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HARMFUL EFFECTS OF CHEMICAL SUBSTANCES USED BY THE US ARMY
IN INDOCHINA*

by

V.I. Dmitriyev

The American troops conducting military activity in Indochina used various chemical substances (G.M. Yegiazarov, 1971; Ngo Vin Long, 1972 et al.). We will give a brief description of some of them.

Orthochlorobenzalmalononitrile (CS). Officially it is an "irritating agent" and is grouped with the so-called toxic agents for police use. It has the odor of pepper. It has an almost instantaneous effect on man.

A disabling dose for man is approximately $1-5 \frac{\text{mg} \cdot \text{min}}{\text{m}^3}$. In its physical and chemical properties, it is a solid substance with boiling temperature $310-315^\circ$. Tests on animals conducted by Vietnamese scientists showed that monkeys die with a toxic agent concentration equal to $50,000 \frac{\text{mg} \cdot \text{min}}{\text{m}^3}$ (Keyuort, 1971).

Chloroacetophenone (CN) has a tear-producing effect. The stimulus threshold is $0.3 \frac{\text{mg} \cdot \text{min}}{\text{m}^3}$. A disabling dose for man is $50-80 \frac{\text{mg} \cdot \text{min}}{\text{m}^3}$. The average lethal dose is approximately $10,000 \frac{\text{mg} \cdot \text{min}}{\text{m}^3}$. In its physical and chemical properties, it is a solid substance with boiling temperature of 246° .

Adamsite (DM) is dihydrophenarsazinochloride with an improved formula. It causes headaches, vomiting, and irritation of the nasopharynx.

*From the editor. The editorial board of the journal has received letters requesting a discussion of which chemical substances were used by the US Army during the Vietnam war. On our request, Candidate of Medical Sciences, V.I. Dmitriyev, responds to this question.

These symptoms occur about 1--2 min after exposure to the toxic agent. When removing the injured from a contamination zone, irritation of the mucous membranes continues to increase for 10--30 min. A disabling dose for man is $22 \frac{\text{mg} \cdot \text{min}}{\text{m}^3}$. In its physical and chemical properties, it is a solid substance with boiling temperature of 410° .

Ethylbromacetate. It causes the death of monkeys with a concentration of approximately $25,000 \frac{\text{mg} \cdot \text{min}}{\text{m}^3}$.

In the opinion of the Vietnam specialists, the American command in 1964-1969 used about 7000 T of toxic substances in Vietnam using chemical ammunition of various types. In particular, pumping units for injecting the toxic agent into underground shelters, chemical bombs, plastic containers and canisters ejected from aircraft and helicopters, grenades shot from grenade launchers were used. For increasing the damaging effect of the chemical ammunition, often they were used simultaneously with napalm and pellet bombs, and also with bombs and shells of the ordinary type (Kushner, 1971).

Defoliants are substances causing the leaves of vegetation to fall off. They are grouped with growth regulators.

Herbicides are substances to combat weeds and other undesirable vegetation. They suppress selectively (according to type) or all vegetation completely. The boundaries between these two chemical poisons are conventional. With appropriate doses they can be interchangeable. In relatively low concentrations, these substances have been used in agriculture, for example, for destroying weeds, for removing leaves from certain vegetation (cotton, potatoes, sugar beets) in order to make a future harvest of the crop easier. The Americans used chemical poisons in Indochina in concentrations exceeding, by tens and hundreds of times, those recommended in the USA for handling agricultural problems; this converted these substances into a chemical weapon. The main military propose for using defoliants and herbicides in Indochina was destruction of the leafy cover in the forests in order to make it easier to discover supply routes and bases of the patriots, and also destruction of agricultural crop plants in liberated regions.

According to the data of the foreign press, the herbicide defoliants used in Vietnam have code names of "orange," "yellow," "blue," and "white," products. Compounds of the 2,4-D and 2,4,5-T type were used in their composition (respectively manufactured on a base of 2,4-dichlorophenoxyacetic and 2,4,5-trichlorophenoxyacetic acids), and also cacodylic (dimethylarsonic) acid and other arsenic compounds. The poisonous chemicals were distributed by special spraying devices mounted on aircraft and helicopters. Between 1962 and 1969 a total of 50,000 T of defoliants and herbicides were used in South Vietnam (Kuntse, 1972).

