

RESEARCH ARTICLE

INFANT HEALTH RISK RESULTING FROM HUMAN MILK AND CEREALS CONSUMPTION IN NORTH OF CÔTE D'IVOIRE USING THE THEORICAL EXCESS CALCULATION.

A. O. Alle¹, A. Dembele², S. K. Traore³, K. B. Yao⁴ and A.Trokoure⁵.

- 1. Institut Polytechnique Félix Houphouet Boigny, Yamoussoukkro.
- 2. Laboratoire National d'Apui au Développement (LANADA), Abidjan.
- 3. Université Nandjui Abrogoua, Abidjan.
- Institut Polytechnique Félix Houphouet Boigny, Yamoussoukkro. 4.
- Université Félix Houphouet-Boigny, Cocody-Abidjan. 5.

..... Manuscript Info

Published: October 2019

.....

Manuscript History Received: 14 August 2019 Final Accepted: 16 September 2019

Key words:-

Organochlorine pesticides, foodstuffs, children health assessment, theoretical excess calculation.

Abstract

.....

Organochlorine pesticides have been widely used in the north of Côte d'Ivoire in agriculture (cotton field) and in vector-borne disease eradication programs (tse-tse fly). The residues of these compounds were determined in a total of 100 samples of human breast milk and in 80 samples of cereals (maize and rice) collected in Korhogo and Sinématili, in the north region of Côte d'Ivoire, using gas chromatography with electron capture detector. The results showed the presence of the same type of organochlorine pesticides in human milk and in the foodstuffs. The DDT and its congeners and the cyclodiene compounds recorded the higher average concentrations in both cereals and human milk. However, p,p-TDE, p,p-DDE and p,p-DDD constituted the main metabolites of DDT in the cereals samples. As Children have lower weights than adults, they are more vulnerable by eating food contaminated by the organochlorine pesticides. Risk assessment for infant from 0 to 18 months resulting from cereals and milk consumption was carried out by using the theoretical excess calculation (f). The high values of f were obtained for infants from 0 to 6 months.

Copy Right, IJAR, 2019,. All rights reserved.

Introduction:-

Introduction of organochlorine pesticides (OCPs) revolutionized agricultural production and has been credited with the elimination of malaria and other diseases from Africa, Europe and United States. However, OCPs are also known to have major environmental consequences and cause great damage to living organisms (Zawiyah et al., 2006; Hongtao et al., 2008; Beard, 2006; Alle et al., 2009). Because of their highly lipophilic nature, organochlorine pesticides and their metabolites may easily concentrate in fatty foods (such as milk and meat products) leading to bioconcentration throw the food chain (Darko, 2008; Marin et al, 2011; Muralidharan et al, 2009; Gebremichael et al, 2013).

.....

Food is a basic life necessity and contaminated food with toxic pesticides is associated with severe effects on human health (Geetanjali et al., 2009). Because humans occupy the top position in trophic levels, they are obviously exposed to higher level of these contaminants from aquatic and terrestrial food chains and become vulnerable to the

Corresponding Author:-A. O. Alle. Address:-Institut Polytechnique Félix Houphouet Boigny, Yamoussoukkro. toxic effects (William et al., 2008). During the past forty years, special emphasis has been therefore placed on the toxic effects of OCPs on humans and particularly on children (Ennacer et al., 2008; Seurin et al., 2012; Lopez-Espinosa et al., 2008; Ennacer et al., 2008). The infants and children of low age (0-18 month) can be more or less sensitive than the adult for comparable pesticides exposure levels (Boucher et al., 2013). In order to protect consumers against toxicological effects of pesticide residues in foodstuffs, it is necessary to make an evaluation of human health risks (Mishra et al., 2001; Akoto et al, 2013; Kroes et al, 2002; Bempah et al, 2011). Accumulation of OCPs has been related to increase risk of various types of human cancer including breast, lung, cervix, prostate, endometriosis, hypospadias and cryptorchidias and genotoxic effects (Mishra et al, 2011).

In the present study, organochlorine pesticides were measured in samples of human milk and two cereals from Korhogo and Sinématiali, two locations in the north of Côte d'Ivoire. The study area is characterized by intensive agriculture (cotton, paddy and maize ...), and also infested by vector-borne malaria and onchocerciasis. Our aim was to investigate the organochlorine pesticide levels in the samples collected from these areas and then evaluate the potential health risk on infant and children from 0 to 18 months, related to the consumption of human milk, and rice and maize flours using the theoretical excess calculation (f).

