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Carcinogenic Pesticide Residues Crossing the Minimum Residual Limit (MRL) Present in Food Commodities and Its Public Health Impact in Tamilnadu, India - An Exploratory Analysis

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Abstract: *AIM: The aim of the study is to analyse the levels of carcinogenic pesticide residue in daily use Food Commodities in Tamilnadu and their harmful health effects. MATERIALS AND METHODS: A total of 25 samples to be collected in Tamil Nadu, India using multistage cluster random sampling technique. Sampling Technique used were Multistage Cluster Random Sampling Technique. RESULTS: Among Cereals, the carcinogenic pesticides in RICE which is collected from dindugal district are Cypermethrin from Pyrethoid (0.016 mg/kg). MASOOR DAL collected from Dindugal district contains two Organochlorine, one organophosphate, pyrethoid, and Thiazide which are carcinogenic pesticide, exceeds the permissible limit. Most cereals, Pulses and spices contains Organochlorine, Organophosphates and Pyrethoids with high exceeding values. CONCLUSION: Overuse of pesticides leads to the buildup of pesticide residues in food products, which are linked to a number of risks to human health. To prevent these cancers, strict preventive measures like consuming organic fruits and vegetables, by usage of biopesticides should be implemented. The national regulatory bodies may use our study as justification to ensure that pesticide residue levels on vegetables are within permissible bounds for safe consumption and that worker exposure is minimized. To address the problems associated with pesticide use that is not safe, India needs a new pesticides management law.*

Key Words: *Carcinogenic pesticide, Cereals, Pulses, Nuts, Spices, pesticide residues, carcinogenicity, maximum residual limit (MRL), Food Safety and Standards Authority of India (FSSAI).*

1. INTRODUCTION:

Pesticides are compounds used to kill pests such as insects, rodents, fungi, and undesirable plants (weeds). Pesticides are primarily used to protect crops, preserve food materials, and prevent vector-borne diseases.[1] Likewise, pesticides are utilized in the diverse fields consisting of agriculture, forestry, aquaculture, meals industry, processing, transportation and garage of timber and different organic products. [2] Massive use of pesticides damages public health and ecosystems. Pesticides have extraordinary distribution and residue styles withinside the surroundings through air, soil and water.[3]

Pesticides not only pollute water, soil and air, they also accumulate on crops. Pesticides are mainly carried by rain and wind from the point of application to neighbouring crops and areas.[4] The amount of pesticide used in a particular area is highly dependent on the intensity of pesticide application and the crop species grown there.

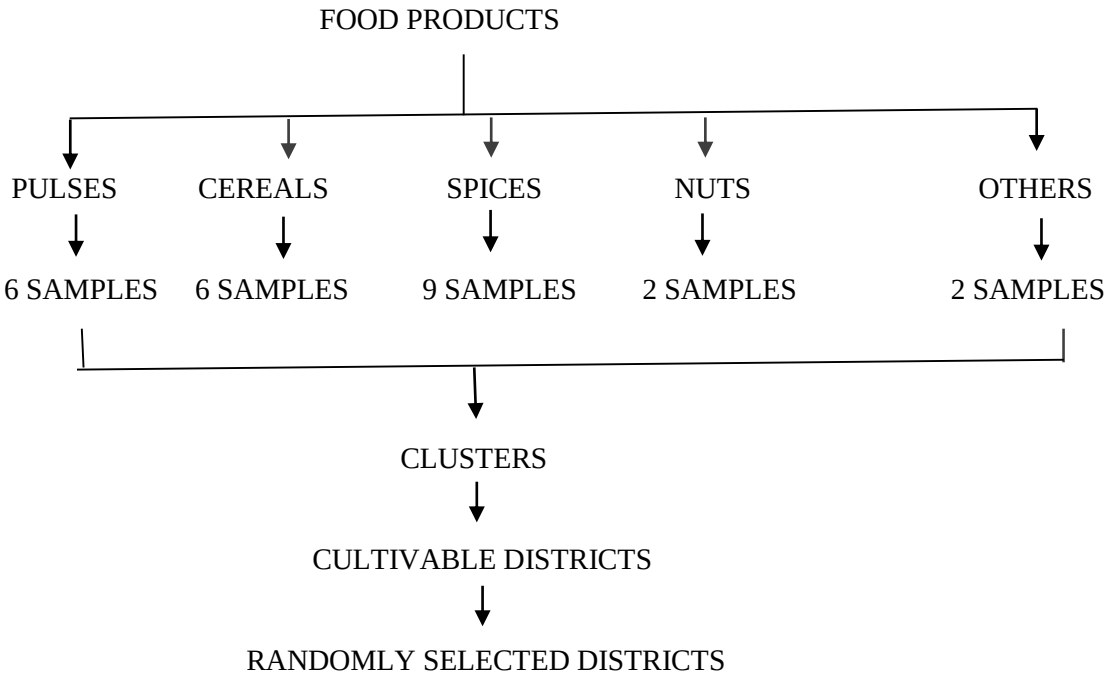
Chemical pesticides are broadly classified into four types depending on their sources: carbamate, organophosphate, organochlorine, and pyrethroid pesticides. [5]. Major portion of pesticide usage in confined to fruits and vegetables than other crops which are used for human consumption. Pesticide residue leads to major health problems in humans like acute poisoning, neurotoxicity, respiratory disorders, skin irritation, etc. [6] One such important human

