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ORIGINAL RESEARCH

Initial Survey of Pesticide Residues in Baby's food and The Exceedances of Maximum Residual Limit (MRLs)

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Abstract:
Introduction: Remnant or by-products of pesticides arising from the field or storage pest applications sometimes find their ways into the final food produce as pesticide residue. Studies have shown the occurrence of these residues in various food produce including tea, fruits, vegetables, beverages and even baby and infants food. With about 800 pesticides permitted for use globally, residue becomes almost inevitable. This study assessed the pesticide residues in the common baby food and compared with international maximum residual limits..
Materials and Methods: Using gas chromatography with mass spectrometric detection, five infant and baby's food tagged A, B, C, D and E were analyzed.
Results: In all, multiple residues involving various twenty five pesticides were detected in the five food products. Fifteen of the pesticides including resmethrin (0.0002 µg/g), chlorpyrifos (0.0002 µg/g), allethrin (0.0004 µg/g), piperonyl butoxil (0.0003 µg/g), cyfluthrin (0.0001 µg/g), chlorpyrifos methyl (0.0002 µg/g), diclorovos (0.0001 µg/g), fluridane (0.0002 µg/g), fludioxonil (0.0002 µg/g and 0.0001 µg/g), lindane (0.0002 µg/g), daminozide (0.0002 µg/g), methy paraoxon (0.0001 µg/g) and DDE.p.p (0.0002 µg/g and 0.0001 µg/g) were above the WHO and USEPA maximum residual limits.
Conclusion: The potential interaction of different mixtures for those pesticides that are below international residual limits as well as the occurrence of those at concentrations above these standards called for serious concerns, giving their critical effects on nervous, endocrine and immune systems. Further studies are required to determine the status of residue in other foods and the elimination of these residues, particularly in the infants and baby's food.

Keywords: Pesticides, Pesticide residues, Baby food, WHO and USEPA maximum residual limit.

All co-authors agreed to have their names listed as authors.

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1. INTRODUCTION

Pesticides application has been of great benefit to mankind, boasting yields through reduction in pest attacks. Some of these pesticides including their metabolites or breakdown products have been shown to be relatively toxic and possible hormone disruptors, with harmful effects on consumers or the environment (32). A prominent route of entry is through residue in plant and animal products. These pesticide residues are the low concentrations of pesticides that are often remain behind in crop after harvesting or storage and make their way into the food chain (57).

Sometimes these pesticides need to remain on the crop to do their job. For example, they may need to be on the surface of the fruit or the vegetable to protect it from pests during storage (56). Some pesticides are applied after harvest for this purpose. Therefore, strict regulations must be followed to control the use of these chemicals and to ensure that concentrations do not exceed statutory maximum residue levels (MRLs).

Of particular concern is the exposure of infants and children to food contaminants because of their possible increased susceptibility for adverse effects (35). The directives of the European Union on infant formulas, follow on formulas, processed cereal-based foods, and baby foods state that these products “shall not contain any substance in such quantity as to endanger the health of infants and young children”, and that maximum levels “shall be established without delay” (24). The European Commission also said that the important premise for pediatricians is that infants should not be exposed to any unnecessary risk. Maximum concentrations are also required for organically grown baby foods which may contain residue concentrations exceeding those acceptable for infants. This study therefore aimed at assessing the pesticide residues in five selected baby/infant food, to determine the compliance to international maximum level.

1.1 Aim of study

The aim of this study was to assess the pesticides residue in five baby foods tagged A, B, C, D and E in order to ascertain their compliance to National and International Standards.