Material And Methods:-

Sampling and Collection:

Cereals and milk samples were collected in two localities in the north of Côte d'Ivoire (Korhogo and Sinématiali). In these two studied areas, organochlorine pesticides were widely used for cotton culture and malaria control for a long period.

Forty (40) maize and rice samples were collected from Korhogo and Sinématiali markets, on market days. Indeed, during market days, the cereals which are sold, really come from the municipality and are likely to be ground in mortar (milling increases the risks of pesticides contamination). Rice and maize were selected after a sociological survey which revealed that they were among the most consumed cereals in the areas. For each cereal sample, a mass of about 250 g was taken off in aluminum foil.

Human breast milk samples (100) were collected from mothers (17 to 56 years old, average age 30), living in one of both localities. The breast samples were extracted manually (5 to 10 mL) into sterilized containers by lactating mothers.

Once in laboratory, all the samples were stored at -20°C until the analysis processing.

Sample Extraction and Clean up

Pesticide-grade anhydrous sodium sulfate, sodium chloride, cyclohexane, petroleum benzene, dichloromethane, nitril acetate, and hexane were obtained from Merck (Darmstadt, Germany). Fluorisil (PR Grade, 60-100 mesh) was purchased from Silica (Silica Co, USA). The organochlorine pesticides were extracted and purified, following the method used by Manda et al (2003).

Cereals samples extraction

A quantity of 10 to 20 mg of cereal were weighed and ground. The powder obtained was set into a 500 mL beaker and then mixed with 60 mL of distilled water and 115 mL of nitril acetate in a blinder (or mechanically shaken for an hour if necessary). After a vacuum (or filtration), the filtrate was transferred into a one liter separating funnel. The cake (the remaining paste) was mixed again with 60 mL of distilled water and 115 mL nitril acetate and the extracted matter was first gathered in the separating funnel where 100 mL of cyclohexane were added. After a vigorous shaking and a degasification, a quantity of distilled water up to 600 mL was added to the mixture. 10 mL of saturated NaCl solution were added and the organic phase was collected and successively washed two times with 100 mL of cyclohexane. The organic phase was collected.

Finally a glass wool filtration was made in a 500 ml flask and the filtrate was concentrated up to 10 mL. This volume will be used for clean-up.

Milk samples extraction

Two to five grams of human breast milk were weighed and add to 20 g of anhydrous sodium sulfate 'Na₂SO₄) and the whole were homogenized so as to obtain a powder. The sample was then extracted twice with 150 mL 4:1 (v/v)

petroleum benzene and dichloromethane in a glass column containing 20 g of fluorisil. The aliquots of different extracts were collected in a 500 mL flask previously dried in an oven (100 °C), cooled and weighed. The aliquots were then completely evaporated in a rotavapor at (40-50 °C) and the flaks was dried in the oven, cooled and weighed again for fat weight determination. The extracts were dissolved in hexane and filled up to an appropriate volume (10 mL) for the clean-up.

Clean-Up

Purification of the two extracts (obtained after extractions) was done with a chromatography column with a stationary phase consisting of 20 g of Fluorisil. The elution was made with 150 mL of a benzene oil and dichloromethane (4:1 v/v) mixture. The eluate was collected in a 500 mL flask, then concentrated to 50 mL at 35 °C in a Rotavapor, removed in 100 mL flask and dried. After repeating all this with 50 mL of hexane, the residue was concentrated again to less than 10 mL; then it was removed to a 10 mL volumetric flask and finally filled up to the turn of the gauge. The sample was then ready for the chromatographic analysis.