health risk is carcinogenicity of pesticides. The link between pesticides and cancer has been a concern for long period. Agriculture, on the other hand, is traditionally associated with the use of pesticides. The World Health Organization (WHO) estimates that cancer will be the leading cause of death worldwide in 2020, taking the lives of approximately 10 million people. [7] In India deaths due to Cancer was 9% of the total population. [8] Given the many drawbacks associated with the use of non-scientific pesticides in agriculture, there is an urgent need to minimize the use of chemical pesticides in pest control. This study analyses the levels of carcinogenic pesticide residue in daily use Food Commodities in Tamilnadu and their harmful health effects. It is done to create awareness on toxicity of chemical pesticides and set futuristic goals to start a new law to prevent the pesticide residual contamination in Tamilnadu for a healthy future generation.

2. MATERIALS AND METHODS:

A total of 25 samples to be collected in Tamil Nadu, India using multistage cluster random sampling technique.

SAMPLING TECHNIQUE: Multistage Cluster Random Sampling Technique



LABORATORY INTERVENTION

The modified QuEChERS method, as proposed by Anastassiades *et al*. (2003) [9], was used for sample preparation and pesticide extraction. According to this method, 10 g of ground composite sample was mixed with 10 mL of acetonitrile (ACN) in a 50 ml Teflon centrifuge tube and shaken well manually and then homogenized in a vortex shaker. 5 ml of water and 4 g anhydrous magnesium sulphate (MgSO4) with 1 g sodium chloride (NaCl) were added to the mixture and shaken vigorously for 1 minute. The mixture was again homogenized in a vortex shaker for 1 min and centrifuged for 5 min at 3000 rpm. 5 ml supernatant was transferred to 15 ml Teflon centrifuge tube, which contained the mixture of 750 mg anhydrous MgSO4, 125 mg primary secondary amine (PSA) and C18 sorbent. The mixture was shaken manually, then homogenized in a vortex shaker for 1 min and centrifuged at 3000 rpm for 5 min. A fraction of 2 ml of the extracted sample in glass tubes was evaporated in Turbo Vapevaporator at 30 °C using nitrogen gas of 10 psi pressure. The residues were reconstituted using n-hexane for GC MS/MS analysis.

SAMPLE TYPE	SAMPLE WEIGHT	WATER ADDED
Cereals	5g	10g
Dried Fruits	5g	7.5g
Spices	2g	10g

TABLE 1: LIST OF PULSES AND THEIR RESPECTIVE COLLECTION DISTRICT

S.No	PULSES	DISTRICTS
1.	MOONG DAL	Dindugal

2.	TOOR DAL	Salem
3.	MASOOR DAL	Dindugal
4.	CHICKPEA	Dindugal
5.	BLACK GRAM	Dindugal
6.	SOYA BEAN	Coimbatore

TABLE 2: LIST OF CEREALS AND THEIR RESPECTIVE COLLECTION DISTRICT

S. No	CEREALS	DISTRICTS
1.	Rice	Dindugal
2.	Wheat	Dindugal
3.	Maize	Salem
4.	Ragi	Salem
5.	Samai	Dindugal
6.	Varagu	Salem