2. MATERIAL AND METHODS

2.1 Material

Gas Chromatography coupled to a mass spectrometer (MS) as a detector is commonly used in pesticide residue analysis, because many pesticides are not amenable to LC-MS or ionize poorly under soft ionization techniques. The Gas Chromatography (hp5890 series 2) with the following specification were used for the analysis of residue; Detector (mass spectrometer), Injector type (split lens injector), Column type (O.V-3), Injector temperature (2200C), Open temperature (240C), Detector temperature (270C), Carrier gas (nitrogen), Combustion gasses (hydrogen and compressed air), Hydrogen flow (45 ml per minute), Nitrogen flow (22 ml/ minute), Ramping rate (100C/minute), Holding time (2 minutes), Initial temperature (50C), weighing balance.

2.2 Baby food sample

Food A is made from rice. It can be eaten by both adults and children. It was produced and packaged in U.K.

Food B is a baby cereal food made of wheat. It is recommended for a day old baby to children above one year by the manufacturers. It was produced and packaged in U.S.A.

Food C is baby milk recommended for babies of 6-12 months by the manufacturers. Produced and packaged in the Netherlands, Europe.

Food D is wholegrain wheat. It can be eaten by both adults and children. It was produced and packaged in U.K.

Food E is a cereal that is made from grains and recommended for children above 7 months by the manufacturer. It was produced and packaged in Europe.

All the baby food samples were sourced from various standard supermarkets in Lagos, Nigeria

Gas Chromatography coupled to a mass spectrometer (MS) as a detector is commonly used in pesticide

2.3 Methods

2.3.1 Sample collection

A weighing scale was used to measure 20g of each sample into two replicate bottles and sent to a private contracted laboratory for pesticide residue analysis.

2.3.2 Sample Preparation and Extraction

10 g samples were extracted with 10 ml of acetonitrile and the extract was then cleaned up using anhydrous magnesium sulphate C18 and primary secondary amine (PSA). 1ml of the cleaned extract was injected. 10 g of samples of each of the five baby milk and cereals were weighed into an amber bottle and 10 ml of acetonitrile was added to each sample. These were checked using mechanical checker for about 30 minutes, before the samples were filtered. The samples were then cleaned up using anhydrous magnesium sulphate C18 and the primary secondary amine (PSA). The extract concentrated to 1 ml and stored in Vail for analysis.

The residues were analyzed with gas chromatograph GC- 2010 equipped with 63Ni electron capture detector that allowed the detection of contaminants even at trace level concentrations from the matrix to which other detector do not respond. The GC conditions and the detector response were adjusted so as to match the relative retention times and response. The conditions used for the analysis were: capillary column coated with ZB-5 (30m x 0.25mm, 0.25 mm film thickness). Carrier gas and make-up gas was nitrogen at a flow rate of 1.0 and 29 ml/min, respectively. The injector and detector temperature were set at 280 and 300oC, respectively. The oven temperature was programmed as follows: 60oC held for 1 min, ramp at 30oC/min to 180oC, held for 3 min, ramp at 3oC/min to 220oC, held for 3 min, ramp at 10oC/min to 300oC. The injection volume of the GC was 1.0 L. The residues detected by the GC analysis were further confirmed by the analysis of the extract on two other columns of different polarities. The first column was coated with ZB-1 (methyl polysiloxane) connected to ECD and the second column was coated with ZB-17 (50% phenyl, methyl polysiloxane) and ECD was also used as detector.

3. RESULT

From the residual analysis on the five baby food, varied concentrations of various pesticides including insecticides, fungicides, herbicides and several others were obtained.

3.1 Food A

In food A, there were eleven pesticides detected and their residual concentration include carbendazim (0.0001µg/g), permethrin total (0.0002 µg/g), piperonyl butoxil (0.0003 µg/g), DDDP_P (0.0002 µg/g), melathion (0.0004µg/g), resmethrin (0.0002µg/g), alletrin (0.0004µg/g), MAK-246 (0.0002µg/g), endosulfan 2 (0.0006µg/g), fludioxonil (0.0002µg/g) and endosulfan sulphate (0.0002µg/g) (Table 1)