In the regions which were subjected to the chemical substances, not only the vegetation but also the animal world was destroyed. Many birds, fish, frogs, insects (especially bees) were killed. The chemical substances caused various diseases in domestic animals (cattle, buffalo and swine).

Defoliants and herbicides affect both levels of a two-layer forest. Then 45% of the trees in the first layer and 20% of the bushes in the second layer die. Several years after the use of chemical substances, the vegetation of the upper layer does not produce leaves. The defoliants and herbicides, besides direct damage, have a long-term indirect harmful effect on the vegetation. They change the structure of the soil, the climatic conditions, the hydrologic cycle, etc. The results of destroying the vegetation covering sharply increases soil erosion, and decreases its moisture content. During the rains, most of the fertile layer of the soil is washed away and microbiologic and chemical changes occur in it. Fertility of the soil is sharply decreased as a whole.

In 1969-1970, the American command concentrated its efforts on destroying agricultural crops. It has been established that the "orange product" causes wilting of the leaves and bending of the corn stalks within a day. The weight of the corn cobs in the undamaged vegetation does not exceed 65 g. Young rice plants, after being treated with the "orange product" die in one day and the mature rice collapses. After the effect of defoliants and herbicides, the grains of rice and corn have an undesirable odor, become bitter, and are unsuitable for use as food. One should note that the growth and development of corn and rice is significantly retarded when they are grown in soil which has previously been subjected to "orange" contamination.

In the regions where defoliants and herbicides were sprayed, the plantations of manioc [cassava] are flattened a day after the damage and the centers of the stalks are destroyed. Cases of damage to manioc leaves have been noted even in sections 8-10 km from the epicenter of chemical substance spraying. The outer part of the sweet potato affected by the "orange product" wilts and its roots die. The stalks of banana vegetation become brittle; at first they bend toward the ground and after 7-8 days break off. The bananas ripen earlier than usual, are deformed, and their outer skin is covered with dark spots. The fruit is easily blown off the trees by the wind, by being bumped or they fall off themselves. In some cases, the banana vegetation dies after about three days. After the effect of the "orange product" in corn and rice grains, the content of protein nitrogen is significantly decreased. In the sweet potato and manioc tubers, the content of bonded nitrogen is decreased to one-third of normal and the quantity of free nitrogen, on the other hand, is increased. At the same time, the starch content is decreased.

Other defoliants and herbicides also show a pronounced toxic effect on agricultural crops. For instance, the "white product" first destroys the chlorophyll in the leaves of the corn and rice and then this causes

the stalk of the vegetation to break off. The rice and corn plantations are completely destroyed after 6-8 hours. The papaya fruit is rapidly deformed, wilts and drops and the tree itself dies after two days. The breadfruit tree dies after 1-2 days. Coconut palms and rubber trees are particularly sensitive to the effects of defoliants and herbicides. Some of the green coconuts drop off even from palm trees which are 3 km from the area sprayed with poisonous chemicals. The coconuts which remain on the palms ripen earlier, their shells become soft, and the milk bitter. After a few days, the coconut palms die.

Often in South Vietnam, chemical substances were used not only in the forest regions but also close to populated areas; this resulted in injury to a considerable part of the peaceful population. According to the data of the Provisional Revolutionary Government of the Republic of South Vietnam (Ngo Vin Long, 1972), in 1961-1969, 1,293,000 persons were subjected to the effect of poisonous chemicals. In the first ten months of 1970, 185,000 cases of persons being poisoned were recorded. Three hundred persons died and a significant number of those injured became chronic patients.