TABLE 3: LIST OF SPICES AND THEIR RESPECTIVE COLLECTION DISTRICT

S. No	SPICES	DISTRICTS
1.	Turmeric	Salem
2.	Cardamon	Theni
3.	Coriander Seeds	Coimbatore
4.	Tamarind	Dindugal
5.	Clove	Kanyakumari
6.	Cinamon	Coimbatore
7.	Black Pepper	Kanyakumari
8.	Garlic	Dindugal
9.	Ginger	Kanyakumari

TABLE 4: LIST OF NUTS AND THEIR RESPECTIVE COLLECTION DISTRICT

S.No	NUTS	DISTRICTS
1.	Groundnut	Salem
2.	Cashewnut	Theni

TABLE 5: LIST OF OTHER FOOD COMMODITIES AND THEIR RESPECTIVE COLLECTION DISTRICT

S.No	OTHERS	DISTRICTS
1.	Coffee	Dindugal
2.	Tea	Dindugal

3. RESULT:

Carcinogenic pesticide reported in pulses:

Among Spices MOONG DAL collected from Dindugal district contains carcinogenic pesticides Phosfomidon (0.022mg/kg), Profenophos (0.013mg/kg) and Chlorpyrifos (0.012mg/kg) which are in Organophosphate group exceeds the permissible limit. TOOR DAL collected from Salem district contains two carcinogenic pesticide which are Cypermethrin (0.014mg/kg) and Carbaryl (0.14mg/kg) and they exceed the normal permissible limit. MASOOR DAL collected from Dindugal district contains two Organochlorine, one organophosphate, pyrethoid, and Thiazide which are carcinogenic pesticide, exceeds the permissible limit. CHICKPEA collected from Dindugal district contains Endosulfan (0.018mg/kg) from Organochlorine, Diazinon (0.032mg/kg) from Organophosphate, Acitamipid(0.7mg/kg) from Neonicotinoides, Quinolphos(0.034mg/kg) from Organothiophosphate. BLACK GRAM collected from Dindugal district contains Deltamethrin (0.015mg/kg) from Pyrethroid group, Acephate (0.11mg/kg) from Organophosphate group, Buprofezin (0.031mg/kg) from Thiazide group exceeds the normal permissible limit. The carcinogenic pesticides reported in SOYA BEAN which is collected from Coimbatore are Deltamethrin (0.013mg/kg) from Pyrethoid.

Carbaryl from Carbamate group Classified under IARC class 2B causes Kidney & Liver Cancer. Endosulfan from Organochlorine group classified under IARC class 2A causes liver tumor. Diazinon from Organophosphate group Classified under IARC class 2A causes Lung Cancer.

Carcinogenic pesticide reported in cereals:

Among Cereals, the carcinogenic pesticides in RICE which is collected from dindugal district are Cypermethrin from Pyrethoid (0.016 mg/kg) and Chlorantraniphole from Ryanoid (0.054 mg/kg). In WHEAT collected from Dindugal district, the carcinogenic pesticides present are Hepatochlor from Organochlorine (0.011 mg/kg), Bifenthrin from Pyrethoid (0.041 mg/kg) group classified under US-EPA Group C causes Bladder Tumor, Liver Tumor

and Lung cancer. The carcinogenic pesticides present in Maize which are collected from Salem district are Hepatochlor from Organochlorine (0.021mg/kg), Acetamiprid from Neomicotinoids (0.18mg/kg) and Primiphos from Organophosphate (0.19 mg/kg). The carcinogenic pesticide presents in Ragi which is collected from Salem is Dicofol from Organochlorine (0.024 mg/kg).

Carcinogenic pesticide reported in Spices:

The Carcinogenic pesticide present in TURMERIC is Propargite which is in Acaricide group (0.015 mg/kg). In CARDAMON Endosulfan from Organochlorine group (0.24 mg/kg) exceeds the permissible limit. In Clove there is a presence of Cypermethrin from Pyrethoid group (0.014 mg/kg) which is carcinogenic. In CINAMON, Phorate from Organophosphate group exceeds the permissible limit (0.022mg/kg). The carcinogenic pesticide in Garlic is Dicofol (0.014 mg/kg) which is in Organochlorine group. In Ginger the carcinogenic pesticides are Chlordane (0.22 mg/kg) from Organochlorine and Cypermethrin (0.17 mg/kg) from Pyrethoids.

