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CONTAMINANTS IN HUMAN MILK

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ABSTRACT. Olszyna-Marzys, A. E. (Institute of Nutrition of Central America and Panama, Guatemala City, Guatemala C.A.). Contaminants in human milk. Acta Paediatr Scand, 67: 571, 1978.—There is a paucity of information regarding excretion of contaminants in human milk, due to experimental difficulties and until recently a general lack of interest. Because of the high fat content of milk and as its acidity is higher than that of plasma, nearly all liposoluble and basic agents consumed by the mother will be excreted in the milk. Distinction must be made between, on the one hand drugs and social toxicants such as smoking and alcohol, whose intake can be stopped or limited during pregnancy and lactation, and ecological toxicants present in a polluted environment to which the mother is exposed. Cases have occurred of heavy prenatal and postnatal intoxication of infants with hexachlorobenzene in Turkey and methylmercury in Iraq due to consumption of fungicide-treated seed wheat by pregnant and lactating mothers. Recent attention has been concentrated on contamination of milk with organochlorine compounds such as DDT and PCB's, that are found in many parts of the world. The heaviest contamination with DDT has been found in Guatemala, resulting in suckling infants consuming many times the Acceptable Daily Intake of this compound proposed by WHO, with unknown future effects.

KEY WORDS: Human milk, contaminants, toxicants, pesticides

Owing to experimental difficulties and until recently a general lack of interest, there is a paucity of information regarding excretion of contaminants in human milk.

As Knowles entitled his second recently published review of the problem of excretion of drugs in milk, "Breast milk is a source of more than nutrition for the neonate" (9). Nearly all agents ingested by the mother will be found in her milk in some form or other. Their distribution across the membrane between plasma and milk is influenced by their concentration, solubility in fats and water, pKa or degree of ionization and transport mechanisms.

Since human milk is relatively high in fat, liposoluble drugs will tend to concentrate in it. Because its acidity is higher than that of the plasma, concentration of basic components in the milk will be promoted.