Gas Chromatography Analysis:

The organochlorine pesticides analysis was performed on a SHIMADZU GC-14A with ⁶³Ni electron capture detector. A capillary column (DB-1 phase, 30m x 0,25 I.D x 0,25 μ m film thickness) was used with Nitrogen as carrier gas at a flow rate of 18 mL/min. Sample volumes of 2 μ L were injected. Split injection of sample was done at 250°C and the detector temperature was 300 °C. The column oven was programmed from an initial temperature of 100 °C and held at that temperature for 5 min, raised to 170°C (at a rate of 5 °C/min) and held for 10 min, then raised to 250°C (at the rate of 10 °C/min) and held for 20 min (with a total run time of 45 min). Qualitative and quantitative analysis were done by comparison with external standard. The minimum determination limit expressed on fat basis for all OCs studied was estimated to 5 ng/kg. In order to determine gas chromatography system precision and accuracy, a 0.5 mg/L concentrated multi-element solution containing every organochlorine pesticide was prepared (pesticide standards: pesticides mix 118 and 2, 4'-DDT and metabolites mix 3, were purchased from Dr Ehrenstorffer , Ausberg, Germany, and most of them were of over 99% certify purity). LOD was calculated by using NF V03-120 French standard or ISO one. Precision and accuracy of the GC system was determined by injecting five times, 2 mL of 0.5 mg/kg concentrated multi-element solution in every organochlorine pesticide. The results obtained were used to calculate the expected values (exactness and fidelity).

A comparison test of pesticides mean values was performed using variance analysis or F test on the threshold of 1% and 5%.

Health risk assessment

Infant health risks due to organochlorine pesticides via cereals (maize and rice) and human milk intakes were assessed according to theoretical excess calculation (f), calculated using the formula (1) below:

 $f = \frac{EDI}{C_I}$ (1) (Even *et al.*, 2002),

where EDI is the Estimated Daily Intake and C_i, the average daily credit, calculated with the formula:

 $EDI = \sum_{i} (Conso_i \cdot [i] (2) and$

 $C_J = ADI \times b.w.(3)$

where ADI is the Acceptable Daily intake (mg/kg b.w./d), b.w. the average body weight of the consumer (in kg), conso_i the average daily consumption of the product (kg/d), and [i] the potential residue (mg/kg).

Infants mean body weights were obtained following a survey conducted by the maternal and child Welfare (PMI) on a sample of 100 children of 0 to 6, 6 to 12 and 12 to 18 months.

Results And Discussion:-

The results below concern infants and small children (from 0 to 18 months), the most sensitive group compared to adults for comparable exposure levels.

Sociological survey

The results of the sociological survey conducted with the Maternal and Child Welfare (PMI) on a sample of 100 children are reported on Figure 1.



Figure 1:-weight change and the amount of feed consumed by infants from 0 to 18 months

With regard to figure 1, while the quantity of milk consumed decreases, the amount of cereal and the infant's weight increase. The quantity of consumed cereal from 0 to 6 months is very weak. So that we can consider that from 0 to 6 months, the risk assessment takes into account only the breast milk consumption. During this period, the baby is exclusively breastfed. But beyond six months, in addition to the milk, the baby can consume maize or rice flour.

Homemade food (rice or maize) is subjected to high temperature (100°C, the boiling point of water) before its consumption by the infant, while breast milk is consumed raw. If the heat shows the ability to degrade the organochlorine pesticides, risk due to the cereals will be lower so that the risk assessment will take into account only the milk consumption beyond six months.

During baking, when substrate undergoes heating, the loss of pesticide residues may be through some physicochemical process, e.g., evaporation, co-distillation and thermal degradation which may vary with the chemical nature of the individual pesticides (Jaggi *et al*, 2001, Tevary *et al* 2005). According to OCPs, which boiling points are above 200°C, heating may have not big influence on their stability during infant homemade food cooking so the cereals and the human milk contributed both to risk assessment. But a more refined study of the eat effect on organochlorine pesticides during infant's homemade food cooking are deemed necessary in the future.

Organochlorine pesticides residues in cereals in Korhogo and Sinématiali

The mean concentrations of organochlorine pesticides residues obtained in cereals are presented in table 1. This table gives also the FAO's Maximum Residue Limits (MRL).