Endosulfan and Chlordane from Organochlorine group classified under IARC 2A and 2B respectively causes Liver tumor. Dicofol which is in organochlorine group classified under US-EPA group C cause Liver Adenoma. Cypermethrin from Pyrethoid group classified under IARC Group 2B causes lung cancer. Chlorphyriphos which is in Organophosphate causes rectal and lung cancer.

Carcinogenic pesticide reported in Nuts:

The carcinogenic pesticide in Groundnut is Malathion (0.013 mg/kg) which is in Organophosphate group classified under IARC Class 2A cause Non-Hodgkins Lymphoma. In Cashewnut there is a presence of Propargite (0.11mg/kg) from Acaricoid group classified under US-EPA Group C causes Intestinal cancer. Other pesticides which exceed the permissible limit in Groundnut is Acephate (0.054 mg/kg) from Organophophate group. In Cashewnut there is a presence of Diafenthiuron(0.24 mg/kg) from Aromatic Ether.

TABLE 6: PESTICIDES RESIDUES IN PULSES:

S.No	PULSES	Pesticides	Type	IARC Class	MRL Value	Present Value (mg/Kg)	Carginogenicity
1.	MOONG DAL	Carbaryl	Carbamates	2B	0.01	0.013	Kidney & Liver Cancer
		Profenophos	Organophosphate	3	0.01	0.012	Irritation to skin, eyes
		Phosfomidon	Organophosphate	3	0.01	0.022	Genotoxicity
		Chlorpyrifos	Organophosphate	NC	0.01	0.013	Rectal, Lung cancer
2.	TOOR DAL	Cypermethrin	Pyrethoids	2B	0.01	0.014	Lung Tumor
		Acetamiprid	Neonicotinoids	3	0.07	0.18	
		Carbaryl	Carbomates	2B	0.07	0.14	
		Thiamethroxam	Neonicotinoid	NC	0.01	0.019	
3.	MASOOR DAL	Chlordane	Organochlorine	2B	0.05	0.14	Liver Cancer
		Heptochlor	Organochlorine	2B	0.01	0.012	Thyroid, Pitiutary cancer
		Deltamethrin	Pyrethroid	3	0.05	0.10	
		Monochrotopos	Organophosphate	NC	0.01	0.032	
		Buprofezin	Thiazide	NC	0.01	0.013	Genotoxicity
4.	CHICKPEA	Endosulfan	Organochlorine	2A	0.01	0.018	Liver Tumor
		Diazinon	Organophosphate	2A	0.01	0.032	Lung Cancer
		Acitamipid	Neonicotinoides	3	0.5	0.7	Non-Hodgkin Lymphoma
		Quinolphos	Organothiophosphate	NC	0.02	0.034	Respiratory Failure
5.	BLACK GRAM	Acephate	Organophosphate	NC	0.05	0.11	Nervous System Disorder
		Deltamethrin	Pyrethoid	3	0.01	0.015	Damage to CNS, Respiratory irritation
		Buprofezin	Thiazide	NC	0.01	0.031	Burning Sensation in epigastric region
6.	SOYA BEAN	Deltamethrin	Pyrethoid	3	0.01	0.013	Damage to CNS, Respiratory irritation
		Monochrotopos	Organophosphate	NC	0.01	0.032	
		Thiamethroxam	Neonicotinoid	NC	0.01	0.019	

TABLE 7: PESTICIDES RESIDUES IN CEREALS

S. No	CEREALS	Pesticides	Type	IARC Class	MRL Value	Present Value (mg/Kg)	Carginogenicity
1.	RICE	Chlorantraniphole	Ryanoid	3	0.01	0.054	Corneal Involment
		Cypermethrin	Pyrethoid	2B	0.01	0.016	Lung Cancer
2.	WHEAT	Hepatochlor	Organochlorine	2B	0.01	0.011	Thyroid, Pituitary cancer
		Cypermethrin	Pyrethoid	2B	0.01	0.014	Lung Cancer
		Bifenthrin	Pyrethoid	Group C(US-ESPA)	0.02	0.041	Bladder Tumor, Liver Tumor, Lung cancer
		Primiphos	Organophosphate	NC	0.01	0.015	
		Carbendazin	Organophosphate	NC	0.1	0.82	
3.	MAIZE	Hepatochlor	Organochlorine	2B	0.01	0.021	Thyroid, Pituitary cancer
		Acetamiprid	Neomicotinoids	3	0.08	0.18	
		Primiphos	Organophosphate	NC	0.05	0.19	
4.	RAGI	Dicofol	Organochlorine	US-EPA Group C	0.01	0.024	Liver Adenoma
		Etrimphos	Acaricide	NC	0.01	0.021	