Persons injured by herbicides and defoliants noted perceiving a sharp odor of chlorine or DDT, sharp pain, burning in the nasopharynx and sneezing (91%), crying and vomiting (73%), headache and vertigo (38%), a burning sensation in the area of the eyelids and the skin (41%). These clinical symptoms were apparent after a 24-hour incubation period. Improvement in the patients, if they did not die, began after 3-4 days. However, they continued to suffer from asthenic symptoms in the form of sleeplessness, sexual weakness, and weakening of the vision. For example, 23 out of 43 patients examined could not read for more than 5 min, 9 for not more than 15 min, and 7 for not more than 30 min. Intraocular pressure in most of those afflicted was increased. The eyes were damaged in 27 out of 65 persons. In a number of cases, expansion of the horny layer, cataracts and degeneration of the macula lutea occurred; the ocular and retrobulbar nerves were inflamed (Kushner, 1971).

However, the most serious were the genetic aftereffects. In persons subjected to the direct effect of defoliants and herbicides, it has been statistically proven that there is an increase in the frequency of chromosome anomalies in nuclei of tissue cells (a change in the number of chromosomes, fissures and defects, etc.). These changes were particularly pronounced in children of mothers subjected to the effect of poisonous chemicals (Kuntse, 1972). The changes in structure of the chromosomes can have very sad consequences (N.P. Bochkov, 1971). In pregnant women, for example, this can lead to deformity of the fetus, miscarriage, premature birth and early death of the newborn. And actually, for a long time in Vietnam an alarming increase in birth rate of children with deformities has been noted which, undoubtedly, is caused by the long-term effect of poisonous chemical substances. At the same time, these poisonous chemicals can have a teratogenic effect. Experiments on mice

showed that both 2,4,5-T and 2,4-D cause, not only deformation of the fetus, but also cancer particularly from the powerful effect of the 2-4-5-T formula (Ngo Vin Long, 1972). Thus, defoliants and herbicides have a pathologic effect not only on those who are living but on future generations of people.

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Кандидат медицинских наук В. И. ДМИТРИЕВ

ПОРАЖАЮЩЕЕ ДЕЙСТВИЕ ХИМИЧЕСКИХ ВЕЩЕСТВ, ПРИМЕНЯВШИХСЯ АРМИЕЙ США В ИНДОКИТАЕ

relat kombo

АМЕРИКАНСКИЕ войска при ведении военных действий в Индокитае применяли различные химические вещества (Г. М. Егизаров, 1971; Нго Винь Лонг, 1972 и др.). Остановимся на краткой характеристике некоторых из них.

Ортохлорбензальмалонитрил (CS). Официально он именуется «раздражающим агентом» и относится к так называемым ОВ полицейского назначения. Имеет запах перца. На человека практически оказывает мгновенное действие. Доза, выводящая людей из строя, составляет примерно $1-5 \frac{\text{мг} \cdot \text{мин}}{\text{м}^3}$.

По своим физико-химическим свойствам — твердое вещество с температурой кипения $310-315^\circ$. Опыты на животных, проведенные вьетнамскими учеными, показали, что обезьяны погибают при концентрации ОВ, равной $50\,000 \frac{\text{мг} \cdot \text{мин}}{\text{м}^3}$ (Кей-уорт, 1971).

Хлорацетофенон (CN) обладает слезоточивым действием. Порог раздражения $0.3 \frac{\text{мг} \cdot \text{мин}}{\text{м}^3}$. Доза, выводящая людей из строя, равна $50-80 \frac{\text{мг} \cdot \text{мин}}{\text{м}^3}$.

Средняя летальная доза составляет примерно $10\,000 \frac{\text{мг} \cdot \text{мин}}{\text{м}^3}$. По своим физико-химическим свойствам — твердое вещество с температурой кипения, равной 246° .

Адамсит (DM) — дигидрофенарсазинохлорид усовершенствованной рецептуры. Вызывает головные боли, рвоту, раздражение носоглотки. Эти симптомы появляются уже через 1-2 мин. после воздействия ОВ. При удалении пострадавших из зоны поражения раздражение слизистых оболочек продолжает нарастать в течение 10-30 мин. Доза, выводящая человека из строя, равна $22 \frac{\text{мг} \cdot \text{мин}}{\text{м}^3}$.

По своим физико-химическим свойствам — твердое вещество с температурой кипения, равной 410° .