It is observed that Dieldrin, the metabolite of aldrin was detected at lower levels than aldrin. Its mean concentrations were in rice 7.0 μ g/kg and 0.3 μ g/kg and in maize 1.3 μ g /kg and 0.0 μ g /kg respectively in Korhogo and Sinématiali. This may indicate the non-metabolism of original aldrin contaminant into dieldrin. While almost all the OCPs were detected in analyzed samples (rice or maize) from Korhogo area, in the samples from Sinématiali only DDT and its derivatives and aldrin and its congeners were detected. DDT concentration in both cereals whatever the study area was lower than LOD and total DDT was constituted by its metabolites: p,p-TDE, p,p-DDE and p,p-DDD. This may suggest no recent or continuous use of DDT in both study localities (Korhogo and Sinématiali). Total DDT recorded the highest mean concentrations of 0.1 μ g/kg and 7.5 μ g /kg and in maize at the mean concentrations of 2.8 μ g/kg and 6.4 μ g /kg respectively in Korhogo and Sinématiali. But considering all pesticides of both study areas, the average levels were all below the FAO's and WHO maximum residue limits (MRL).

Moreover, the values obtained herein are lower than those found in a similar study worked out in Nigeria (Gelsomino *et al*, 1997), and in India (Bhupendra *et al*, 1990). Osibanjo *et al* had found for total DDT, mean concentrations of 18.0 and 66.0 μ g/kg respectively in rice and maize. Bhupendra *et al* after analyzing 10 samples of maize and 20 samples of rice had got average concentrations of 85 and 1298 μ g/kg respectively in rice and maize.

The lowness values obtained herein may be due to the spent time between period of large organochlorine pesticides spreading at Korhogo and Sinematiali and the study period (the time and the rate of organochlorine pesticides residues vary in the opposite direction). The second reason may be the fact that Osibanjo and Bhupendra studies are before the ban on production and use of OCPs in accordance with the Stockholm Convention in 2001, period before which, there was a non-compliance with the organochlorine pesticide prohibition all over the world, particular in the third world countries.

Table 1:-Mean concentrations of organochlorine pesticides residues ($\mu g/kg$, wt) in cereals in the two study localities and MLR ($\mu g/kg$,wt)

	Korogho		Sinématiali		
Pesticides	Residues	Residues	Residues	Residues	MRL)
	in maize	in rice	in maize	in rice	
Lindane and isomers	2,3	1,0	< LOD	< LOD	10
DDT et derivatives	6,0	0,3	40,0	12	100
Heptachlore, Heptachlore epoxide	4,0	< LOD	< LOD	< LOD	20
Aldrine, Dieldrine, Endrine	4,0	7,0	6,0	8,0	20
Endosulfan (α + β)	1,8	6,0	1,0	< LOD	100

Organochlorine pesticides residues in human milk at Korhogo and Sinématiali

The results related to human milk are summarized in Table 2. As in the case of rice and maize, the mean concentrations of organochlorine pesticides (OCPs) in milk and the FAO's Maximum Residue Limits (MRL) are shown in the table.

While all human milk samples from Korhogo contained measurable quantities of investigated OCPs, only two groups (DDT and its derivatives and cyclodienes) were detected in sinematiali's milk samples. Among organochlorine pesticides detected in samples from both study areas, total DDT (61,0 µg/kg) and total aldrin (48,0 µg/kg) recorded the highest mean concentration respectively in Korhogo and Sinématiali. The lowest mean concentration (2,0 µg/kg) was represented by endosulfan ($\alpha + \beta$) in the locality of Korhogo. The average concentrations of OCPs found in this study are significantly lower than those found by William *et al* (2008) in Ghana (West Africa) and by Ennacer *et al* (2008) in Tunisia (North Africa).

In the viewpoint of environmental toxicology, elevated OCPs concentrations in human breast milk underlines higher risk to both mother and infant health and deserve stricter regulation to phase out completely the use of OCPs (William *et al*, 2008).

ioedities and Tolerable mean concentrations (µg/kg, npia wt)								
Pesticide	Residues in Korhogo	Residues in	Tolerance					
		Sinématiali						
Lindane and isomers	19,0	< LOD	20 - 2000					
DDT et derivatives	61,0	13,0	1000 - 5000					
Heptachlore, Heptachlore epoxide	6,0	< LOD	50 - 200					
Aldrine, Dieldrine, Endrine	43,0	48,0	20					
Endosulfan (α + β)	2,0	< LOD	20					

Table 2:-Mean concentrations of organochlorine pesticides residues in human milk (μ g/kg, lipid wt) in both study localities and Tolerable mean concentrations (μ g/kg, lipid wt)