TABLE 8: PESTICIDES RESIDUES IN SPICES

S. No	SPICES	Pesticides	Type	IARC Class	MRL Value	Present Value (mg/Kg)	Carginogenicity
1.	TURMERIC	Propargite	Acaricide	Group C	0.01	0.015	
		Acetamiprid	Neomicotinoids	3	0.08	0.18	
		Carbaryl	Carbomates	NC	0.01	0.014	
		Deltamethrin	Pyrethoid	NC	0.05	0.11	
2.	CARDAMON	Endosulfan	Organochlorine	2A	0.1	0.24	Liver Tumor
		Chloranthaniphole	Ryanoid	3	0.01	0.022	Corneal Involment
		Quinolphos	Organothiophosphate	NC	0.01	0.015	Respiratory failure
3.	CORIANDER SEEDS	Hepatochlor	Organochlorine	NC	0.01	0.011	
		Primiphos methyl	Organothiophosphate	NC	0.03	0.054	
4.	TAMARIND	Heptochlor	Organochlorine	NC	0.01	0.022	
		Chlorphyriphos	Organophosphate	NC	0.01	0.015	Rectal, Lung cancer
		Acetamiprid	Neonicotinoide	3	0.02	0.031	
		Carbaryl	Carbamates	NC	0.01	0.014	

5.	CLOVE	Cypermethrin	Pyrethoid	2B	0.01	0.014	Lung Cancer
		Chlorphyriphos	Organophosphate	NC	0.01	0.012	Rectal, Lung cancer
6.	CINAMON	Endrin	Organochlorine	3	0.12	0.24	
		Phorate	Organophosphate	US EPA-B4	0.01	0.022	
7.	BLACK PEPPER	Deltamethrin	Pyrethoid	3	0.01	0.013	Damage to CNS, Respiratory irritation
		Primiphos	Organophosphate	NC	0.15	0.20	
		Monochrotophos	Organophosphate	NC	0.01	0.011	
8.	GARLIC	Dicofol	Organochlorine	US-EPA Group C	0.01	0.014	Liver Adenoma
		Monochrotophos	Organophosphate	NC	0.01	0.011	
9.	GINGER	Chlordane	Organochlorine	2B	0.1	0.22	Liver Cancer
		Cypermethrin	Pyrethoids	2B	0.05	0.17	Lung Tumor
		Deltamethrin	Pyrethoid	3	0.07	0.84	Damage to CNS, Respiratory irritation
		Buprofezin	Thiazide	NC	0.1	0.15	Genotoxicity

TABLE 9: PESTICIDES RESIDUES IN NUTS

S.No	**NUTS**	Pesticides	Type	IARC Class	MRL Value	Present Value (mg/Kg)	Carginogenicity
1.	GROUNDNUT	Malathion	Organophosphate	2A	0.01	0.013	Non-Hodgkins lymphoma
		Carbaryl	Carbamates	3	0.01	0.018	
		Acephate	Organophosphate	NC	0.023	0.054	
2.	CASHEWNUT	Propargite	Acaricoids	Group C(US-EPA)	0.07	0.11	Intestinal Cancer
		Endrin	Organochlorine	3	0.01	0.015	
		Etrimphos	Acaricide	NC	0.01	0.021	
		Diafenthiuron	Aromatic Ether	NC	0.05	0.24	

TABLE 10: CARCINOGENIC PESTICIDE RESIDUES WITH EXCEEDING PERMISSIBLE LIMITS:

S.No			Pesticides	Type	IARC Class	MRL Value	Present Value (mg/Kg)	Carginogenicity
1.	**PULSES**	MOONG DAL	Carbaryl	Carbamates	2B	0.01	0.013	Kidney & Liver Cancer
		TOOR DAL	Cypermethrin	Pyrethoids	2B	0.01	0.014	Lung Tumor
		MASOOR DAL	Chlordane	Organochlorine	2B	0.05	0.14	Liver Cancer
		CHICKPEA	Diazinon	Organophosphate	2A	0.01	0.032	Lung Cancer
2.	**CEREALS**	RICE	Cypermethrin	Pyrethoid	2B	0.01	0.016	Lung Cancer