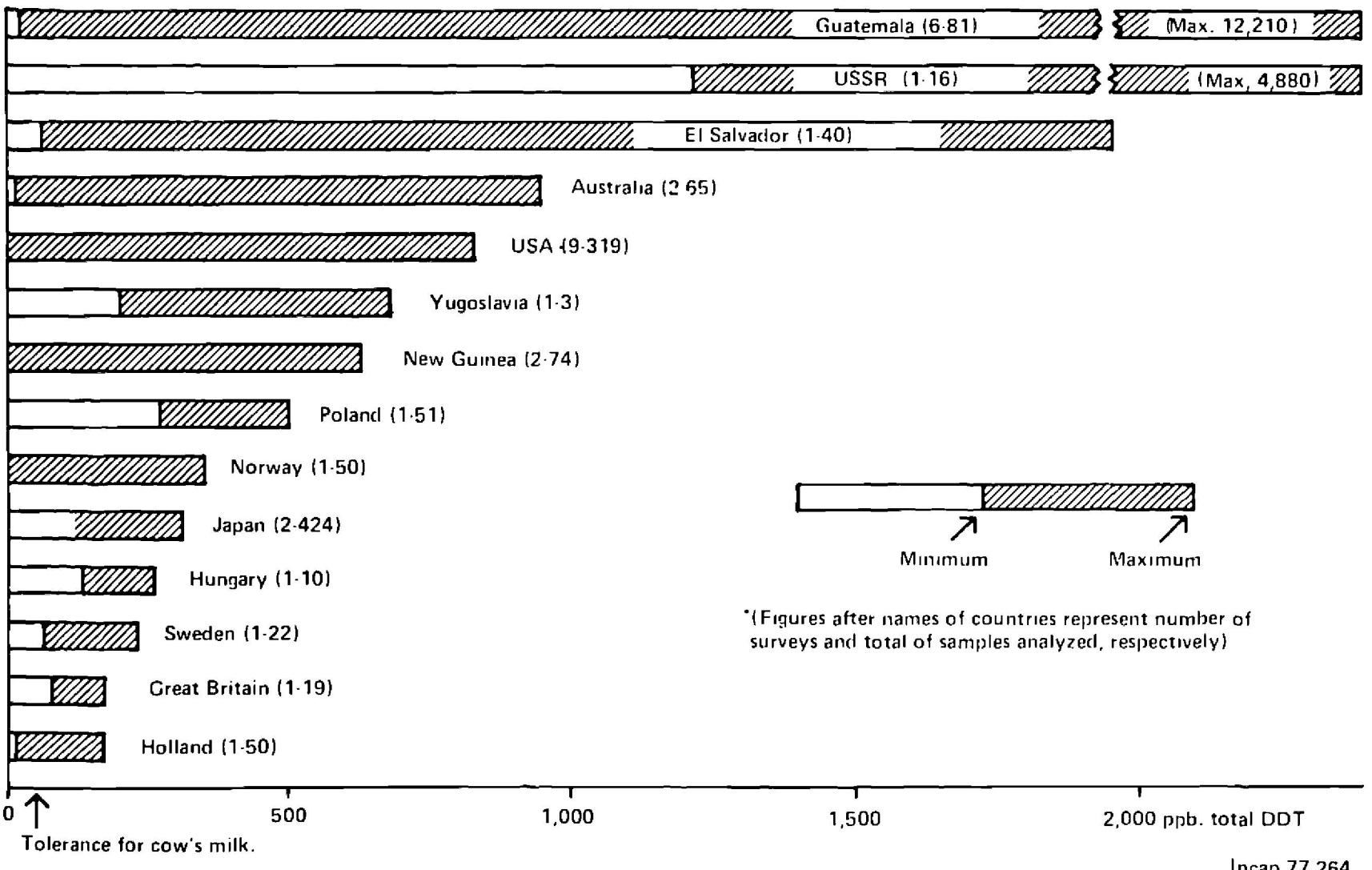

Fig. 1. Maxima and minima of total DDT content of human milk found in various countries, 1964–1976 (in parts per billion (1 000 millions)).

Knowles (8) has tabulated literature references to nearly sixty compounds or classes of compound whose excretion in the milk has been reported in human or animal studies. Arena (2) also talks about oral contraceptives and "social toxicants" such as alcohol and smoking, and includes pesticides among "ecological toxicants".

It is necessary to emphasize the difference between this last group of contaminants, on the one hand, and drugs and social toxicants on the other. When required, the ingestion of drugs and smoking or drinking can be stopped or limited, voluntarily or by persuasion, by the individual. Ingestion of ecological toxicants by exposure to environmental contamination can only be reduced by concerted action of the society and authorities.

However, even in the case of drugs and social toxicants, while the perils of medication, smoking, drinking and narcotic drugs during gestation are being increasingly recognized and caution exercised in the prescription of drugs during pregnancy, especially since the thalidomide tragedy, there is much less hesitancy in prescribing them during the period of lactation. This is perhaps due to the fact that, as we know, in most industrialized countries breast feeding has been drastically reduced or eliminated, so that not much attention is paid to that period by most members of the medical community. However, in developing countries, breast feeding is still predominant and may be continued for eighteen or even more months after birth.

When medication is indicated for the mother during the lactation period, several factors have to be taken into consideration. In some cases, such as that of radioactive iodine, the amount of drug excreted is considerable, whereas in others only minute quantities pass into the milk (3). In this respect there may be a considerable difference between different species. In the case of DDT, for instance,

