S INTERNATIONAL PROGRAMME ON CHEMICAL SAFETY

Health and Safety Guide No. 73

ROTENONE HEALTH AND SAFETY GUIDE

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Health and Safety Guide No. 73

ROTENONE
HEALTH AND SAFETY
GUIDE

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INTRODUCTION

This Health and Safety Guide is not based on an existing Environmental Health Criteria document, but on critical national reviews. The hazard evaluation in the Health and Safety Guide was made on the basis of carefully selected studies, after scrutiny of the original publications.

In order to assist the peer-review process of the present Health and Safety Guide, a background companion document was prepared by the IPCS and can be obtained from the Director on request; the IPCS does not intend that the background document should be published.

The first three sections of this Health and Safety Guide present essential technical information and the hazard evaluation. Section 4 includes advice on preventive and protective measures and emergency action; health workers should be thoroughly familiar with the medical information to ensure that they can act efficiently in an emergency. The section on regulatory information has been extracted from the legal file of the International Register of Potentially Toxic Chemicals (IRPTC) and from other United Nations sources.

The target readership includes occupational health services, those in ministries, governmental agencies, industry, and trade unions who are involved in the safe use of chemicals and the avoidance of environmental health hazards, and those wanting more information on this topic. An attempt has been made to use only terms that will be familiar to the intended user. However, sections 1 and 2 inevitably contain some technical terms.

Revision of the information in this Guide will take place in due course, and the eventual aim is to use standardized terminology. Comments on any difficulties encountered in using the Guide would be very helpful and should be addressed to:

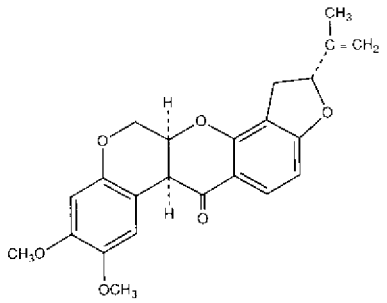
The Director
International Programme on Chemical Safety
World Health Organization
1211 Geneva 27
Switzerland

THE INFORMATION IN THIS GUIDE SHOULD BE CONSIDERED AS A STARTING POINT TO A COMPREHENSIVE HEALTH AND SAFETY PROGRAMME

1. PRODUCT IDENTITY AND USES

1.1 Identity

Rotenone is a naturally occurring chemical with insecticidal and piscicidal properties obtained from the roots of several tropical and subtropical plant species belonging to genus *Lonchocarpus* or *Derris*.

Chemical formula:	$C_{23}H_{22}O_6$
Chemical structure:	
Plant names:	*Derris elliptica; Lonchocarpus utilis; L. urucu; L. nicou;* (barbasco; cube; haiari; nekoe; timbo)
Common names of plant extracts:	tubatoxin; tuba-root; derris-root; aker-tuba; cube-root
Formulations:	Formulations of rotenone often contain various concentrations of other pesticides
Trade/trivial names:	Derril, Tubatoxin, Extrax, Mexide
CAS registry number:	83-79-4
RTECS registry number:	DJ2800000

The purity of rotenone preparations varies widely, depending on origin. Identified impurities include dehydrorotenone and rotenonone.

1.2 Physical and chemical properties

Rotenone is a colourless, crystalline solid with a melting point of 165–166 °C and has a very low solubility in water at ambient temperatures. It is soluble in acetone, carbon disulfide, ethyl acetate, and chloroform. It is less soluble in ether, carbon tetrachloride, and petroleum solvents. Solutions are readily oxidized, in the presence of light and alkali, to products with weaker insecticidal properties.

1.3 Analytical methods

Rotenone can be extracted with chloroform and determined by ultraviolet (UV) spectroscopy, or analysed using HPLC with UV detection.

Paper and thin layer chromatographic as well as colorimetric methods have been described both for the analysis of formulations and the determination of residues in several crops.

1.4 Uses

Rotenone is a selective, nonsystemic insecticide used on fruit trees, such as apple, apricot, peach, persimmon, pomegranate, and quince, to control aphids, maggots, bagworms, codling moths, Japanese beetles, leaf hoppers, Mexican bean beetles, cabbage worms, thrips, stinkbugs, flea beetles, and vegetable weevils. It is also used to control grubs, ticks, lice, and fleas on cattle. Rotenone has been used on humans for external treatment of chiggers (2% lotion) and scabies (10% emulsion). Emulsifiable concentrates and wettable powders of rotenone are also extensively used in lakes, ponds, and reservoirs to control undesirable fish.