		WHEAT	Cypermethrin	Pyrethoid	2B	0.01	0.014	Lung Cancer
		MAIZE	Hepatochlor	Organochlorine	2B	0.01	0.021	Thyroid, Pituitary cancer
		RAGI	Dicofol	Organochlorine	US-EPA Group C	0.01	0.024	Liver Adenoma
3.	**SPICES**	TURMERIC	Propargite	Acaricide	Group C	0.01	0.015	
		CARDAMON	Endosulfan	Organochlorine	2A	0.1	0.24	Liver Tumor
		CLOVE	Cypermethrin	Pyrethoid	2B	0.01	0.014	Lung Cancer
		CINAMON	Phorate	Organophosphate	US EPA-B4	0.01	0.022	
		GARLIC	Dicofol	Organochlorine	US-EPA Group C	0.01	0.014	Liver Adenoma
		GINGER	Chlordane	Organochlorine	2B	0.1	0.22	Liver Cancer
4.	Nuts	GROUNDNUT	Malathion	Organophosphate	2A	0.01	0.013	Non-Hodgkins lymphoma
		CASHEWNUT	Propargite	Acaricoids	Group C(US-EPA)	0.07	0.11	Intestinal Cancer

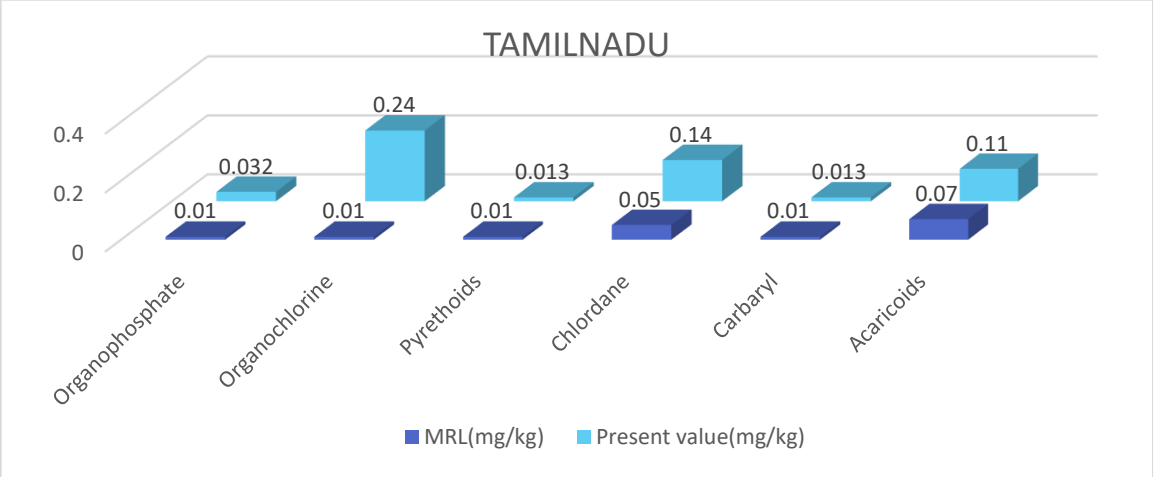


Figure 1 represents graphical representation of pesticide samples in Tamilnadu compared with normal limit of WHO standards.

4. DISCUSSION:

The presence of aldrin, dichlorane, dieldrin, endrin, endosulfan, heptachlor epoxide, dichlorodiphenyl-trichloroethane, lindane, methoxychlor, and mirex was found in a study of organochlorine pesticide residues in grain in Nigeria [10]. While, in present study Organophosphate, Organochlorine, pyrethoids, Chlordane, Carbaryl and Acaricoids were found to be the major source of components in carcinogenic pesticide.

A study in Poland found that 34% of 380 grain samples contained pesticide residues. Their study found that mixed grains (less than 10%) and avena grains (less than 15%) had the lowest levels of pesticide residues among the grains studied, while wheat and corn grains had the highest levels of pesticide residues (which is over 50%).[11] On the other hand Coriander seeds and Tamarind had the lowest level of pesticides, whilst rice, wheat and maize had the highest levels of pesticides in the present study.