Этилбромидатетат. Вызывает гибель обезьян при концентрации, равной примерно $25\,000 \frac{\text{мг} \cdot \text{мин}}{\text{м}^3}$.

По оценке вьетнамских специалистов, американское командование в 1964-1969 гг. использовало в Южном Вьетнаме около 7000 т отравляющих веществ с помощью химических боеприпасов различных типов. Применялись, в частности, насосные установки для закачки ОВ в подземные убежища, химические бомбы, пластмассовые контейнеры и канистры, сбрасываемые с самолетов и вертолетов, гранаты, выпускаемые из гранатометов. Для увеличения поражающего действия химические боеприпасы нередко применялись одновременно с напалмовыми и шариковыми бомбами, а также с бомбами и снарядами обычного типа (Кушнер, 1971).

Дефолианты — вещества, вызывающие опадение листьев растений. Они относятся к регуляторам их роста.

Гербициды — средства борьбы с сорными и другими нежелательными растениями. Они уничтожают выборочно (по видам) или полностью всю растительность. Границы между этими двумя ядохимикатами условные. При соответствующих дозах они могут заменять друг друга. В относительно низких концентрациях эти вещества используются в сельском хозяйстве, например для уничтожения сорняков, для сбрасывания листьев с некоторых растений (хлопка, картофеля, сахарной свеклы) с целью облегчения предстоящей уборки урожая. Американцы применяли ядохимикаты в Индокитае в концентрациях, в десятки и сотни раз превышающих те, которые рекомендуются в США для решения задач сельского хозяйства, что уже само по себе превратило эти вещества в химическое оружие. Основными целями военного применения дефолиантов и гербицидов в Индокитае были уничтожение листового покрова в лесах для облегчения обнаружения путей снабжения и баз патриотов, уничтожение посевов продовольственных культур, в освобожденных районах.

По данным зарубежной печати, применявшиеся во Вьетнаме гербициды и дефолианты имеют подиорованные названия: «оранжевый», «желтый», «голубой» и «белый» продукты. В их состав входят соединения типа «2-4-Д» и «2-4-5-Т». Известно, что при токсическом действии на основе 2-4-дихлорфено-

От редакции. В редакцию журнала поступили письма с просьбой рассказать о том, какие химические вещества применялись армией США во время войны во Вьетнаме. По нашей просьбе на этот вопрос отвечает кандидат медицинских наук В. И. Дмитриев.

Harmed Effects of Chemical Substances Used by the U.S. Army in Vietnam
2, 4-D; 2, 4, 5-T (total)
2, 4-D; 2, 4, 5-T (Canary)
2, 4-D; 2, 4, 5-T (Canary)
2, 4-D; 2, 4, 5-T (Canary)
2, 4-D; 2, 4, 5-T (Canary)
2, 4-D; 2, 4, 5-T (Canary)

soning with organophosphorus compounds.] *Voenno-Med. Zh.* 4: 74; 1974. (Russian)

The subclinical form of poisoning by trichlorfon and dichlorvos was studied in 84 healthy subjects exposed to these pesticides for one day during disinsection. The subjects displayed no clinical symptoms of poisoning whatsoever immediately upon termination of the exposure. However, statistically significant reduction of the blood cholinesterase activity, leukocytosis, neutrophilia, and reductions in the eosinophil, lymphocyte, and monocyte counts were detected. A follow-up investigation carried out 2 weeks after exposure revealed normalization of the blood picture and slight increase of the cholinesterase activity toward the normal value.