Rotenone is available as a technical-grade solution at concentrations of 35%, 90%, or 95%, as a formulation intermediate at a concentration of 50%, and as a wettable powder containing 5% or 20% active substance. It is also available as a 5% emulsifiable concentrate.

2. SUMMARY AND EVALUATION

2.1 Human exposure to rotenone

Human exposure mainly occurs in connection with its extraction and formulation, and its use as a pesticide. No data have been found on the extent of human exposure.

2.2 Effects on the environment

Rotenone is highly toxic for aquatic life. Most values for the 96-h LC_{50} for different fish species and for daphnids (water fleas) lie in the range of 0.02–0.2 mg/litre. If used as a piscicide, it may also cause a temporary decrease in numbers of other aquatic organisms, such as daphnids. On the other hand, it is readily oxidized on soil and plant surfaces to less toxic products and seems to have a low persistence. Its toxicity for birds is very low. Rotenone is non-phytotoxic.

2.3 Uptake, metabolism, and excretion

Rotenone may be absorbed by ingestion and by inhalation. On the basis of rabbit studies, absorption through the intact skin is low. The metabolism and pharmacokinetics of rotenone are not completely understood, but the compound is metabolized by the mammalian liver. Most of the ingested compound is eliminated in the faeces.

2.4 Effects on animals

Rotenone exerts its toxic action by acting as a general inhibitor of cellular respiration. The acute oral toxicity of rotenone is moderate for mammals, but there is a wide variation between species. Rotenone by the oral route is less toxic for the mouse and hamster than for the rat; the pig seems to be especially sensitive. The reported oral LD_{50} values in the rat vary quite considerably, possibly because of differences in the plant extracts used. Recent studies have shown that in rats rotenone is more toxic for females than males. It is highly irritating to the skin in rabbits.

No evidence of carcinogenic action has been found in long-term studies on rats and mice, and tests have not revealed any significant genotoxic activity. An NOAEL of 0.4 mg/kg per day has been determined for rats (2-year

study) and dogs (6-month study). In short-term studies on rats, dose-dependent bone marrow atrophy and forestomach lesions were observed. In dogs, in addition to weight loss, haematological effects were found after six months' oral administration of rotenone at 10 mg/kg per day. Fetotoxic effects were observed in mice and rats at doses that elicited adverse reactions in the mother. The no-observed-effect level (NOEL) was 0.4 mg/kg per day. There were no indications of a teratogenic action in rodents below doses that were maternally toxic.

2.5 Effects on human beings

Acute poisoning causes nausea, vomiting, numbness, and tremors. A lowest lethal dose of 143 mg/kg has been cited in a child, but it may be that the compound is less toxic in adults. Occupational exposure to powdered rotenone containing plant materials has been reported to induce dermatitis, ulcers in the nose, and irritation of mucous membranes.

3. CONCLUSIONS AND RECOMMENDATIONS

3.1 Conclusions

The acute oral toxicity of rotenone is moderate in mammals, but there is a wide variation between species. Chronic toxic effects in long-term feeding studies have been found in experimental animals.

Clinical experience seems to indicate that humans, in particular children, are rather sensitive to the acute effects of rotenone.

There is no evidence for any carcinogenic, genotoxic, or teratogenic action of rotenone.

Rotenone is highly toxic for aquatic life. It is readily oxidized on soil and plant surfaces to less toxic products and has a low persistence in the environment.

3.2 Recommendations

It is recommended that rotenone should be handled with caution, particular attention being paid to keeping it away from children.

Care should also be taken to avoid unintentional contamination of surface waters.

The use of rotenone for medicinal purposes is to be discouraged.

4. HUMAN HEALTH HAZARDS, PREVENTION AND PROTECTION, EMERGENCY ACTION

4.1 Human health hazards, prevention and protection, first aid

Pure rotenone is moderately toxic for humans, but since the concentration of active ingredient in many marketed formulations is low, the use of this pesticide has resulted in few intoxications.