Table 1. Pesticide (residual concentrations) in baby food A, B, C, D and E

	FOOD A @ µg/g		FOOD B @ µg/g		FOOD C @ µg/g		FOOD D @ µg/g		FOOD E @ µg/g	
1	Allethrin	0.0004	Allethrin	0.0004	Acephate	0.0001	Carbofuran	0.0003	Aldicarb	0.0003
2	Carbendazim	0.0001	DDEP_P	0.0002	Aldicarb	0.0002	Chlorpyrifos methyl	0.0002	Chlordane (a)	0.0001
3	DDDP_P	0.0002	Endosulfan 2	0.0004	Chlordane (a)	0.0001	Cyfluthrin	0.0001	Chlordane (b)	0.0001
4	Endosulfan	0.0006	Endosulfan sulphate	0.0001	Chlordane (b)	0.0002	DDEP_P	0.0001	Daminozide	0.0002
5	Endosulfan sulphate	0.0002	Fludioxonil	0.0001	Chlorpyrifos	0.0002	Fluridone	0.0002	Endosulfan	0.0003
6	Fludioxonil	0.0002	MAK-246	0.0002	Daminozide	0.0002	Melathion	0.0003	Formothion	0.0002
7	MAK-246	0.0002	Methyl paraoxon	0.0001	Dichlorvos	0.0001	Piperonyl butoxil	0.0002	Lindane	0.0002
8	Melathion	0.0004	Melathion	0.0003	Endrin	0.0001				
9	Permethrin total	0.0002	Methoprene	0.0001	Endosulfan	0.0004				
10	Piperonyl butoxil	0.0003	Piperonyl butoxil	0.0003	Formothion	0.0002				
11	Resmethrin	0.0002			Lindane	0.0002				

3.2 Food B

In baby food B , detectable pesticides and their residual concentration include methyl paraoxon (0.0001µg/g), piperonyl butoxil (0.0003µg/g), DDEP_P (0.0002µg/g), melathion (0.0003µg/g), methoprene (0.0001µg/g), alletrin (0.0004µg/g), MAK-246 (0.0002µg/g), endosulfan 2 (0.0004µg/g), fludioxonil (0.0001µg/g) and endosulfan sulphate (0.0001µg/g) (Table 1)

3.3 Food C

In baby food C, detectable pesticides and their residual concentrations include chlordane (0.0001µg/g), acephate (0.0001µg/g), lindane (0.0002µg/g), aldicarb (0.0002µg/g), endosulfan (0.0004µg/g), dichlorvos (0.0001µg/g), daminozide (0.0002µg/g), chlordane (0.0002µg/g), formothion (0.0002µg/g), chlorpyrifos (0.0002µg/g) and endrin (0.0001µg/g). The chlordane in this sample occurred twice at different boiling points, i.e. isomers (Table 1)

3.4 Food D

In food D, seven pesticide residues were detected include piperonyl butoxil (0.0002 µg/g), DDDEP_P (0.0001 µg/g), melathion (0.0003 µg/g), fluridone (0.0002 µg/g), chlorpyrifos methyl (0.0002 µg/g), carbofuran (0.0003 µg/g) and cyfluthrin (0.0001 µg/g) (Table 1)

3.5 Food E

In food E, detectable pesticides and their residual concentration include chlordane (0.0001µg/g), lindane (0.0002 µg/g), aldicarb (0.0003 µg/g), endosulfan (0.0003 µg/g), daminozide (0.0002 µg/g), chlordane (0.0001 µg/g) and formothion (0.0002 µg/g). The chlordane occurred twice in this at different boiling points. They are isomers with different chemical structures (Table 1)

4. DISCUSSION AND CONCLUSION

4.1 Discussion

Pesticide residue in baby food is a consequence of pest management in the field and during storage of farm produce. The fact that extensive agricultural production now required one form of pesticides ranging from herbicides, insecticides and fungicides to be successful also means there will always be pesticide residues in several of farm produce. The challenge is at what concentrations does those residues occurred and the health implication of these residues, particularly in the young children and babies.