Kumar (2012) reported the 2,4-D and isoproturan can decrease carbohydrate accumulation in wheat [12] . To prevent insect infestation, degradative pesticides such as carbamates, organophosphates, synthetic pyrethroids, and

insect growth regulators are applied to grain both before and during storage [13]. Similarly, the present study reveals that the presence of pesticides like Pyrethoids and organochlorine in Wheat are the indication for Lung and Liver cancer.

A study of pesticide residues in grains conducted in Pakistan found that wheat contained the highest concentrations of the tested pesticides than corn and rice, and corn had much higher concentrations than rice [14]. One study found that wheat was the crop with the highest pesticide residues, dominated by methomyl, metalaxyl and imidacloprid. Because methomyl is highly toxic to humans, its use as an insecticide is restricted. Boscalid, chlorpyrifos, cyprodinil, fenhexamide, imidacloprid, metalaxyl, and tebuconazole were among the other pesticide residues discovered in wheat samples [15]. In contrast ginger and cardamon had the highest concentration of pesticide value than rice. The accumulation of pesticide residues depends not only on food but also on the physicochemical properties of pesticide molecules [16].

Many foods contain multiple residues per product, with up to nine residues detected in tea. Imazalil, thiabendazole, chlorpyrifos, maneb group, procymidone, methidathion, lambda-cyhalothrin, carbendazim, iprodione, orthophenylphenol, vinclozolin, endosulfan, pyrimethanil, fenhexamid, prochloraz, cyprodinil, and boscalid were the pesticide residues that were most frequently found. Bell peppers had one of the highest percentages of samples containing residues above the maximum levels detected by the Brazilian Pesticide Residue Monitoring Program. While in present study Pyrethoid is the only carcinogenic pesticide present with higher concentration than MRL value in black pepper.

A study of pesticide residues in cereals in Pakistan found that wheat contained the highest levels of tested pesticides (HCH, BHC, DDT and dieldrin) than corn and rice. Corn contained much higher concentrations of pesticides than rice. Our study showed that Maize contains highest concentration than Wheat.

According to Zia et al. (2009) [17] Samples of pulses, particularly Gram and Mung Dal, were found to be contaminated with multiple pesticides, with a high concentration of HCH. The highest concentration of methyl parathion residues was detected on Masoor, with Mash and Mung following closely behind. In present study Chlordane were found maximum on Masoor Dal.

In addition, cereal grains are always sprayed with insecticides before being stored in large silos for up to a year at room temperature in order to minimize losses. More lipophilic pesticide residues tend to stay on the seed coat, though some can migrate to areas where bran and germ have high triglyceride concentrations. There were more pesticide residues in the bran than in the flour for those that could enter the grain through translocation [19]. Cypermethrin concentrations in pulses were highest on seed coats.[20]

Food safety is an increasing challenge around the world as the population grows and the need to produce food to feed a growing population. Pesticide use increases agricultural production, but pesticide residues above the MRL adversely affect human and animal health. Food safety is seriously threatened by pesticide residues found in high concentrations in fresh crops. In addition, the use of pesticides in horticultural crops pollutes the environment and is teratogenic and carcinogenic to humans, leaving deadly degradation products in food that cause immunosuppressive effects. Evidence of larger pesticide residues may be found.

The revision of Maximum Residue Levels (MRLs) for pesticides used in tea and other crops and commodities was one of the draft FSS (Contaminants, Toxins and Residues) Amendment Regulations, 2020 that the FSSAI notified the public about. The FSSAI has received requests and, based on their data, has determined that the maximum residual amounts (MRLs) of five widely used pesticides—emamectin benzoate, fenpyroximate, hexaconazole, propiconazole, and quinalphos—have been increased, even though these regulations are still being reviewed.[21]

Acephate exposes fetuses to pesticides that disrupt the hormones in agriculture. Acetamiprid and liver cancer are related. The liver cancer group's blood samples showed acetamiprid to be present. After exposure, carbendazim may increase the risk of developing cancer. Chlorpyrifos (organophosphate) causes Colorectal cancer, Prostate cancer, Breast, Lung and Kidney cancer. Perchlorin use has been connected to the development of multiple myeloma. Cypermethrin and the BG-1 ovarian cancer cell are related. Cypermethrin increased the expression of cyclin D1 and stimulated the growth of the BG-1 ovarian cancer cell line.[22]

Research on cancer examines the dangers of consuming particular products that contain pesticide residues. The levels of pesticide residues containing organochlorines were found to be considerably higher in cancer patients.[23] In addition the present study states that Cypermethrin, the carcinogenic pesticide which involves in Lung cancer is present in majority of the food commodities.

