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OCCUPATIONAL HEALTH HAZARDS IN THE PRODUCTION AND APPLICATION OF PESTICIDES

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The results of a long-term survey of working conditions and health status of workers in a pesticide industry in Serbia are presented. The survey has been completed with ophthalmological findings as well as with a description of ten cases of intoxication in pesticide applicators. The difficulties in assessing health hazards in the course of simultaneous exposure to products known for different toxicodynamic properties are pointed out.

In conclusion the authors suggest further improvement of preventive measures as well as a more systematic investigation of the combined effects of pesticides in which ophthalmological examinations should be included.

In spite of the constant development of technological processes the contamination of working environment continues to threaten the health of exposed workers.

During the production of pesticides workers are exposed to various chemical compounds simultaneously or alternatively. Due to a different mode of action and toxic effects produced by each compound it is difficult to evaluate the hazard of such combined exposure. In addition to additive or synergistic effect of several chemicals, factors such as intercurrent acute or chronic diseases, fatigue, nutritional status, alcoholism, hygienic and general educational level of exposed persons make this evaluation even more complicated. This is obviously the reason that few relevant data can be found in the literature.

Here are presented the results of a long-term survey of the working conditions and health status of workers in a chemical industry in Serbia. The survey has been completed with ophthalmological investigations as well as with a description of ten intoxications which occurred in the course of pesticide application. Safety aspects of pesticide production and application are also discussed.

Occupational hazards in the course of pesticide production

The pesticide plant workers have been exposed to organochlorine compounds, carbamates, organophosphates, organic mercurials, lead arsenate and to a less extent to other chemicals. The range of exposure can be seen from the total production materialised in the year 1972:

Organochlorine compounds powdered	4.600 tons
Organochlorine compounds solution-emulsion	220 tons
Organophosphorus compounds	1.000 tons
Mercury compounds	150 tons
Carbamates (fungicides)	2.000 tons

The technological process takes place in well designed and mechanized installations. The materials used as fillers are: chalk, kaolin, bentonite, talc, and SiO_2. The most used solvents are benzene, xylene, methanol, crude oil, white spirit and trichloroethylene.

Working conditions

The assessment of working conditions included microclimate, lighting, noise control, dust count and the measurement of toxic substances in the working atmosphere.

The microclimate was found to be in physiological range. Lighting was satisfactory too. The sound level was registered between 90 and 92 decibels.

The concentration of toxic powdered materials in some working places exceeded the maximum permissible levels. Thus the gravimetric measurement of Lindane and DDT dust samples revealed the concentrations 2—3 times higher than permitted. On the contrary for the same working places the granulometric method did not show such aberrations.

The chemical analysis discovered higher concentrations of Lindane and DDT than permitted. During the production of lead arsenate the concentrations of arsenic and lead in some working places were also above the permissible levels. Excessive levels of organophosphorus compounds were found too.

Health status of exposed workers

A group of 150 workers, 79% males and 21% females, has been under medical control for the last 3 years. The majority of workers have been exposed to various pesticides for 6—10 years.

Taking into consideration numerous occupational hazards the investigation of the state of health of exposed workers had to be detailed and thorough. The elements of investigation were: detailed occupational history, anamnesis, clinical findings of occupational health specialist, ophthalmologist, neuropsychiatrist, x-ray of lungs, electrocardiogram and

pulmonary function tests (if needed). The laboratory analysis included: sedimentation rate, blood count formula, standard urine analysis, functional liver tests (various flocculation tests), electrophoresis of serum proteins, bilirubin in blood, total, direct and indirect, cholesterol in blood, transaminases and cholinesterase activity in blood.

The following toxic substances and metabolites were measured: arsenic, lead, CS_2, paraaminophenol and coproporphyrin in urine.

Using all elements mentioned above, no case of severe intoxication was discovered. In 3.1% of workers some signs and symptoms of mild intoxication with lead arsenate were noted.

In 18.75% of workers the asthenovegetative syndrome (neurasthenia with asthenia) as the first sign of mild intoxication was found. The actual etiological factor of this syndrome is very difficult to determine. It could be lead, arsenic or organic solvents of organochlorine and organophosphorous compounds.

A high percentage (14%) of stomach and intestinal diseases was noted in the exposed group. The percentage of these diseases was considerably lower in unexposed group of workers in the same chemical industry. A certain correlation between the length of exposure to pesticides and these findings could be established.

As a result of synergetic action of toxic dusty materials a rather high percentage (26%) of chronic conjunctivitis and pharyngitis was noted.

