



WORLD HEALTH ORGANIZATION
INTERNATIONAL AGENCY FOR RESEARCH ON CANCER

IARC Monographs on the Evaluation of Carcinogenic Risks to Humans

Volume 20 Some Halogenated Hydrocarbons

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CHLORDECONE

VOL.: 20 (1979) (p. 67)

CAS No.: 143-50-0

Chem. Abstr. Name: 1,1a,3,3a,4,5,5a,5b,6-Decachlorooctahydro-1,3,4-metheno-2H-cyclobuta[cd]pentalen-2-one

5. Summary of Data Reported and Evaluation

5.1 Experimental data

Chlordecone was tested in one experiment in mice and in two in rats by oral administration: it produced hepatocellular carcinomas in males and females of both species.

Chlordecone impairs fertility and is foetotoxic.

5.2 Human data

No case reports or epidemiological studies were available to the Working Group.

The extensive production and the widespread use of chlordecone and its persistence in the environment (where it may also occur as a result of degradation of the pesticide mirex) indicate that human exposure occurs. This is confirmed by many reports of its occurrence in human body fluids. A group of highly exposed workers is known to exist. Oligospermia with hypomobility of the sperm has been reported in heavily exposed workers.

5.3 Evaluation

There is *sufficient evidence* that chlordecone is carcinogenic in mice and rats. In the absence of adequate data in humans, it is reasonable, for practical purposes, to regard chlordecone as if it presented a carcinogenic risk to humans.

Subsequent evaluation: Suppl. 7 (1987) (p. 59: **Group 2B**)

For definition of the terms, see [Preamble Evaluation](#).

Synonyms

- Compound 1189
- Decachloro ketone
- Decachlorooctahydro-1,3,4-metheno-2H-cyclobuta[cd]pentalen-2-one
- Decachloropentacyclo(5.2.1.0^{2,6}.0^{3,9}0^{5,8})decan-4-one
- Decachlorotetracyclodecanone
- ENT 16391
- GC 1189
- Kepone
- Merex

HEXACHLOROBENZENE

VOL.: 20 (1979) (p. 155)

5. Summary of Data Reported and Evaluation

5.1 Experimental data

Hexachlorobenzene was tested by oral administration in one experiment in mice and in one in hamsters. In mice, it produced liver-cell tumours in animals of both sexes. In hamsters of both sexes, it produced hepatomas, liver haemangiotheliomas and thyroid adenomas. An experiment involving intraperitoneal administration in mice was considered to be inadequate.

Hexachlorobenzene is foetotoxic and produces some teratogenic effects. It was not mutagenic in yeast and did not induce dominant lethal effects in male rats.

5.2 Human data

No case reports or epidemiological studies were available to the Working Group.

The production and use of hexachlorobenzene as a fungicide over the past several decades and its occurrence as a byproduct in the manufacture of other chemicals indicate that widespread human exposure occurs in both the general and working environments. This is confirmed by many reports of its occurrence in the general environment and in human body fluids.

A group of people who were accidentally exposed over a period of time is known to exist; many of these showed toxic manifestations, some lasting for as long as 20 years. No data on carcinogenic effects have been reported.

5.3 Evaluation

There is *sufficient evidence* that hexachlorobenzene is carcinogenic in mice and hamsters. In the absence of adequate data in humans, it is reasonable, for practical purposes, to regard hexachlorobenzene as if it presented a carcinogenic risk to humans.

For definition of the italicized terms, see [Preamble Evaluation](#).

Subsequent evaluations: [Suppl. 7 \(1987\)](#); [Vol. 79 \(2001\)](#)

HEXACHLOROBUTADIENE

VOL.: 20 (1979) (p. 179)

CAS No.: 87-68-3

Chem. Abstr. Name: 1,1,2,3,4,4-Hexachloro-1,3-butadiene

5. Summary of Data Reported and Evaluation

5.1 Experimental data

Hexachlorobutadiene was tested in one experiment in rats by oral administration: it produced benign and malignant tumours in the kidneys of animals of both sexes. It was tested inadequately in one experiment in mice by intraperitoneal injection.

5.2 Human data

No case reports or epidemiological studies were available to the Working Group.

The occurrence of hexachlorobutadiene as a by-product in the production of various chlorinated hydrocarbons for over 50 years and its use in some areas as a pesticide indicate that widespread human exposure in both the occupational and general environment occurs. This is confirmed by reports of its occurrence in the environment.

5.3 Evaluation

There is *limited evidence* that hexachlorobutadiene is carcinogenic in rats.

Subsequent evaluations: Suppl. 7 (1987) (p. 64) [Vol. 73 \(1999\)](#)

For definition of terms, see [Preamble Evaluation](#).