In this current study, several pesticides (carbendazim, permethrin total, piperonyl butoxil, DDD, p, p1, malathion, resmethrin, allethrin, fludioxonil, endosulfan sulphate, methyl paraoxon, DDE, p, p1, methoprene, chlordane, acephate, lindane, aldicarb, endosulfan, dichlorvos, daminozide, formothion, chlorpyrifos, endrin, fluridone, chlorpyrifos methyl, carbofuran, cyfluthrin) were detected at a level that is above the WHO/USEPA standard.

Resmethrin belongs to a group of insecticides called pyrethroids. Resmethrin was found in Baby food A at 0.0002 µg/g, which was above the MRLs for WHO and USEPA concentration of 0.00005 µg/g and 0.00006 µg/g respectively (61 and 69). Resmethrin is classified by the United States Environmental Protection Agency (U.S. EPA) as "likely to be carcinogenic to humans" (61). Resmethrin can alter neurological function and cause subtle neurobehavioral impairments when exposure occurs during the period of nervous system development immediately after birth (55). It has also been shown that processes such as learning ability, activity level, and memory, as well as emotion, sight, and hearing can all be affected by this insecticide. Pyrethroids have been shown to adversely affect the developing nervous system of children (60.

Endrin was currently found in Baby food C at 0.0001µg/g, which was same concentration as the MRLs for WHO and USEPA at concentration of 0.0001µg/g and 0.0001µg/g respectively. Endrin is an organochloride, it is primarily used as an insecticide, as well as a rodenticide and piscicide (59). Upon entering the body, it can be stored in body fats and can act as a neurotoxin on the central nervous system, which can cause convulsions, seizures, or even death (39). Higher doses of endrin have been found to cause the following in mammals: renal tubular necrosis; inflammation of the liver, fatty liver and liver necrosis; possible kidney degradation and a decrease in body weight (12) Just like other Organochlorine pesticides, they have been found to affect the developing nervous system of children (17).

Chlordane or Chlordan is an organochlorine compound used as a pesticide. Chlordane in this current study was detected at concentrations of 0.0001µg/g and 0.0002µg/g in Baby food C at different isomers. In Baby food E, chlordane was detected at concentrations of 0.0001µg/g and 0.0001µg/g because chlordane also appeared twice in Baby food E at different isomers. The MRLs for WHO and USEPA is 0.02 µg/g and 0.0002 µg/g respectively (64, 72). In this current study, chlordane residual level was below the MRLs of WHO and the same as USEPA MRLs in Baby food C. Chlordane residual level concentration is below MRLs of WHO and USEPA in Baby food E. Exposure to chlordane metabolites may be associated with testicular cancer. However, studies have linked chlordane in human tissues with cancers of the breasts, prostate, brain and cancer of blood cells- leukemia and lymphoma (18). The non-cancer health effects of chlordane compounds include diabetes, insulin resistance, migraines, respiratory infections, immune- system activation, anxiety, depression, blurry vision, confusion, intractable seizures as well as permanent neurological damage, probably affects more people than cancer (10). Chlordane can affect the digestive and nervous system of children; it is also toxic to liver (22)

Chlorpyrifos was currently found Baby food C at concentration of 0.0002µg/g, which is above the MRLs for WHO but below the USEPA concentration at concentration of 0.00002µg/g and 0.0002µg/g respectively. Chlorpyrifos is used around the world to control pest insects in agricultural, residential and commercial settings (3). Many epidemiological and experimental animal studies suggest that infants and children are more susceptible than adults to effects from low exposure to chlorpyrifos, because they have a decreased capability to detoxify chlorpyrifos and its metabolites (36; 15).

Acephate was found in Baby Food C at concentration of 0.0001µg/g, which is below the MRLs for WHO at 0.0002µg/g but above the MRLs for USEPA at 0.00002µg/g. Acephate is an organophosphate insecticide. This chemical family attacks and block an enzyme in the nervous signal, which eventually destroys the nervous system. The EPA classifies acephate as a “possible human carcinogen (27). Mice that were fed high doses of acephate all at once had DNA damage in blood cells (4). Children may have different symptoms than adults such as drooling, seizures, muscle weakness, lethargy, coma and pupil constriction (34).

