELL LIQUID

CAS No. 8007-24-7

Submitted to the US EPA By

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1. Introduction

Cashew nut shell liquid (CNSL) is one of the sources of naturally occurring phenols. It is obtained from the shell of a cashew nut. About 30-35% CNSL is present in the shell, which amounts to approximately 67% of the nut.

CNSL is traditionally obtained as a by-product during the process of removing the cashew kernel from the nut. The processes used are mainly hot-oil and roasting in which the CNSL oozes out from the shell.

The cashew tree is cultivated globally in tropical areas such as East Africa, South and Central America and the Far East. The world availability of CNSL is in the region of 50,000 tons/year.

2. Production Volume

Production volume of CNSL as reported in 1986 – 2006 IUR:

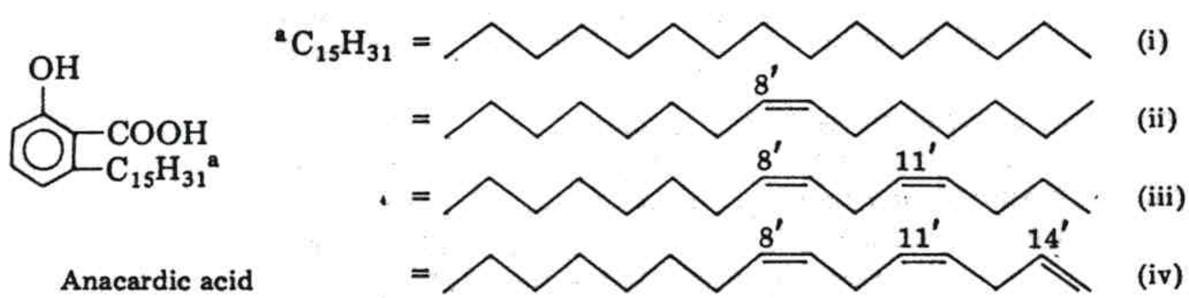
CAS No.	1986 Range	1990 Range	1994 Range	1998 Range	2002 Range	Chemical Name
8007247	>1M - 10M	>1M - 10M	>10M - 50M	>10M - 50M	>10M - 50M	Cashew, nutshell liq.

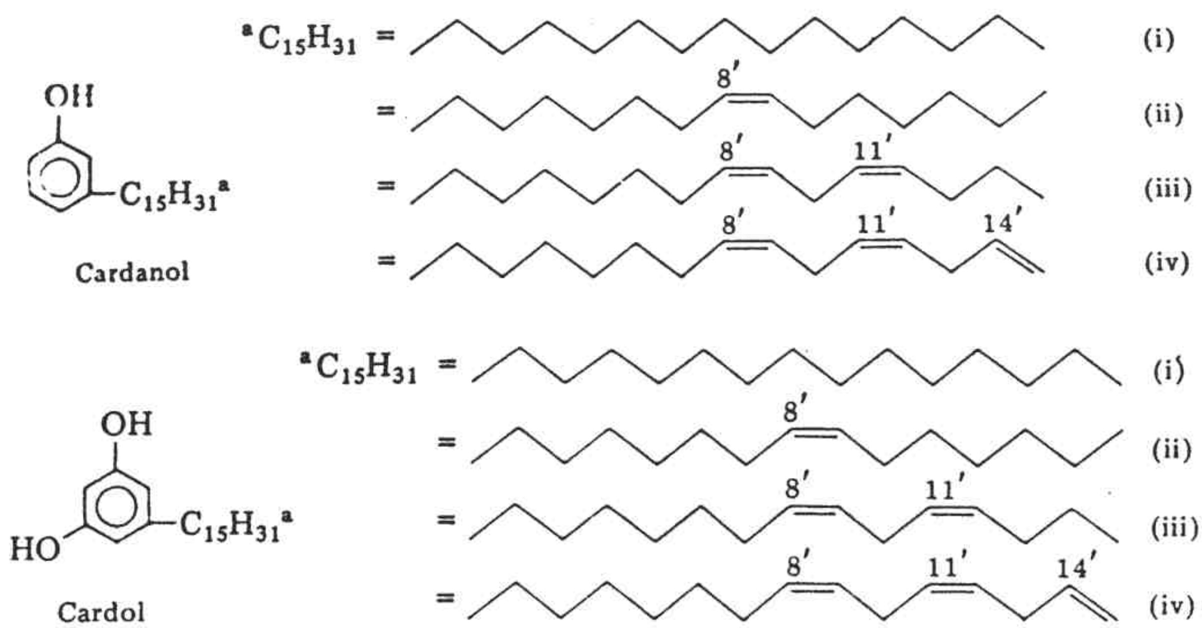
CAS No.	2006 Range	Chemical Name
8007247	>10M - 50M	Cashew, nutshell liq.

3 Form and Composition

Natural (i.e. cold, solvent extracted) CNSL is a liquid that contains approximately 70% anacardic acid (Fig 1), 18% cardol, and 5% cardanol, with the remainder being made up of other phenols and less polar substances. As can be seen in Figure 1, anacardic acid, cardanol and cardol consist of mixtures of components having various degrees of unsaturation in the alkyl side-chain.

Figure 1: Structures of Anacardic acid, Cardanol and Cardol





In technical (i.e. heat extracted) CNSL, the heating process leads to decarboxylation of the anacardic acid to form cardanol. Typically, the composition of technical CNSL is approximately 52% cardanol, 10% cardol, 30% polymeric material, with the remainder being made up of other substances.

The technical CNSL is often further processed by distillation at reduced pressure to remove the polymeric material. The composition of distilled technical CNSL is approximately 78% cardanol, 8% cardol, 2% polymeric material, < 1% 2-methyl cardanol, 2.3% heptadecyl homologue triene, 3.8% heptadecyl homologue diene and the remainder other homologous phenols.