Synonyms

- C 46
- Dolen-Pur
- HCBD
- Hexachloro-1,3-butadiene
- Perchlorobutadiene

HEXACHLOROCYCLOHEXANE (TECHNICAL HCH AND LINDANE)

VOL.: 20 (1979) (p. 195)

5. Summary of Data Reported and Evaluation

5.1 Experimental data

α -HCH was tested in several experiments in mice by oral administration: it produced benign and malignant liver tumours in animals of both sexes; a treatment of 16 weeks was sufficient to produce tumours. Two feeding experiments in rats, one of which suggested a carcinogenic effect on the liver, were considered to be inadequate.

β -HCH was tested in four experiments in mice by oral administration: two were inadequate, and another was inadequately reported but suggested hepatocarcinogenicity; in the fourth study, β -HCH induced benign and malignant liver tumours in animals of both sexes. Two feeding experiments in rats were considered to be inadequate.

Lindane was tested in six experiments in mice by oral administration: it produced benign and malignant liver tumours in animals of both sexes in two experiments, one of which involved only small groups of animals. The results of a third experiment suggested hepatocarcinogenicity but were inadequately reported. The results of a fourth experiment also suggested hepatocarcinogenicity but were considered inadequate because of the low number of control animals used. The other experiments were considered inadequate for an evaluation of carcinogenicity. Lindane was also tested in three feeding studies in rats: two were considered inadequate; in the other a slight excess of thyroid tumours was observed in females. Lindane was tested inadequately in mice by skin application and by subcutaneous and intraperitoneal administration.

Experimental data on the long-term effects of the δ - and ϵ -isomers were considered to be inadequate.

Technical HCH was tested in three experiments in mice by oral administration, producing liver tumours. A feeding experiment in rats was considered to be inadequate.

Lindane is embryotoxic. α - and β -HCH and lindane, when tested individually and/or as a mixture, were not mutagenic in bacteria, yeast or *Drosophila*. Lindane induces chromosome aberrations, polyploidy and mitotic arrest in a number of plant systems. It also induced chromatid breaks in human lymphocytes *in vitro*.

5.2 Human data

Several case reports indicate a relationship between exposure to HCH or lindane and the occurrence of aplastic anaemia. Two cases of acute myeloid-type leukaemia in cousins exposed to lindane and one case of acute myelomonocytic leukaemia, secondary to aplastic anaemia, that was associated with dermal exposure to a lindane/toxaphene mixture have also been reported.

The only epidemiological study related to possible carcinogenic effects of HCH or lindane in humans involved exposure to many pesticides; the Working Group was thus unable to draw any conclusion specific to HCH or lindane.

The extensive production of HCH and lindane and their use in veterinary, agricultural and consumer products since the early 1950s indicate that widespread human exposure occurs. This is confirmed by many reports of their occurrence in the general environment and by reports of their presence in body fluids and tissues, both in the general population and in exposed workers.

5.3 Evaluation

There is *sufficient evidence* that α -HCH, lindane and technical HCH are carcinogenic in mice; there is *limited evidence* that β -HCH is carcinogenic in mice.

For definition of the italicized terms, see [Preamble Evaluation](#).

Previous evaluation: [Vol. 5 \(1974\)](#)

Subsequent evaluation: [Suppl. 7 \(1987\)](#)

Last updated: 31 March 1998

HEXACHLOROPHENE

VOL.: 20 (1979) (p. 241)

CAS No.: 70-30-4

Chem. Abstr. Name: 2,2'-Methylenebis(3,4,6-trichlorophenol)

5. Summary of Data Reported and Evaluation

5.1 Experimental data

Hexachlorophene was tested in one experiment in rats by oral administration; it had no carcinogenic effect. It was inadequately tested in one experiment in mice by skin application.

Hexachlorophene is embryotoxic and produces some teratogenic effects. It was not mutagenic in *Salmonella typhimurium* and was negative in a dominant lethal assay in male mice. Cytogenetic tests with cultured human lymphocytes were also negative.

N.B. - Subsequent to the meeting of the Working Group, the Secretariat became aware of completed studies on the carcinogenicity of hexachlorophene in which no carcinogenic effects were observed in mice or rats following its oral administration or in mice following exposure prenatally or *via* the mother's milk or following its s.c. injection to newborn mice (Rudali & Assa, 1978).

5.2 Human data

No case reports or epidemiological studies were available to the Working Group.

Malformations have been reported in children born to mothers repeatedly exposed to hexachlorophene.