Allethrin was found in Baby food A and B at concentration of 0.0004µg/g each, which were both above the MRLs for WHO and USEPA at concentrations of 0.00002µg/g each (Table 2). Allethrin is synthetic form of a chemical found naturally in the chrysanthemum flower (9). Exposure of children to large doses by any route may lead to nausea, vomiting, diarrhea, hyper-excitability, in-coordination, convulsive twitching, convulsions, bloody tears, incontinence, muscular paralysis, prostration and coma (8). Allethrin is a central nervous system stimulant (42).

Piperonyl butoxil or piperonyl butoxide (PBO) was found in Baby Food A at 0.0003µg/g, which is above the MRLs for WHO and USEPA at concentration of 0.0001µg/g and 0.0002µg/g respectively (Table 2). It is an organic compound used as a component of pesticide formulations (68). Children’s exposure to Piperonyl butoxil negatively affects neurodevelopment, mental development or psychomotor development (5)

Cyfluthrin was detected in Baby Food D at 0.0001µg/g, which was above the MRLs for WHO and USEPA at concentration of 0.00001µg/g and 0.00002µg/g (Table 2). Cyfluthrin is a synthetic pyrethroid insecticide that has both contact and stomach poison action (41). Short and long term studies of the effects of cyfluthrin on mammalian systems have resulted in pockets of inflammation in the kidneys of females and reversible damage to the sciatic nerve (64).

Dichlorvos was detected in Baby food C at concentration 0.0001µg/g, which was the same as the WHO MRLs and above the MRLs for WHO and USEPA at concentration of 0.0001µg/g and 0.00001µg/g respectively (Table 2). Dichlorvos or 2, 2-dichlorovinyl dimethyl phosphate is an organophosphate that is widely used as an insecticide to control household pests, in public health and protecting stored products from insects (48) Dichlorvos, like other organophosphate insecticides, acts on acetylcholinestrase, associated with the nervous systems (45). Symptoms of dichlorvos exposure include weakness, headache, tightness in chest, blurred vision, salivation, sweating, nausea, vomiting, diarrhea, abdominal cramps, eye pain, runny nose, wheezing, cyanosis, anorexia, muscle fasciculation, paralysis, dizziness, ataxia, convulsions, hypotension (low blood pressure) and cardiac arrhythmias (23). Dichlorvos have been found to affect neurodevelopment and growth in developing children, neurobehavioural effects such as impairment on maze performance, locomotion and balance in neonates exposed in utero and during early life (1). Possible mechanisms for these effects include inhibition of brain DNA synthesis and reduced brain weight in offspring (13). Research findings also suggest that Organophosphates exposure may be related to respiratory disease in children through deregulation of the autonomic nervous system (38).

Carbofuran was detected in Baby food D at 0.0003µg/g, and this was below the MRLs for WHO at concentration of 0.0005µg/g but above the MRLs for USEPA at 0.0001µg/g (Table 2). Carbofuran causes cholinesterase inhibition in both humans and animals, affecting nervous system function (11). Symptoms of carbofuran poisoning in children include: nausea, vomiting, abdominal cramps, sweating, diarrhea, excessive salivation, weakness, imbalance, blurring of vision, breathing difficulty, increased blood pressure and incontinence (33).

Formothion was detected in Baby food C at 0.0002µg/g and Baby food E at 0.0001µg/g. The MRLs for WHO and USEPA is 0.006µg/g and 0.0001µg/g respectively (Table 2). In this study, formothion residual level was below MRLs of WHO in Baby food C but equal to the MRLs of USEPA standard in Baby food E. Formothion is a systemic and contact insecticide used on tree fruits, vines, olives, hops, cereals, sugar cane, and rice. Formothion have been shown to be cholinesterase inhibitor in children, which means it affects normal nervous system function. Early symptoms of formothion poisoning include nausea or vomiting, dizziness and weakness (16).