Risk assessment for infants

To estimate the exposure magnitude to OCPs detected in cereals and maternal breast milk in infants living in Korhogo and Sinématiali, the theoretical overtake of the admissible daily intake (f) was calculated using formula (1). Literature reports suggest the use of EDI for risk assessment. Our aim in this study was to compare the estimated daily intake (EDI) to the Acceptable Daily intake (ADI). A high value of f may suggest a high overtakes of ADI and a potential contamination risk of the infant. Estimated daily intakes in formula (1) were calculated with the values of the pesticide residues observed in this study. The admissible daily intakes are from the guideline standards proposed by FAO/WHO. The average weights of infants, the average daily milk and cereals intake use in formula (1) are summarized in table 3. These values are the same which are depicted by figure 1. Tables 4, 5 and

tables 6, 7 contain the f values, concerning the risk related respectively to milk and maize consumption and milk and rice one in both localities.

According to risk assessment associated with milk and maize consumption in Korhogo, f values were less than 1 for total HCH and total DDT. The highest values were reported with heptachlore and aldrin and its congeners. For these compounds, f values were all above 1 precisely between 3 and 101 (i.e. heptachlore). A similar trend is also noticed for milk and maize consumption in Sinématiali, where f highest values (113) corresponded to cyclodienes (aldrin and its congeners). Let's notice that for all pesticides detected in Korhogo or in Sinématiali, f values for infants from 0 to 6 months were higher than those of infants from 6 to 12 and 12 to 18 months old. This may be attributed to infant body weight. In fact, when the baby growths, his body weight increases. Therefore, his ADI decreases and the risk due to contamination may be lower.

We noticed that f values resulting to risk assessment for milk and rice flour consumption followed the same trend as in the case of milk and maize consumption (the highest values are observed with the group of aldrin). Indeed, f highest values corresponded to cyclodiene compounds. These values were 101 and 113 respectively in Kohogo and Sinématiali. For all pesticides which were concerned, 0 to 6 months infants recorded also the highest values.

A similar study conducted by Even *et al* (2002), on risk assessment resulting to exposure of infants and young children to pesticide residues brought by currents and baby food has yielded results that are higher than herein ones. The f values obtained in this study for lindane were 1,05; 1,99; 3,97 and 6,97 respectively for 0 to 3, 4 to 6, 7 to 12 and 13 to 18 months infants. Considering the OCPs toxicity and the importance of milk and dairy products for child nutrition, Heck *et al* (2007) have determined the estimated daily intake (EDI) of these compounds, through milk, for elementary school children of Santa Maria (Rio Grande do Sul, Brazil). They found in their study, that EDIs values were all below the acceptable daily intake of FAO/WHO. These results may suggest a lower contamination risk of children, elder than ours. In a study conducted in Korea on 100 samples of homemade baby food by determining EDI of organochlorine pesticides, Yunsun *et al* (2013) obtained EDIs values lower than the thresholds proposed by the United Environmental Protection Agency and Health Canada. They concluded that the potential risks were limited. Ennaceur *et al* (2008) by comparing the infant's daily intake of organochlorine pesticides through human breast milk to guidelines proposed by WHO and health Canada, showed that some individuals accumulated OCPs in milk close to or higher than these guidelines. Mishra *et al* (2011) in a study made on risk exposure of infants from north-east India resulting to human breast milk consumption found that high daily intake of DDTs and HCHs by the infants exceeded the TDI (Tolerable Daily Intake). That suggested a high risk for infants of the study area.

The present work is one of the first studies concerning infant exposure to organochlorine pesticides in the north of Côte d'Ivoire. The f high values obtained here could be attributed to high pesticides application with infant dietary habits, especially human milk and cereals consumption. The environmental problems became a major concern of our societies, in particular the risk bound to the exposure in organochlorine pesticides (Jaeger et al, 2012). The health risks due to organochlorine pesticides are the object of numerous debates. Many authors have shown a link between organochlorine pesticides level and infant's health. Organochlorine pesticides pose a serious risk for infant's health since their enzymatic and metabolic systems are not fully active (Heck et al, 2007). The infant contamination by OCPs involves two steps: firstly, mother-baby transfer during pregnancy and secondly biomagnification through food chain. DTT exposure is reported to be a risk factor for premature birth and low birth weight (Rogan and Rogan, 2003). In Côte d'Ivoire, because of the lot of benefits of maternal milk, the maternal and child Welfare (PMI) recommend exclusively breast-feeding from 0 to 6 months despite of its potential contamination by OCPs. After 6 months, mother is allowed to add to human milk, homemade baby food (maize or rice flour). Indeed, Lonnerdal, 2000 and Oddy, 2001 have reported that infants receive all essential and valuable minerals through breast-feeding as it contains an optimal balance of proteins, carbohydrates, lipids and other potential immune factors for their health and resistance to common infections and chronic diseases.