The extensive production and use, particularly in germicidal soap, of hexachlorophene over the past several decades indicate that widespread human exposure occurs in both the general and the working environment. This is confirmed by its presence in human body fluids. Episodes of intoxication have also been reported.

5.3 Evaluation

The available data do not allow an evaluation of the carcinogenicity of hexachlorophene to be made.

Subsequent evaluation: Suppl. 7 (1987) (p. 64: **Group 3**)

For definition of terms, see [Preamble Evaluation](#).

Synonyms

- Acigena
- Almederm
- AT 7
- AT-17
- B32
- Bilevon
- Bis(2-hydroxy-3,5,6-trichlorophenyl)methane
- Bis(3,5,6-trichloro-2-hydroxyphenyl)methane

- Compound G-11
- Cotofilm
- Dermadex
- 2,2'-Dihydroxy-3,3',5,5',6,6'-hexachlorodiphenylmethane
- 2,2'-Dihydroxy-3,5,6,3',5',6'-hexachlorodiphenylmethane
- Exofene
- Fostril
- G 11
- G-11, Gamophen
- Gamophene
- G-Eleven
- Germa-Medica
- Hexabalm
- 2,2',3,3',5,5'-Hexachloro-6,6'-dihydroxydiphenylmethane
- Hexachlorofen
- Hexachlorophane
- Hexachlorophen
- Hexafen
- Hexide
- Hexophene
- Hexosan
- Isobac 20
- Nabac
- Neosept V
- Phisodan
- pHisoHex
- Ritosept
- Septisol
- Septofen
- Steral
- Steraskin
- Surgi-Cen
- Surgi-Cin
- Surofene
- Tersaseptic
- Trichlorophene
- Turgex

METHOXYCHLOR

VOL.: 20 (1979) (p. 259)

CAS No.: 72-43-5

Chem. Abstr. Name: 1,1'-(2,2,2-Trichloroethylidene)bis(4-methoxybenzene)

5. Summary of Data Reported and Evaluation

5.1 Experimental data

Methoxychlor was tested in one experiment in mice and in several experiments in rats by oral administration. The study in mice gave negative results. In at least four experiments in rats, dietary concentrations of 1000 mg/kg or more were used. A suggestion that it was hepatocarcinogenic, made in an earlier study that was inadequately reported, was not confirmed in three more recent experiments. Methoxychlor was inadequately tested in mice by repeated skin application and by subcutaneous injection of single doses.

Methoxychlor was not mutagenic in bacteria, yeast or *Drosophila melanogaster*. Cytogenic and dominant lethal tests in mice were also negative.

Methoxychlor is foetotoxic.

N.B. - Subsequent to the meeting of the Working Group, the Secretariat became aware of a paper by Reuber (1979a), reporting the results of a study carried out in 1969 in which oral administration of methoxychlor induced testicular carcinomas in 27/51 male Balb/c mice, compared with 8/71 controls, but in none of the C3H mice tested. A further paper by Reuber (1979b) reported the results of a study carried out in 1951 in which oral administration of methoxychlor to Osborne-Mendel rats induced liver carcinomas.

5.2 Human data

No case reports or epidemiological studies were available to the Working Group.

The extensive production and the widespread use of methoxychlor over the past several decades, together with the persistent nature of the compound, indicate that widespread human exposure occurs. This is confirmed by many reports of its occurrence in the general environment and by its presence in human blood.

5.3 Evaluation

The available data did not provide evidence that methoxychlor is carcinogenic in experimental animals.

Previous evaluation: [Vol. 5 \(1974\)](#)

Subsequent evaluation: Suppl. 7 (1987) (p. 66: **Group 3**)

For definition of groups, see [Preamble Evaluation](#).

Synonyms

- 1,1-Bis(*para*-methoxyphenyl)-2,2,2-trichloroethane
- 2,2-Bis(*para*-methoxyphenyl)-1,1,1-trichloroethane

- 2,2-Di-*para*-anisyl-1,1,1-trichloroethane
- *para,para'*-Dimethoxydiphenyltrichloroethane
- Dimethoxy-DDT
- Dimethoxy-DT
- Di(*para*-methoxyphenyl)trichloromethyl methane
- DMDT
- *para,para'*-DMDT
- Maralate
- Marlate
- *para,para'*-Methoxychlor
- Metox
- Methoxy-DDT
- 1,1,1-Trichloro-2,2-bis(*para*-methoxyphenyl)ethane
- 1,1,1-Trichloro-2,2-di(4-methoxyphenyl)ethane

Last updated: 31 March 1998

MIREX

VOL.: 20 (1979) (p. 283)

CAS No.: 2385-85-5

Chem. Abstr. Name: 1,1a,2,2,3,3a,4,5,5,5a,5b,6-Dodecachlorooctahydro-1,3,4-metheno-1*H*-cyclobuta(cd)pentalene

5. Summary of Data Reported and Evaluation

5.1 Experimental data

Mirex has been tested in one experiment in two strains of mice and in one experiment in rats by oral administration. It has also been tested in two strains of mice by subcutaneous injection of single doses. In the studies using oral administration, it produced benign and malignant liver tumours in mice and rats of both sexes. An excess of liver tumours was also found in males of one of the two strains of mice following a single subcutaneous injection; this experiment also suggested that it produced reticulum-cell sarcomas in males of both strains.