Endosulfan was detected in Baby food C at concentration of 0.0004µg/g and in Baby food E at concentration of 0.0003µg/g. The MRLs for WHO and USEPA is 0.0006µg/g and 0.000006µg/g respectively (Table 2). In this current study, endosulfan residual level is below MRLs of WHO but above USEPA MRLs in Baby food C. Endosulfan is a xenoestrogen-a synthetic substance that imitates or enhances the effect of estrogens and it can act as an endocrine disruptor, causing reproductive and developmental damage (65). Studies on children from many villages in Kasargod district, Kerala, India have linked endosulfan exposure to delays in sexual maturity among boys while birth defects of the male reproductive system, including cryptorchidism were also more prevalent in the study (52).

Endosulfan sulfate was detected in Baby food A at 0.0002µg/g and B at 0.0001µg/g. The MRLs for WHO and USEPA is 0.0002µg/g and 0.01µg/g respectively (72). In this study, endosulfan sulfate residual level is same as MRLs of WHO but below USEPA MRLs in Baby food A. Children suffer from acute hemolytic anemia (premature destruction of red blood cells) after exposure (50).

Endosulfan II was detected in Baby food A at 0.0006µg/g and B at 0.0004µg/g. The MRLs for WHO and USEPA is 0.002µg/g and 0.0003µg/g respectively (Table 2). (63 and 50). In this study, endosulfan II residual level is below WHO MRLs but above USEPA MRLs in Baby food A. Endosulfan II (beta) is an organochlorine compound. Symptoms of poisoning in children with endosulfan II include hypersensitive to stimulation, sensation of pricking, tingling or creeping on skin, headache, dizziness, nausea, vomiting, tremor, mental confusion, hyperexcitable state. In severe cases: convulsions, seizures, coma and respiratory depression (49).

Chlorpyrifos methyl was detected in Baby food D at 0.0002µg/g, which was above the MRLs for WHO at concentration of 0.0001µg/g but below USEPA at 0.0003µg/g (Table 2). Chlorpyrifos methyl is an organophosphorus insecticide (43). Symptoms of poisoning with chlorpyrifos methyl include excessive salivation, sweating, tearing, muscle twitching, weakness, tremor, headache, dizziness, nausea, vomiting, abdominal cramps, diarrhea, respiratory depression, tightness in chest, wheezing, productive cough, fluid in lungs, pin-point pupils, sometimes with blurred or dark vision, loss of consciousness and cholinesterase inhibition (41). Infants exposed to chlorpyrifos methyl residues after birth suffered severe impairment of motor and mental development (46).

Aldicarb was detected in Baby food E at 0.0003µg/g, which was below USEPA at concentration of 0.00005µg/g (Table 2). In this study, aldicarb residual level is below MRLs of WHO and above USEPA MRLs in Baby food E. Aldicarb is a carbamate insecticide. Aldicarb is a cholinesterase inhibitor in children which prevents the breakdown of acetylcholine in the synapse. In case of severe poisoning, the victim dies of respiratory failure.

Carbendazim was found in Baby food A at 0.0001µg/g. The MRLs for WHO and U.S. EPA for carbendazim is

0.0001-0.0007µg/g and 0.0002 µg/g respectively (Table 2). In this study, carbendazim residual level was therefore below the MRLs of USEPA in Baby food A. Carbendazim is one of the most widely used broad-spectrum benzimidazole fungicide and a metabolite of benomyl. Studies have found high doses of carbendazim cause infertility and destroy the testicles of laboratory animals. If carbendazim is ingested in large quantity, it might increase the risk of childhood cancer (31).