75-0611. Dmitriyev, V. I. (Author address not given). Porazhayushcheye deystviye khimicheskikh veshchestv, primenyavshikhsya armiyey SSHA v Indokitaye. [Harmful effects of chemical substances used by the US Army in Indochina.] *Voenno-Med. Zh.* 1: 88-90; 1974. (4 references) (Russian)

The harmful effects of poisons, defoliants, and herbicides deployed by the US Army in Vietnam are described. The herbicides deployed in large amounts destroyed crops, trees, and animals, and also caused poisoning of about 1,293,000 humans. The principal herbicides used in Vietnam were 2,4-D and 2,4,5-T. Sneezing, lachrymation, emesis, headache, irritation of the nasal and oral cavities, and vertigo developed after about 24 hr in subjects exposed to these preparations. The poisoning was fatal in an estimated 300 cases. Asthenia, sleeplessness, and lesions of the eye persisted long after exposure. The mutagenic and teratogenic effects of these preparations were, however, more serious than the direct toxic effects. Increased frequency of chromosomal aberrations, abortion, stillbirth, premature birth, increased postnatal mortality, and especially teratogenesis were observed in pregnant women and their babies. Both 2,4,5-T and 2,4-D were considered responsible for cancer in infants from mothers exposed to these preparations.

75-0612. Anonymous. The use of mercury and alternative compounds as seed dressings. *WHO Tech. Rep. Ser.* 555: 7-29; 1973.

The use of alkylmercury compounds as seed dressings should be strictly limited to the treatment of nuclear stocks of cereal seed used for the first few generations of seed multiplication. Arylmercury and alkoxyalkylmercury compounds and hexachlorobenzene should be used to dress cereal seed only if absolutely necessary and if safeguards exist to prevent the seed from being diverted from its intended use; the latter should not be used on cereal seed to be exported for the production of seed. Only dressed seed to be exported for the production of food should be distinctly dyed to distinguish it from food grain. Bags of dressed seed should be adequately labeled and appropriate authorities

should be kept informed as to the whereabouts of consignments of dressed grain. An instruction leaflet on the handling and hazards of dressed cereal should be provided for the user in the appropriate language or dialect. National authorities should determine that stocks of alkylmercury compounds are being stored safely, used for an appropriate purpose, or disposed of in a safe manner. Research is needed on the development of low toxicity compounds for seed dressing, methods of producing pathogen-free seed by nonchemical means, the possibility of rendering dressed seed unpalatable and thus unacceptable for use as food, and the development of more effective dyes for identifying dressed grain.

75-0613. Franck, R. (Max-von-Pettenkofer-Institut, Bundesgesundheitsamt, Berlin, Germany). Lebensmittelrecht - nationale und internationale Entwicklung. [The food law - national and international development.] *Z. Ernährungswiss. (Suppl.)* 16: 159-166; 1973. (German)

General problems of legislation concerning food adulteration, food additives, and residues in West Germany and on an international level are discussed. While maximum allowable residue levels have now been established for 78 active ingredients in plant protection formulations, a total of 260 active ingredients are registered in West Germany. The zero tolerance established for pesticide residues in baby food and dietetic food should be abandoned as unrealistic and meaningless, and replaced either by the limit of sensitivity inherent in the analytical method adopted or by toxicologically tolerable limits. Such limits have been set at 0.01 ppm for most pesticides, at 0.1 ppm for malathion in prepared food, and at 0.01 ppm for aldrin, dieldrin, and other diene derivatives in food products as offered for sale.

75-0614. Gruebner, P.; Meyer, R.; Haensel, H. (Pflanzenschutzamt beim RLN des Bezirkes Dresden, Dresden, DDR). Zur hygienisch-toxikologischen Ueberwachung des Einsatzes von Agrochemikalien. 1. Mitteilung: Rueckstandskontrollen von Pflanzenschutzmitteln im Gemuesebau des Bezirkes Dresden. [Hygienic-toxicological surveillance of the use of agricultural chemicals. 1. Monitoring of pesticide residues in vegetable gardening in the district of Dresden.] *Z. Gesamte Hyg. Ihre Grenzgeb.* 20: 30-32; 1974. (14 references) (German)

The organization of the hygienic-toxicological surveillance of the use of pesticides, and of the pesticide residue monitoring in vegetable gardening in the district of Dresden, East Germany, is described. The practice of pesticide residue control in food products is coordinated and linked with surveillance of the use of the pesticides involved to elucidate the causes of unacceptably high residue levels, i.e., short waiting times after application, overdosage, or use in an improper manner. The results of the residue controls are evaluated in cooperation with the hygiene inspection to determine the possible causes