Mirex is foetotoxic and produces teratogenic effects. It was negative in a dominant lethal assay in mice.

5.2 Human data

No case reports or epidemiological studies were available to the Working Group.

The extensive production and the widespread use of mirex since the late 1950s, together with the persistent nature of the compound, indicate that widespread human exposure has occurred. This is confirmed by many reports of its occurrence in the general environment and by its presence in human fat.

5.3 Evaluation

There is *sufficient evidence* that mirex is carcinogenic in mice and rats. In the absence of adequate data in humans, it is reasonable, for practical purposes, to regard mirex as if it presented a carcinogenic risk to humans.

Previous evaluation: [Vol. 5 \(1974\)](#)

Subsequent evaluation: Suppl. 7 (1987) (p. 66: **Group 2B**)

For definition of terms, see [Preamble Evaluation](#).

Synonyms

- CG-1283
- Dechlorane
- Dechlorane 515
- Dechlorane 4070
- Dodecachlorooctahydro-1,3,4-methano-2*H*-cyclobuta(cd)-pentalene
- Dodecachloropentacyclo(3.3.2.O^{2,6}.O^{3,9}.O^{5,10})decane
- ENT 25,719
- Ferriamicide

- Hexachlorocyclopentadiene dimer
- 1,2,3,4,5,5-Hexachloro-1,3-cyclopentadiene dimer
- HRS 1276
- Perchlorodihomocubane
- Perchloropentacyclodecane
- Perchloropentacyclo(5.2.1.O^{2,6}.O^{3,9}.O^{5,8})decane

Last updated: 31 March 1998

TOXAPHENE (POLYCHLORINATED CAMPHENES)

VOL.: 20 (1979) (p. 327)

CAS No.: 8001-35-2

5. Summary of Data Reported and Evaluation

5.1 Experimental data

Toxaphene (polychlorinated camphenes) was tested in one experiment in mice and in one in rats by oral administration: a dose-related increase in the incidence of hepatocellular carcinomas was observed in male and female mice, and an increased incidence of thyroid tumours was observed in male and female rats.

Toxaphene is mutagenic in *Salmonella typhimurium*; it did not induce dominant lethals in mice.

5.2 Human data

No epidemiological studies relating specifically to the carcinogenicity of toxaphene were available to the Working Group.

Two cases of acute aplastic anaemia associated with dermal exposure to toxaphene:lindane mixtures have been reported, one terminating in death due to acute myelomonocytic leukaemia. The only epidemiological study that related to possible carcinogenic effects of toxaphene in humans has weaknesses which prevented the Working Group from drawing any conclusion specific to toxaphene.

An increased frequency of chromosomal aberrations has been observed in the lymphocytes of workers exposed to toxaphene.

The extensive production and the widespread use of toxaphene, together with the persistent nature of the compound, indicate that human exposure occurs. This is confirmed by many reports of its occurrence in the general environment.

5.3 Evaluation

There is *sufficient evidence* that toxaphene is carcinogenic in mice and rats. In the absence of adequate data in humans, it is reasonable, for practical purposes, to regard toxaphene as if it presented a carcinogenic risk to humans.

Subsequent evaluation: Suppl. 7 (1987) (p. 72: **Group 2B**); [Vol. 79 \(2001\) \(p. 569\)](#)

For definition of terms, see [Preamble Evaluation](#).

Synonyms

- Agricide Maggot Killer
- Alltex
- Alltox
- Camphechlor
- Camphochlor
- Camphofene Huileux

- Chem-Phene
- Chlorinated camphene
- Chlorocamphene
- Clor Chem T-590
- Compound 3956
- Crestoxo
- Cristoxo-90
- ENT 9,735
- Estonox
- Fasco-Terpene
- Geniphene
- Gy-Phene
- Hercules 3956
- Hercules Toxaphene
- Kamfochlor
- M 5055
- Melipax
- Motox
- Octachlorocamphene
- Penphene
- Phenacide
- Phenatox
- Polychlorcamphene
- Polychlorocamphene
- Strobane-T
- Synthetic 3956
- Toxadust
- Toxafeen
- Toxakil
- Toxaphen
- Toxon 63
- Toxyphen
- Vertac 90%

CHLOROFORM

VOL.: 20 (1979) (p. 401)

5. Summary of Data Reported and Evaluation

5.1 Experimental data

Chloroform was tested in three experiments in mice and in one in rats by oral administration. It produced hepatomas and hepatocellular carcinomas in mice, malignant kidney tumours in male rats and tumours of the thyroid in female rats. Chloroform was also tested in one experiment by subcutaneous injection and in one by intraperitoneal injection in mice: these experiments were considered to be inadequate.