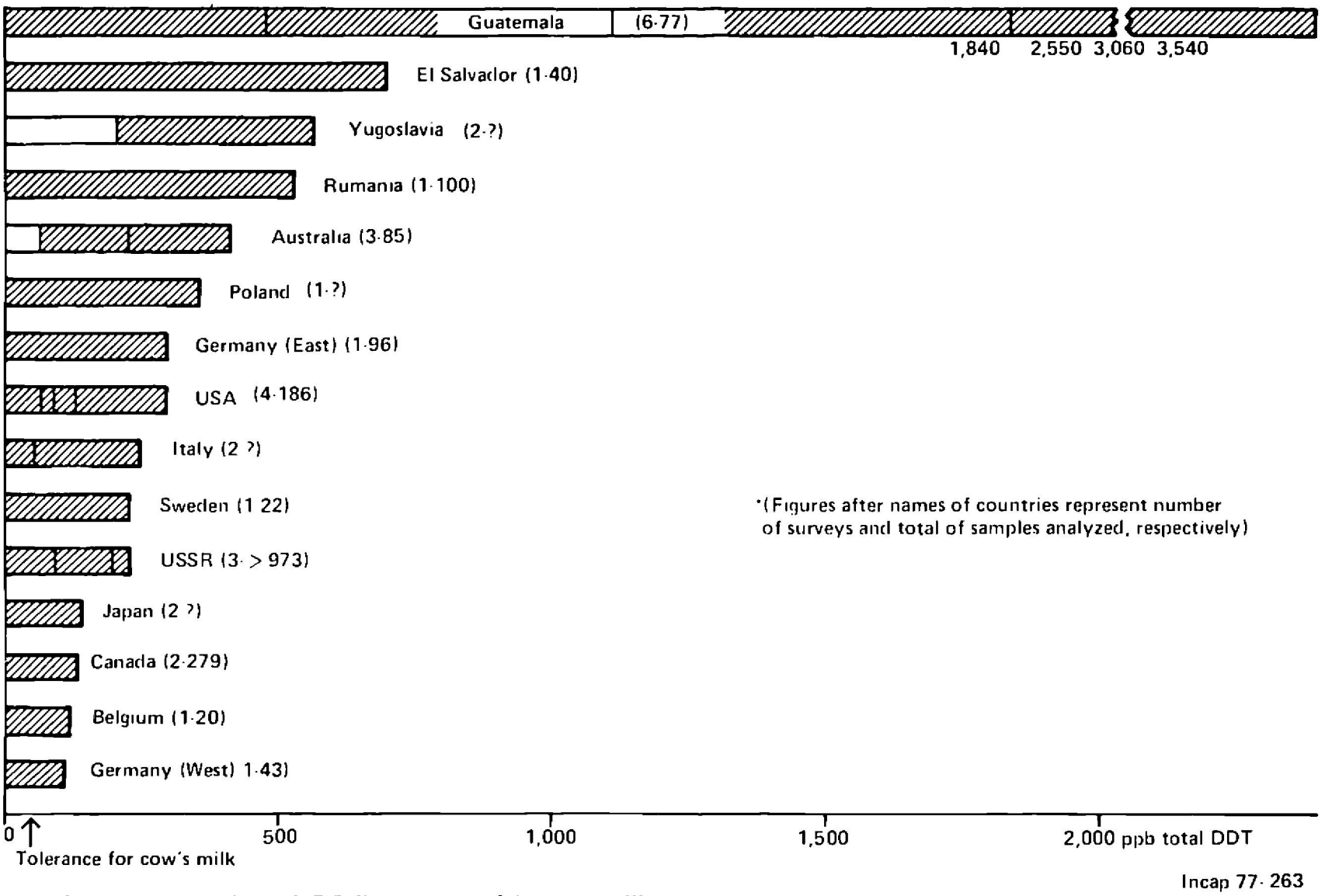

Fig. 2. Averages of total DDT content of human milk found in various countries, 1961–1975 (in parts per billion (1 000 millions)).

human mothers excrete some 12.5% of the intake of this compound, while cows excrete only about 1.5%. Human milk has always been found to contain more DDT than cow's milk (9).