Table 1 summarises the composition of typical batches of technical and distilled technical grades of CNSL.

Table 1: Composition of typical batches of Technical and Distilled CNSL

	Cardanol	Cardanol monoene	Cardanol diene	Cardanol triene	Cardol diene	Cardol triene	Polymer	2-methyl cardanol	C17 triene	C17 diene	Unidentified phenols
T-CNSL	0.06	17.10	10.78	24.42	2.36	7.50	30.6				5.83
D-CNSL	-	25.9	16.2	35.8	2.04	5.90	2.5	0.60	2.27	3.75	5.04
AT-CNSL	0.09	24.7	15.6	35.3	3.41	10.8	-				8.42

T-CNSL = Technical grade, D-CNSL = Distilled grade, AT-CNSL = Technical grade component percentages adjusted for removal of polymer.

4. Commercial Uses / Applications

CNSL resins have been used extensively in the manufacture of friction-resistant components in applications such as brake and clutch linings. These resins are used as binders for friction ingredients and also as friction ingredients themselves in the form of fine dusts obtained from the completely cured resins.

CNSL-aldehyde condensation products and CNSL-based phenolic resins are used in applications such as surface coatings, adhesives, varnishes and paints. Various polyamines synthesized from CNSL or cardanol are used as curing agents for epoxy resins.

CNSL and its derivatives have been used as antioxidants, plasticisers and processing aids for rubber compounds and modifiers for plastic materials. Resins based on the reaction products of cardanol phenol and formaldehyde are used to improve the resistance of rubber articles to cracking and ozone. CNSL, cardanol and cardol are all used to provide oxidative resistance to sulfur-cured natural rubber products. Cardanol, CNSL or sulfurated CNSL is added to rubber gum stock or nitrile rubber to improve the processability, mechanical properties and resistance to crack and cut properties of the vulcanisates.

A number of products based on CNSL are used as antioxidants, stabilizers and demulsifiers for petroleum products. Metal xanthates of partially hydrogenated, sulfurized cardanol is used to lower the pour point of lubricating oils as well as acting as antioxidant and anticorrosive properties. Soluble metal derivatives of CNSL are used to improve the resistance to oxidation and sludge formation of lubricating oils. Oxidized CNSL and its derivatives are used as demulsifying agents for water in oil type petroleum emulsions.

5. Worker/consumer exposure

Only large industrial manufacturers use CNSL. There are no direct consumer applications and therefore no direct sales to the general public. The most likely source of consumer exposure to CNSL is through contact with contaminated nuts, although reports of adverse effects arising from such contact appear to be rare.

Exposure of workers to CNSL during production is most likely to occur during removal of the kernels from the nuts, after processing to remove the CNSL, especially in countries where the shelling has not been mechanized. Exposure to CNSL can lead to sensitization and dermatitis. Workers in these countries are given some protection to exposure through the use of barrier creams.

Workers involved in the further processing the CNSL to manufacture commercial products are likely to have minimal exposure to the CNSL as it is expected that good industrial hygiene practices will be followed and personal protective equipment worn to minimize exposure.

5. Evaluation of Existing Environmental Fate Data

1. Biodegradation

Distilled CNSL has been shown to be biodegradable when tested using OECD Method 301D (96% degradation after 28 days) in a GLP study.

2. Hydrolysis

Hydrolysis as a function of pH is used to assess the stability of a substance in water. Hydrolysis is a reaction in which a water molecule (or hydroxide ion) substitutes for another atom or group of atoms present in an organic molecule. None of the major components of CNSL contain a functional group that would be susceptible to hydrolysis. Therefore, hydrolysis need not be measured.

In addition, low water solubility often limits the ability to determine hydrolysis as a function of pH. The water solubility of cashew nutshell liquid was determined to be 3.04×10^{-4} g/L. Therefore, these materials are expected to be stable in water and it would be unnecessary to attempt to measure the products of hydrolysis.

3. Photodegradation

Indirect photo-oxidation by hydroxy radicals (1500000 molecule/cm^3) is predicted to occur with a half-life estimated at 0.351-1.254 hrs (calculated using AOPWIN v1.91 at 25 °C, rate constant, 102.3748 – 365.8109 E-12 cm^3/molecule/sec, 12-hour day).

4. Transport and Distribution between Environmental Compartments

Based on Epiwin V3.12 Level III Fugacity Model estimations, the major components of cashew nutshell liquid will distribute mainly to soil (37.3 - 77.7%) if released to the air compartment, almost exclusively to sediment (94.8 – 97.3%) if released to water, exclusively to soil if released to soil and mainly to sediment (66.9 – 69.9%) if released simultaneously to all air, soil and water compartments.

Summary of Environmental Fate Testing:

Distilled CNSL has been shown to be biodegradable when tested using OECD Method 302D (96% degradation after 28 days) in a GLP study. None of the major components of CNSL contain a functional group that would be susceptible to hydrolysis. Indirect photo-oxidation by hydroxy radicals (1500000 molecule/cm3) is predicted to occur with a half-life estimated at 0.351-1.254 hrs (calculated using AOPWIN v1.91 at 25 °C, rate constant, 102.3748 – 365.8109 E-12 cm3/molecule/sec, 12-hour day). Based on Epiwin V3.12 Level III Fugacity Model estimations, the major components of cashew nutshell liquid will distribute mainly to soil (37.3 - 77.7%) if released to the air compartment, almost exclusively to sediment (94.8 – 97.3%) if released to water, exclusively to soil if released to soil and mainly to sediment (66.9 – 69.9%) if released simultaneously to all air, soil and water compartments.