4.1.1 *Prevention and protection*

The prevention of occupational poisoning depends on ensuring a safe work environment and proper work practices. The following precautions should be observed whenever rotenone is handled and used, in order to reduce the risk of accidental contamination.

- Avoid contact with the skin and eyes.
- Do not smoke, drink, or eat while handling rotenone. Wash hands and any exposed skin before eating, drinking, or smoking, and after work.
- Avoid breathing dust from powder products. Disposable dust masks should be worn, whenever appropriate.
- When unloading and handling containers of concentrates, wear protective PVC or neoprene gloves.
- When handling leaking containers, or when dealing with leaks and spills, wear overalls and PVC or neoprene gloves and boots. If overalls become contaminated, change and wash them thoroughly before reuse.
- Store products in closed original labelled containers out of reach of children and away from food and animal feed.

4.1.2 *First aid*

If material has contaminated the skin, remove all contaminated clothing, and wash affected areas with soap and water. If the material is in the eyes, flush with clean water for at least 5–10 minutes. In case of ingestion, seek medical aid immediately. Until then, if the patient is conscious, give a glass of water or a slurry of activated charcoal, if available, and induce vomiting.

4.2 Advice to physicians

Rotenone is moderately toxic for humans. There is no specific antidote. In cases of ingestion, gastric lavage is indicated, unless it can be safely assumed that a non-toxic dose has been taken. Treatment should be symptomatic and supportive. There is no evidence of chronic toxicity in humans.

4.3 Explosion and fire hazards

Fight fires with alcohol-resistant foam, carbon dioxide, or dry powder. Confine the use of water sprays to the cooling of unaffected stock only, thus avoiding polluted run-off from the site. Fire service personnel should be advised that self-contained breathing apparatus may be necessary, because of the generation of noxious fumes.

4.4 Storage and transport

All products should be stored in secure buildings, out of reach of children and animals, and local regulations should be complied with. Containers should be sound and adequately labelled.

Rotenone should be transported in a separate compartment to prevent contamination of any food or animal feed.

4.5 Spillage and disposal

Avoid personal contact with rotenone or any of its formulations. Keep spectators away from any leakage. This pesticide is highly toxic for fish. Prevent contamination of other goods or cargo, and of surface waters.

Absorb spillage of liquid products with sawdust, earth, or sand, sweep up and place in separate container. Activated carbon can also be used to adsorb rotenone. Empty any product remaining in damaged or leaking containers into a clean, empty container, which should be suitably labelled. Sweep up any spilled powder with damp sawdust, taking care not to raise a dust cloud. Remove trapped material with suction hoses. Place in separate container for subsequent disposal. As it is easily destroyed by heat the compound can be disposed of by simple burning. Empty containers should be punctured to prevent reuse.

5. HAZARDS FOR THE ENVIRONMENT AND THEIR PREVENTION

Rotenone is not persistent, as it is readily decomposed in air and light. However, it has a high acute toxicity for aquatic organisms. Therefore, surface waters must not be contaminated.

6. CURRENT REGULATIONS, GUIDELINES, AND STANDARDS

6.1 Exposure limit values

The Joint FAO/WHO Meeting of Pesticide Residues in Food (JMPR) has not reviewed the compound to establish an ADI. A threshold limit value, time weighted average (TWA) for rotenone of 5 mg/m^3 has been recommended by the US ACGIH and adopted by several countries.

Some exposure limits for food products are given in Table 1.

Table 1. Exposure limits for food products in some countries

Country	Food product	Exposure limit description	Value (mg/kg)	Effective date
Austria	All products		0.05	1988
Germany	All products of plant origin	Maximum residue limit	0.1	1990
France	Fruits and vegetables		0.05	1989
Italy	Specified fruits and vegetables		0.04	1985
Netherlands	All products		0.05	1988

6.2 Transport and labelling

The European Communitylegislation requires labelling as a dangerous substance using the symbol:

T

* ES: Tóxico
DA: Giftig
DE: Giftig
EL: Τοξικό
EN: Toxic
FR: Toxique
IT: Tossico
NL: Vergiftig
* PT: Tóxico

The label must read:

Toxic by inhalation, in contact with skin and if swallowed; keep out of reach of children; keep away from food, drink and animal feeding stuff; if you feel unwell, seek medical advice (show the label where possible).

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