Other factors to be considered when prescribing medication are how and to what extent the agent in question (or its metabolites) may affect the child, and the possibility that its known presence may still be more innocuous than that of unknown products which might exist in substitutes for mother's milk.

In any case, with medication we are more or less in control of the situation. The problem may be more difficult with social toxicants. Alcohol and barbiturates taken separately in moderate amounts are said not to affect the suckling child. Cigarette smoking results in passing alone some 0.4–0.5 mg of nicotine, one of the most toxic drugs, in each litre of milk in the case of mothers smoking ten to twenty cigarettes a day, with a variety of physiological effects. And yet apart from the known difficulty of stopping smoking there is the added difficulty in convincing heavily-smoking mothers that doing so during pregnancy and lactation may affect the infant.

If cigarette smoking by the lactating mother may be bad for the child, marijuana smoking may result in a real tragedy, and more and more documented cases showing what this potent drug can do to a baby are coming to light.

However, it is over "ecological toxicants" that neither the mother nor other individuals as such have much control. In some cases of massive intoxication of the mother, followed by prenatal and postnatal transmission of the toxicants to the foetus and then to the suckling infant, the causes of the tragedies have been a combination of poverty, ignorance, lack of adequate precautions and use of highly toxic

Table 1. *Chlorinated pesticides in human milk—Guatemala, C.A.*

Values expressed in ppm, whole-milk basis. S.D.=standard deviation, n.d.=not detected. Values below 0.001 ppm ar not reported

Community	Crop	No. of samples	Total DDT Mean ± S.D. (Range)	Total DDT Positive samples	Total HCH Mean ± S.D. (Range)	Total HCH Positive samples	Dieldrin Mean ± S.D. (Range)	Dieldrin Positive samples
El Rosario, Champerico	Cotton, corn, sesame	27	1.84±1.25 (0.342–4.97)	27	0.006±0.005[c] (0–0.019)	23	0.002±0.003 (0–0.010)	23
Cerro Colorado, La Gomera	Corn, cotton	9	3.06±1.81[a] (1.57–6.68)	9	0.015±0.019 (0–0.057)	5	n.d.	
La Bomba, Chiquimulilla	Corn	10	1.11±0.80[b] (0.411–1.77)	10	0.0024±0.009[d] (0.010–0.035)	10	n.d.	

[a] Excluding one sample containing 12.21 ppm.
[b] Excluding one sample containing 11.50 ppm.
[c] Excluding one sample containing 0.069 ppm.
[d] Excluding one sample containing 0.101 ppm.

Table 2. *Chlorinated pesticides in human milk—Guatemala, C.A.*

Values expressed in ppm, whole-milk basis. S.D.=standard deviation, n.d.=not detected. Values below 0.001 ppm are not reported

Community	Crop	No. of samples	Total DDT Mean ± S.D. (Range)	Total DDT Positive samples	Dieldrin Mean ± S.D. (Range)	Dieldrin Positive samples	Heptachlor epoxide Mean ± S.D. (Range)	Heptachlor epoxide Positive samples
Guatemala, City	–	15	0.480±0.345 (0.025–1.03)	15	n.d.		n.d.	
Morales, Izabal	Banana	10	2.55±1.68 (1.14–6.60)	10	0.005	1	0.002	1
Escuintla	Cotton	10	3.54±2.55 (0.600–9.26)	10	0.070	1	n.d.	

compounds that could have been replaced by more harmless ones. Such were the cases, for instances, in children of nursing mothers who had eaten hexachlorobenzene-treated seed wheat in Turkey in 1956, and those in Iraq in 1972 whose mothers had consumed home-made bread prepared from wheat treated with a methylmercury fungicide—in this latter case a repetition of the Guatemalan intoxication in 1956 (13). Studies conducted by Amin-Zaki et al. (1, 5) during the first seven months after the poisoning, on 15 infant-mother pairs exposed to methylmercury during pregnancy, showed that this substance passes readily from