Fluridone was detected in Baby food D at 0.0002µg/g, which was far above both the MRLs for WHO and USEPA at concentration of 0.00001µg/g and 0.00005µg/g respectively (Table 2). Fluridone is an aquatic herbicide often used to control invasive plants. However, fluridone can cause mild to moderate skin and eye irritation at high concentrations (7). Exposure during infancy to relatively low levels of fluridone may cause subtle, long-lasting neurological effects. Fluridone have been found to cause developmental problems and learning disabilities in children who exhibited cognitive, motor, and behavioral deficits (67).

Fludioxoil was detected in Baby food A at 0.0002µg/g and B at 0.0001µg/g The MRLs for WHO and USEPA is 0.0001µg/g and 0.00005µg/g respectively (Table 2). In this study, fludioxonil residual level was above WHO and the USEPA MRLs in Baby food A and above USEPA MRLs standard in Baby food B. Fludioxonil is a non-systemic fungicide used for crops treatment crops (particularly cereals, fruits and vegetables and ornamental plants; often in combination with another fungicide such as cyprodinil (30). Children suffer from acute hemolytic anemia (premature destruction of red blood cells) after exposure to fludioxonil (58).

Lindane was detected in both Baby food C and E at concentration of 0.0002µg/g, which was above the MRLs for WHO at concentration of 0.0001µg/g (Table 2). Lindane is an organochlorine chemical variant of hexachlorocyclohexane that has been used both as an agricultural insecticide and a pharmaceutical treatment for lice and scabies (40). In children, lindane affects the nervous system, liver and kidneys and may well be a carcinogen, producing range symptoms from headache and dizziness to seizures, convulsions and more rarely, death.

Daminozide was detected in Baby food E at concentration of 0.0001µg/g, which is above the MRLs for WHO and USEPA at joint concentration of 0.00001µg/g. Daminozide is a plant growth regulator, a chemical sprayed on fruit to regulate their growth and make their harvest easier (51). Daminozide remains classified as a probable human carcinogen by the EPA (62). Daminozide act on the central nervous system of children (47).

Methyl paraoxon was detected in Baby food B at concentration of 0.0001µg/g, which was above the MRLs concentration for WHO and USEPA at 0.00002µg/g and 0.00001µg/g respectively (Table 2). Methyl paraoxon is an organophosphorus insecticide known for many years to be inhibition of the critical enzyme acetylcholinesterase, with the resulting excess acetylcholine accumulation leading to symptoms of cholinergic excess (54). Methyl paraoxon was found to cause muscular weakness, numbness, and convulsions in children exposed immediately after birth (66).

DDD, p, p1 was detected in Baby food A at 0.0002µg/g, which was above the MRLs for WHO and USEPA at concentrations of 0.0001µg/g and 0.0000002µg/g respectively (Table 2). DDD, p, p1 is an organochlorine compound and have been found to affect the developing nervous system of children (37).

Table 2. The comparison between the pesticide residual concentrations in FOOD SAMPLES relative to USEPA and WHO MRLs