Conclusion:-

Organochlorine pesticide residues level and infant risk assessment by the theoretical overtake of the admissible daily intake (f) based on human milk and rice or maize flour consumption by baby was investigated in this study. The comparison of our findings to those reported widely according to the pesticide residues in milk and in cereals shows that they are lower than the results found in some African countries like Ghana, Nigeria and Tunisia or in other developed nations. The mean residues concentrations in milk or cereal's samples were almost lower than FAO/WHO values. The f higher values were obtained for infants from 0 to 6 months old. This study aims firstly, to

pinpoint the problem or the effects of the widespread use of organochlorine pesticides in the world in general and in the north of Côte d'Ivoire in particular and then to evaluate possible long-term impacts of OCPs to infant health.

Tobleon 2. Average	waight of infant	t and amount a	of mills and	corola concu	mad nor day
rableau J:-Average	weight of infan	гана ашойн с	л шик ана	cerears consu	med ber dav

Age (month)	Mean wt (kg)	Mean milk Consumption (kg/d)	Mean cereals consumption (kg/d)
0 to 6	5,5	1,296	0
0 à 12	8,4	0,81	0,252
0 à 18	9,6	0,486	0,525

Table 4:-Evaluation of the risk associated with the consumption of milk and maize in Korhogo

Pesticides	Residues In maize (mg/kg)	Residues in milk (mg/kg)	ADI (mg/kg)	Age (month)	f
Lindane and isomers				0 - 6	0,90
	0,0023	0,0019	0,005	6 - 12	0,37
				12 - 18	0,19
DDT et derivatives				0 - 6	0,70
	0,006	0,061	0,020	6 - 12	0,30
				12 - 18	0,31
Heptachlore, Heptachlore epoxide				0 - 6	14
	< LOD	0,008	0,0001	6 - 12	5,7
				12 - 18	3
Aldrine, Dieldrine, Endrine				0 - 6	101
	0,004	0,043	0,0001	6 - 12	42
				12 - 18	23,9
Endosulfan (α + β)				0-6	-
	0,0018	0,002	-	6 - 12	-
				12 - 18	-

Table 5:-Evaluation of the risk associated with the consumption of milk and maize in Sinématiali

Pesticides	Residues in maize (mg/kg)	Residues in milk (mg/kg)	ADI (mg/kg p.c)	Age (month)	f
DDT et derivatives				0 - 6	0,18
	0,004	0,013	0,020	6 – 12	0,063
				12 - 18	0,044
Aldrine, Dieldrine, Endrine				0 - 6	113
	0,006	0,048	0,0001	6 – 12	6,40
				12 - 18	27,20
Endosulfan($\alpha + \beta$)				0 - 6	-
	0,001	-	-	6 - 12	-
				12 - 18	-

Table 6:-Evaluation of the risk associated with the consumption of milk and rice in korhogo

Pesticides	Residues in rice (mg/kg)	Residues in milk (mg/kg)	ADI (mg/kg p.c)	Age (month)	f
Lindane and isomères				0 - 6	0,90
		0.0010	0.005	6 – 12	0,37
	< LOD	0,0019	0,005	12 - 18	0,20
DDT et dérivés	0.04	0.061	0.020	0 - 6	0,70
	0,04	0,001	0,020	6 – 12	0,30

				12 - 18	1,25
Heptachlore, Heptachlore				0 - 6	14
epoxide	< LOD	0,008	0,0001	6 – 12	5,70
				12 - 18	3
Aldrine, Dieldrine,				0 - 6	101
Endrine	0,006	0,043	0,0001	6 – 12	43
				12 - 18	22,55
Endosulfan				0 - 6	-
$(\alpha + \beta)$	0,001	0,002	-	6 - 12	-
				12 - 18	-