Table 3. *Chlorinated pesticides in human milk—El Salvador, C.A.*

Values expressed in ppm, whole-milk basis. S.D.=standard deviation

Community	Crop	No. of samples	Total DDT Mean ± S.D. (Range)	Total DDT Positive samples	Total HCH Mean ± S.D. (Range)	Total HCH Positive samples	Dieldrin Mean ± S.D. (Range)	Dieldrin Positive samples
Santiago de Maria, El Salvador	Coffee	40	0.695±0.460[a] (0.062–1.96)	40	0.012±0.010[b] (0.001–0.040)	27	0.005±0.004 (0.001–0.015)	23

[a] Excluding one sample containing 5.50 ppm.
[b] Excluding one sample containing 0.089 ppm.

Heptachlor epoxide	
Mean ± S.D. (Range)	Positive samples
0.007±0.002 (0–0.008)	19
n.d.	
0.003±0.007 (0–0.021)	3

mother to foetus, resulting in higher blood mercury levels in the foetus than in its mother, and that neonatal blood mercury levels are maintained through ingestion of mercury in the mother's milk, resulting in clinical manifestations of methylmercury poisoning.

Although no similar cases of intoxication have been described in the literature in the case of organochlorine compounds, it is the contamination with these that has been the subject of most studies of contamination of human milk since the first one in 1951 (10). Figs. 1 and 2 summarize the levels of DDT, its metabolites and isomers found in human milk in various countries. Apart from insecticides, several more recent studies also include non-pesticidal polychlorinated biphenyls (PCB) and similar industrial contaminants. In addition to the results shown in the tables, series of studies have been carried out since 1970 in all the prefectures of Japan, showing the main contaminant to be the isomers of BHC (HCH) and not DDT (7).

Heptachlor epoxide	
Mean±S.D. Range)	Positive samples
0.003±0.002 (0.001–0.004)	2

As far as DDT is concerned, the highest values published to date have been those in Guatemala, reported by the present author and his collaborators. The results of the first study, carried out in 1970–1971 and published in 1973 (11, 12), are summarized in Table 1.

Extremely high contamination was found in three rural localities, two of them in cotton-growing areas. Based on the practical residue limit of 0.05 ppm of DDT in commercial milk and the WHO-recommended acceptable daily intake (ADI) of 0.005 mg per kg body weight for adults, the figures meant that human milk in Guatemala contained between 7 and 244 times the maximum DDT concentration legally tolerated in the USA and a number of other countries, and that, taking into account the average amount of mother's milk consumed daily by a Guatemalan child, between 6 and 207 times the amount of DDT considered by WHO as acceptable would be ingested by these infants.

Two further studies, one in three other localities in Guatemala and one in neighbouring El Salvador, showed levels of the same order (Tables 2 and 3) (4). The levels were higher in rural than in urban areas and higher in cotton-growing areas than in areas without cotton. However, it is considered that massive, indiscriminate and ever-increasing (tenfold per acre in as many years) spraying of cotton fields, most of it aerial, has been mainly responsible for the heavy contamination of the Central American Isthmus with DDT (6).

Our findings have since helped to promulgate legislation on the use of pesticides in Guatemala, with DDT scheduled to be phased out over three years. If it is suitably enforced, the DDT levels in the population should gradually fall. However, in the meantime, the possible effect of this massive feeding of babies with DDT during the first months of their life is not known. Claims of innocuity of exposure to DDT, as made by formulators and sprayers,

apply to adults, not infants. A high prevalence of malnutrition, infectious diseases and other negative factors in the area would make the isolation of any effects and specific attribution of them to DDT rather problematic. Nevertheless, the synergistic effect of these factors on insults presented by other potential toxicants is well known, and it is difficult to imagine that the addition of such massive contamination of their only food to their other miseries would have no ill-effect whatever on the children.

It is only to be hoped that the increasing consciousness of the problem will lead to the adoption of measures with which to tackle it.

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