The results of haematological investigation did not reveal any changes in the number of blood elements. A slight anaemia of normochronic type was noted in 29.6% of cases (3.400.000—3.800.000). The number of reticulocytes decreased (under 0.5%) in 40.6%, and that of stippled cells increased in 6.2% (above 350/1 million of erythrocytes).

Some functional liver tests — based on flocculation, were slightly disturbed in 46.8% of cases.

An increased excretion of toxic substances was found in some cases, but without any symptoms. Thus an increased amount of arsenic in urine was noted in 25.0% of subjects, increased lead in urine in 26.5% and increased coproporphyrin in urine in 25.0%. The values of CS_2 and paraaminophenol were negative or very low.

During the production of organophosphorus pesticides, a decreased activity of cholinesterase in blood was noted in 17.72% of workers in the last months of exposure.

A slight normocytic anaemia with a decreased number of reticulocytes points to the toxic action of chemical compounds in the bone marrow. In our cases, this was probably due to a combined action of arsenic, lead, organic solvents and organochlorine compounds.

Ophthalmological investigation in workers exposed to pesticides

The eye is a very sensitive organ and reacts very fast to many hazards, especially to those of occupational origin. Searching for rather simple,

but sensitive and cheap methods and tests for the diagnosis of early signs and symptoms of occupational intoxication, we chose a detailed examination of the organ of sight.

In the pesticide plant mentioned earlier, 90 workers were examined by an ophthalmologist and an occupational health specialist.

The ophthalmological investigation included working history, anamnesis and a detailed ophalmological examination: visual acuity, visual field, corneal and conjunctival changes, adaptation, colour vision, and accommodation of eye muscles.

The following results were obtained:

Table 1

Kind of eye disturbances

Disturbance reported	No of persons	%
Eye itching	52	57.7
Tearful eyes	57	63.3
Dim vision	45	50.0

Complaints due to eye trouble were found in a rather high percentage; these findings suggest that irritative agents are present in the working atmosphere.

Table 2

Summary of ophthalmological findings

Findings	No. of cases	%
Visual acuity lower than 0.8	21	23.3
Fundus changes	16	17.7
Visual field deficiency-central part — Amsler	5	5.5
Conjunctival hyperaemia — (total)	66	73.2
mild	56	62.2
medium	8	8.8
severe	2	2.2
Blepharitis	1	1.1
Pterygium	1	1.1
Pinguecula	11	12.1
Other changes on the cornea and conjunctiva	4	4.4
Diminution to dark adaptation-Heinsius	23	25.5
Diminution in color vision-Stilling-Hertel	35	38.8
Pupillar reaction disturbances	—	—
Eye muscle paresis or paralysis	1	1.1
Diminution of accommodation	2	2.2

It is interesting to stress that other findings especially the diminution of colour vision and the diminution of adaptation to dark are noted in a high percentage too. The diminution of colour vision was found in 38.8% of the exposed, but in the unexposed group it was found only in 8%. The diminution of accomodation to dark was found in 25.5% of the exposed. In the unexposed group it was 6% only.

The results obtained by this investigation suggest that a further analysis and evaluation ought to be carried out. It might be that some ophthalmological tests could help in the early diagnosis of occupational intoxication.

From the data presented we can conclude that the main occupational hazards in the pesticide plant are those of chemical origin. Besides, physical and psychophysiological hazards are present too. This is due firstly to the fact that in spite of developing mechanization physical work is still present and secondly to the monotony of mechanized technological processes.

The gravimetric dust sampling and granulometric method are not suitable for toxic dust analysis when evaluating working conditions. The technique demands a high temperature (about 100°C) and organochlorine compounds are destroyed above 50°C.

The standard industrial hygiene procedures used in the plant revealed the excessive toxic concentrations of chemicals in some working places. Unfortunately neither these results nor the results of our measurements allow any firm conclusion on the possible synergistic or antagonistic effects of the simultaneous exposure of workers to different pesticide chemicals.

Occupational hazards in the course of pesticide application

The application of pesticides carries along many occupational health and safety problems. These problems originate in unfavourable working conditions (high or low temperature, wind or rain) and in exposure of applicators (unskilled workers employed usually seasonally). Furthermore the medical and technical protective measures are often insufficient, and as a result of all these factors the occurrence of intoxication is quite understandable.

We are now going to demonstrate ten cases of intoxication due to pesticides. They were hospitalized in our Institute in the course of June 1972. These women — workers were employed seasonally in a large farm. They all were young, between 15 and 20 years of age, with no or a very short working history.