Table 7:-Evaluation of the risk associated with the consumption of milk and rice in Sinématiali

Pesticides	Résidues in maize (mg/kg)	Résidues in milk (mg/kg)	ADI (mg/kg p.c)	Age (month)	f
DDT et dérivés				0 - 6	0,15
	0,012	0,013	0,020	6 – 12	0,08
				12 - 18	0,065
Aldrine, Dieldrine, Endrine				0 - 6	113
	0,008	0,048	0,0001	6 – 12	48,40
				12 - 18	25,40

References:-

- 1. Akoto O., Andoh H., Darko G., Eshun K. & Osei-Fosu P., (2013). Health risk assessment of pesticides residue in maize and cowpea from Ejura, Ghana, Chemosphere, 92(1), 67–73.
- 2. Beard, J. (2006). DDT and human health. Sci Total Environ.355(1-3), 78-89.
- 3. Bempah C. K., Donkor A., Yeboah P. O., Dubey B. & Osei-Fosu P. (2011). A preliminary assessment of consumer's exposure to organochlorine pesticides in fruits and vegetables and the potential health risk in Accra Metropolis, Ghana, Food Chem, 128 (4, 15), 1058–1065.
- 4. Bhupendra, S., K.R. Tokroo, S. Mehrotra, U. Nigam and D.S. Tejeshwar, 1990. Organichlorine pesticide residues in different Indian cereals, pulses, spices, vegetables, fruits, milk, butter, deshi ghee, and edible oils. J. Assoc. off Anal. Chem., 73 (4): 509-512.
- Boucher O., Simard M. N., Muckle G., Rouget F., Kadhel P., Bataille H., Chajès V., Dallaire R., Monfort C., Thomé J. P., Multigner L. & Cordier C., (2013). Exposure to an organochlorine pesticide (chlordecone) and development of 18-month-old infants, NeuroToxicology, 35, pp. 162–168.
- 6. Darko, G., & Acquaat, S.O. (2008). Levels of organochlorine pesticides in dairy products in Kumassi, Ghana. Chemosphere, 71, pp. 294-298.
- 7. De Jaeger C., Cherin P., Fraoucene N., Voronska E., 2012. Place, intérêt et danger des produits phytosanitaires. Medecine & Longévité, 4(2), pp. 59-67.
- 8. Ennaceur, S., Gandoura N. & Driss M.R., (2008). Distribution of polychlorinated biphenyls and organochlorine pesticides in human breast milk from various locations in Tunisia: Levels of contamination, influencing factors, and infant risk assessment, Environ. Res, 108 (1), 86–93.
- 9. Even I., Berta J.L., Volatier J.L. (2002). Evaluation de l'exposition théorique des nourrissons et des enfants en bas âge aux résidus de pesticides apportés par les aliments courants et infantiles, Agence Française de Sécurité Sanitaire des Aliments, 116.
- Gebremichael S., Birhanu T. & Tessema D. A., (2013). Analysis of organochlorine pesticide residues in human and cow's milk in the towns of Asendabo, Serbo and Jimma in South-Western Ethiopia, Chemosphere, 90 (5), 1652–1657.
- 11. Geetanjali, Kaushik, Santosh Satya & Nik, S.N. (2009). Food processing a tool to pesticide residue dissipation-A review. Food Res. Int. 42, 26-40.
- 12. Gelsomino, A., B. Petrovicova, I.S. Tiburtin, E. Magnani and M. Felici, 1997. Multiresidue analysis in fruits and vegetables by gel permeation chromatography followed by gas chromatography with electron-capture and mass spectrometric detection. Journal of chromatography A, 782, 105-122.