Chloroform is foetotoxic; it was not mutagenic in the bacterial systems tested.

N.B. - Subsequent to the meeting of the Working Group, the Secretariat became aware of the results of 3 studies, in which mice, rats and dogs were administered toothpaste containing chloroform by gavage or in gelatin capsules on 6 days per week for 80 weeks (mice and rats) or 7 1/2 years (dogs), followed by observation periods ranging from 15-24 weeks. No treatment-related increase in the incidence of tumours was observed in rats receiving 60 mg/kg bw/day chloroform (Palmer *et al.*, 1979) or in dogs receiving 15 or 30 mg/kg bw/day (Heywood *et al.*, 1979). In mice, benign and malignant tumours of the kidney occurred in 8/38 male ICI mice administered 60 mg/kg bw/day chloroform, but no such tumours occurred in females given that dose, or in males and females receiving 17 mg/kg bw/day or in controls. In a second experiment in mice, 7 benign and 2 malignant tumours of the kidney occurred among 49 male CFLP (ICI-redefined) mice given 60 mg/kg bw/day chloroform in toothpaste base compared with 6 benign kidney tumours among 237 male mice given the toothpaste base without chloroform. In a third experiment, groups of C57BL, CBA, CF/1 or ICI male mice received 60 mg/kg bw/day chloroform in toothpaste base or toothpaste base alone; 2 additional groups of male ICI mice received 60 mg/kg bw/day chloroform in arachis oil or arachis oil alone. Two benign and 3 malignant tumours of the kidney occurred among 47 ICI male mice given chloroform in toothpaste base, and 3 benign and 9 malignant tumours of the kidney occurred among 48 ICI male mice given chloroform in arachis oil. One benign tumour of the kidney occurred in each group of respective controls. No kidney tumours occurred in treated C57BL or CBA mice; and no increased incidence of malignant kidney tumours was seen in CF/1 male mice (1/48 treated and 2/45 controls) (Roe *et al.*, 1979).

5.2 Human data

No case reports or epidemiological studies were available to the Working Group.

The past use of chloroform as an anaesthetic and its present use in drugs and cosmetic products, as an insecticidal fumigant and as an industrial solvent indicate that widespread human exposure occurs. This is confirmed by many reports of its presence in air, water and foods.

5.3 Evaluation

There is *sufficient evidence* that chloroform is carcinogenic in mice and rats. In the absence of adequate data in humans, it is reasonable, for practical purposes, to regard chloroform as if it presented a carcinogenic risk to humans.

For definition of the italicized terms, see [Preamble Evaluation](#).

Previous evaluation: [Vol. 1 \(1972\)](#)

Subsequent evaluations: [Suppl. 7 \(1987\)](#); [Vol. 73 \(1999\)](#)

Last updated: 30 September 1999

HEXACHLOROETHANE

VOL.: 20 (1979) (p. 467)

CAS No.: 67-72-1

5. Summary of Data Reported and Evaluation

5.1 Experimental data

Hexachloroethane was tested in one experiment in mice and in one in rats by oral administration. In mice, it produced malignant liver tumours in males and females. In rats, no statistically significant excess of tumours was observed; however, a few renal tumours, rarely seen in untreated animals, were found.

5.2 Human data

No case reports or epidemiological studies were available to the Working Group.

The production and many uses of hexachloroethane for over 50 years, and its occurrence in water and air, indicate that human exposure occurs.

5.3 Evaluation

There is *limited evidence* that hexachloroethane is carcinogenic in experimental animals.

Subsequent evaluations: Suppl. 7 (1987) (p. 64); [Vol. 73 \(1999\)](#)

For definition of terms, see [Preamble Evaluation](#).

Synonyms

- Avlothane
- Carbon hexachloride
- Distokal
- Distopan
- Distopin
- Egitol
- Falkitol
- Fasciolin
- Hexachloroethane
- 1,1,1,2,2,2-Hexachloroethane
- Hexachloroethylene
- Mottenhexe
- Perchloroethane
- Phenohep