Pesticides	Commodities	Pesticide level (µg/g)	WHO MRLs (µg/g)	U.S. EPA MRLs (µg/g)
Carbendazim	Baby food A	0.0001	0.0001 and 0.0007	0.0002
Permethrin total	Baby food A	0.0002	0.002	0.001
Piperonyl butoxil	Baby food A	**0.0003***	0.0001	0.0002
	Baby food B	**0.0003***		
	Baby food D	**0.0002***		
DDD,p,p	Baby food A	**0.0002***	0.0001	0.000002
Malathion	Baby food A	**0.0004***	0.002	0.001
	Baby food B	**0.0003***		
	Baby food D	**0.0003***		
Resmethrin	Baby food A	**0.0002***	0.00005	0.00006
Allethrin	Baby food A	**0.0004***	0.00002	0.00002
	Baby food B	**0.0004***		
Fludioxonil	Baby food A	**0.0002***	0.0001	0.00005
	Baby food B	0.0001		
Endosulfan sulphate	Baby food A	**0.0002***	0.0002	0.01
	Baby food B	**0.0001***		
Methyl paraoxon	Baby food B	**0.0001***	0.00002	0.00001
DDE, p,p	Baby food B	**0.0002***	0.02	0.02
	Baby food D	**0.0001***		
Methoprene	Baby food B	**0.0001***	0.01	0.001
Chlordane	Baby food C	**0.0001***	0.02	0.0002
	Baby food E	**0.0002***		
		0.0001*		
		0.0001*		
Acephate	Baby food C	**0.0001***	0.0002	0.00002
Lindane	Baby food C	**0.0002***	0.0001	0.05
	Baby food E	**0.0002***		
Aldicarb	Baby food C	**0.0002***	0.0005	0.00005
	Baby food E	**0.0003***		
Endosulfan	Baby food C	**0.0004***	0.0006	0.000006
	Baby food E	**0.0003***		
Dichlorvos	Baby food C	**0.0001***	0.0001	0.00001
Daminozide	Baby food C	**0.0002***	0.00001	0.00001
	Baby food E	**0.0002***		
Formothion	Baby food C	**0.0002***	0.006	0.0001
	Baby food E	**0.0001***		
Chlorpyrifos	Baby food C	**0.0002***	0.00002	0.0002

Endrin	Baby food C	0.0001	0.0001	0.0001
Fluridone	Baby food D	**0.0002***	0.00001	0.00005
Chlorpyrifos methyl	Baby food D	**0.0002***	0.0001	0.0003
Carbofuran	Baby food D	**0.0003***	0.0005	0.0001
Cyfluthrin	Baby food D	**0.0001***	0.00001	0.00002

* are used to indicate pesticides with concentration above either the WHO and/ USEPA MRLs.

Pesticide residues in baby foods and unknown patterns of interactions.

Another issue of concerns about pesticide residues in food is the impacts of multiple occurrences of several pesticides in a single food. As seen in all these baby food samples, even when some of the pesticide residues are within the acceptable limit, there are still the various possible interactive patterns between these pesticide residues. The final pattern of the interaction which are still unknown in the current studies, but which could be additive, synergy, antagonistic and possibly potentiating will have serious implications on health of the baby. All these interactive patterns still needs further studies

4.2 Conclusion

Synthetic pesticides have been widely used in industrial agriculture throughout the world since the 1950s. These pesticides have become extremely pervasive in our environment as a result of their widespread due to their repeated use. The health implication of many of these pesticides on human health, particularly on children's health is a serious challenge. The occurrence of many of these pesticides in baby food at concentration above the WHO/USEPA standards in this current study is a serious concern. Since the children have decreased capability to detoxify chemical substances, this could lead to changes in children's cognitive behavior and motor performances as well as endocrine and immune development, as their renal function and hepatic xenobiotic metabolism are not fully developed relative to the adults. Therefore, the occurrence of these pesticides (including: resmethrin, chlorpyrifos, allethrins, piperonyl butoxil, cyfluthrin, dichlorvos, chlorpyrifos methyl, fluridone, fludioxonil, lindane, daminozide, methyl paraoxon, DDE, p, p), particularly above the International standard could seriously impair the children's health, particularly at developmental phase. The health impact of these pesticides on the children must be taken importantly, since the impacts could be irreversible.

4.3 Recommendations

- Parents should reduce children's exposure to pesticides in food, by adopting organically grown foods whenever it is possible. Organic foods are those that have been grown and processed without the use of synthetic pesticides or fertilizers.
- There must be regular check on the level of pesticide residues in all imported baby foods and milk by the government.
- Farmers must be constantly trained and updated about the use and safety of the pesticides.
- Government should identify the sources and origin of the various imported foods and the standardized entry requirements for the importation of foods

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AUTHORS' CONTRIBUTIONS

Dr Babalola did experimental design and editorial work.
Ajoke did the laboratory table work and field sampling. The manuscript was jointly written by both authors.

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