- Heck M.C., Sifuentes dos Santos J., Bogusz Jnior S., Costabeber I. & Emmanualli T., 2007. Estimation of children exposure to organochlorine compounds throught milk in Rio Grane do Sul, Brazil. Food Chem., 102, (1), 288-294.
- 14. Hongtao, H., & Sun and Zhao, Z. (2008). Effect of land use change from pady to vegetable field on the residues of organochlorine pesticides in soils. Envron. Pollut., 156, 1046-1052.
- 15. Jaggi J., Sood C., Kumar V., Ravindranath S. D., Shanker A. (2001). Leaching of pesticides in tea brew. J. Agric. Food chem., 49, 5479-5483.
- 16. Kroes R., Müller D., Lambe J., Löwik M.R.H, Klaveren J. v., Kleine J., Massey R., Mayer S., Urieta I., Verger P. & Visconti A. (2002). Assessment of intake from the diet, Food Chem. Toxicol, 40, (2–3), 327–385.
- Lopez-Espinosa M. J., Lopez-Navarrete E., Rivas A., Fernandez M. F., Nogueras M., Campoy C., Olea-Serrano F., Lardelli P. & Olea N., 2008. Organochlorine pesticide exposure in children living in southern Spain, Environ. Res., 106 (1), 1–6.
- 18. Lonnerdal B., (2000). Breast milk. A truly fonctionnal food Nutrition, 16, 509-11.
- 19. Manda, P., Dano D.S., Fadiga, S., & Dembele, A. (2003). Recherche de résidus de pesticides organochlorés dans le lait maternel et les tissus adipeux des femmes. A. Bioméd., 8(1), 18-24.
- 20. Marin S., Villalba P., Diaz-Ferrero J., Font G., Yusà V., (2011). Congener profile, occurrence and estimated dietary intake of dioxins and dioxin-like PCBs in foods marketed in the Region of Valencia (Spain), Chemosphere, 82 (9), 1253–1261.
- 21. Mishra K. & Sharma R. C. (2011). Assessment of organochlorine pesticides in human milk and risk exposure to infants from North-East India, Sci. Total Environ., 409 (23), 4939–4949.
- 22. Muralidharan S., Dhananjayan V. & Jayanthi P., (2009). Organochlorine pesticides in commercial marine fishes of Coimbatore, India and their suitability for human consumption, Environ. Res., 109 (1), 15–21.
- 23. Oddy WH., (2001). Breastfeeding protects against illness and infections in infants and children: a review of the evidence, brastfeed Rev, 9, 11-8.
- Seurin S., Rouget F., Reninger J. C., Gillot N., Loynet C., Cordier S., Multigner L., Leblanc J. C., Volatier J. L. & Héraud F., (2012). Dietary exposure of 18-month-old Guadeloupian toddlers to chlordecone, Regul. Toxicol. Pharm., 63 (3), 471–479.
- 25. Soliman K. M., (2001). Changes in concentrations of pesticides residues in potatoes during washing and home preparation, Food Chem. Toxicol, 39, 887-891.
- 26. Tewary D. K., Kumar V. P., Ravindranath S. D., Shanker A. (2005). Dissaption behavior of bifenthrin residues in tea and its brew, Food Contam, 16, 231-237.
- 27. William, J. N., Laud, M. T., Pay, D., Peter, K., Huub, J. G., & Elvis, N. (2008). Accumulation of organochlorine contaminants in milk and serum of farmers from Ghana. Environ. Res., 106, 17-26.
- 28. Wen K. C., Shimato T., Nishihara T., Kond M, (1985). Behaviour of pesticides during cooking treatments in food samples. J. Hyg. Chem, 13, 256-259.
- 29. Yunsun Jeong, Sunggyu Lee, Sunmi Kim, Sung-Deuk Choi, Jeongim Park, Hai-Joong Kim, Jeong Jae Lee, Gyuyeon Choi, SOOran Choi, Sungjoo Kim, Su Young Kim, Young Don Kim, Geumjoon Cho, Eunsook Suh, Sung Ku Kim,So-Hee Eun, Soyong Eom, Seunghyo Kim, Gun-Ha Kim, Kyungho Choi, Sungkyoon Kim & Hyo-Bang Moon (2013). Occurrence and exposure assessment of plychlorinated biphenyls and organochlorine pesticides from homade baby food in Korea. Science of the Total Environ., available online 16 August 2013.
- Zawiyah, S., Man, Che Y.B., Nazimah, S. A. H., Tsukamoto, C.K. Cin, I., Hamaniza, A. H., & Norhaizan, I. (2006). Determination of organochlorine and pyrethroid pesticides in fruit and vegetables using SAX/PSA clean-up column. Food chem., 102, 98-103.