Two days before they were admitted to our Institute they worked with some powdered insecticides. They did not even know the names of the preparations. They handled insecticides from the pail with their hands protected by rubber gloves. The weather was sunny, but windy. The workers did not use any respirators. A day before admission they ate plums recently treated with pesticides.

From the safety department of this farm we got the information that the women had worked with a combination of organochlorine and organophosphorous insecticides (Tiodon, Dipterex, Nuvan).

All women complained of headache, dizziness, nausea, vomiting and diffuse abdominal pains. Two of them had respiratory disturbances, the other two had troubles with vision and two women sneezed and sniffed.

The body temperature was not elevated in our patients. The conjunctives and throat were red, hyperaemic. The abdomen was diffusely painful in three patients.

Electrocardiogram and x-ray of lungs did not reveal any pathological changes. By spirometry slight respiratory disturbances were registered in three patients.

Neurological, ophthalmological and otorhinolaryngological investigation did not mark any impairment.

The haematological findings as well as urine analysis did not show any pathological changes. In two patients a slight hypoglicaemia was present (50 and 56 mg%).

It is interesting to mention that in 4 patients a disturbance in liver function was noted. Two patients had a slight depression of Quick time, prothrombine, V factor and VII factor, followed by a decreased activity of pseudocholinesterase and direct hyperbilirubinaemia. Cephaline cholesterol test value was increased in one patient. In two patients the direct bilirubine was increased too. As already mentioned, one of them had a decreased activity of pseudocholinesterase. All patients had normal values of transaminases, alkaline phosphatase, urea and other flocculation tests.

The impairment of liver function was only temporary. After five days all functional tests returned to normal ranges.

Compared with the controls the values of cholinesterase activity were slightly decreased in 8 patients.

The therapy of our patients consisted of 25% Glucose, Aneurine, Ascorbit, Bedoxine, atropine and oxygen (when necessary).

As a hepatoprotective therapy the patients with disturbed liver function tests received in addition Ripason as well as adequate diet.

The patients left the hospital with diagnosis: *Intoxicatio mixta e pesticide gradus laevioris sine sequelarum.* (Under the term »mixta« we wanted to mark the combined effects of organophosphorus and organochlorine compounds).

From this combined exposure some therapeutic and diagnostic difficulties arose. The question is how much the effects of one group of pesticides are covered by the effects of the other group.

In our patients a transitory lesion of liver parenchyma with no consequences was present. Supposing that in the case of intoxication an adequate diet and therapy are not applied, the lesions may become irreversible, especially if the worker continues to be exposed to hepatotoxic compounds.

The following relevant facts should be pointed out. The workers were not informed about the origin of pesticide or about the danger of intoxication. The self protective measures were very poor. The wind blowing in their faces brought a large amount of pesticides in their nose, throat and lungs. All these facts led to acute intoxication, as it happened.

CONCLUSIONS

A correct evaluation of the degree of occupational risk in the production of pesticides by the classical methods of industrial hygiene control is hardly possible.

It is necessary to establish the maximum allowable concentrations concerning the mixtures of the powdered toxic dusts.

In the application of pesticides, the medical and technical protective measures ought to be more effective and strictly carried out. Better information about the toxicity of pesticides is important. Correct use of protective devices is necessary.

In patients poisoned by organophosphorus and organochlorine pesticides an evident but transitory lesion of liver parenchyma was found. This phenomenon could be a consequence of the simultaneous influence of various pesticides since no correlation between clinical signs and the activity of cholinesterase was established.

Ophthalmological control is very useful in workers exposed to pesticides. Therefore the influence of pesticides on the eye ought to be investigated thoroughly.

Further investigations are necessary regarding a possible synergetic effect of toxic compounds on the liver and bone marrow during the production and application of pesticides especially in the course of chronic exposure.

Sažetak

OPASNOST ZA ZDRAVLJE U PROIZVODNJI I PRIMJENI PESTICIDA

Prikazani su rezultati višegodišnjeg praćenja radnih uvjeta i zdravstvenog stanja radnika jedne industrije pesticida u Srbiji. Izvještaj obuhvaća i podatke oftalmoloških pretraga jednog dijela izloženih radnika kao i deset slučajeva otrovanja u toku primjene pesticida. Istaknute su teškoće pri ocjeni opasnosti kada se radi o istodobnoj izloženosti komercijalnim pripravcima različita mehanizma djelovanja.

U zaključcima su dani prijedlozi za djelotvorniju preventivu profesionalnih otrovanja kao i za temeljitiji studij mogućih kombiniranih učinaka pesticida pri kojem se, po mišljenju autora, valja koristiti i oftalmološkim nalazima.

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