Almost 122 and above biochemical pesticides registered with the Environmental Protection Agency (EPA) which include 18 floral attractants, 20 plant growth regulators, 6 insect growth regulators, 19 repellants, and 36 pheromones. Use of Natural pesticides alternatively to Chemical pesticides could enhance reduction in pesticide residual hazardous health effects.[24]

There are 28 pesticides and four pesticides formulations banned for manufacture, import and use. Two pesticides are prohibited from use but are still produced for export. Among them, an order from the Indian Supreme Court in 2011 prohibited the manufacture, distribution, and use of endosulfan throughout the country. Even after five years, endosulfan is still not on India's list of prohibited pesticides. Nevertheless, endosulfan is on the list of pesticides that are registered (as of March 31, 2016). The present study also proves the presence of Endosulfan residues in food commodities which is beyond MRL value.

In India, sulfur, endosulfan, mancozeb, phosphate, methylparathion, monocrotophos, cypermethrin, isoproturon, chlorpyrifos, malathion, carbendazim, butachlor, Quinarphos, copper oxychloride, and dichlorvos are the most often used pesticides on fruits, vegetables, and grains. The maximum residue level, in the event that the pesticide was not applied correctly, is the highest amount of residue that can be legally present in or on food or feed.
Maximum Residue Limits are established. Although international organizations like the European Union, the North American Free Trade Agreement, and the Codex Alimentarius Commission have made an effort to harmonize pesticide laws, there are still differences in these restrictions across national borders. In India, the maximum levels of pesticide residues in crops were regulated by Indian Food Safety and Standards Authority [25]. Bioresmethrin, bromophos, carbaryl, chlorpyrifos-methyl, deltamethrin, dichlorvos, etrimphos, fenitrothion, fenvalerate, malathion, methacrifos, permethrin, phenothrin, pirimiphos-methyl, and pyrethin are among the pesticides used to protect cereals that are listed by the Food and Agriculture Organization and the World Health Organization [26].

Unauthorized pesticide use the practice of applying a specific pesticide to a crop for which it is prohibited remains a major issue in the nation. Despite their extensive knowledge of land use and crop management, farmers are ignorant of pesticides. In India, there are roughly 10,000 cases of pesticide poisoning that are reported annually. The nation's unsafe use of pesticides is entirely the responsibility of the state agricultural departments and the ministry of agriculture. If we can quickly close some of the critical gaps in regulations and strengthen enforcement, pesticide-related deaths and illnesses can be prevented.

For the food trade and consumer safety, pesticide residues in food are a serious concern. The Maximum Residue Limit (MRL) of pesticides on Raw Agricultural Commodities (RAC) is set by many developed and developing nations according to their own Good Agricultural Practices (GAP) and food consumption patterns.

The Food Safety and Standard Authority of India (FSSAI) under Ministry of Health and Family Welfare evaluates the supervised trial residue data based on the approved GAP, for fixation of MRL, keeping in view the dietary exposure and risk assessment only after approval of the same pesticide by the Registration Committee (RC). It is also important to note that the Central Insecticides Board (CIBRC) Registration Committee only tests the pesticides' active ingredients when determining their safety.[27] The effects of contaminants, metabolites, inert ingredients, transformation byproducts, and synergistic effects are all disregarded. As a result, their findings significantly underestimate the toxicity of their goods. In order to improve the current MRL fixation system in India, it became necessary to critically examine every step involved in the process, including the planning of field trials, sampling, sample analysis, data interpretation, and risk assessment.

All pesticides and their applications are examined closely by the CIB, and some are not even allowed to be registered. Sometimes a pesticide can be banned even after registration when it causes serious environmental and public health concerns. Some pesticides are meant for “Restricted Use” which means that they can be used only for prescribed purposes and by authorised personnel by obtaining the appropriate Government license. [28] Still, some of the pesticides are reported in our study. They are **DDT (banned in 2004), Dichlorvos (banned in 2020), Cypermethrin (banned in 2009), Phorate (banned in 2018), Hepatochlor (banned in 2020)**, respectively. [29] Strong regulations and supervision should be compiled by FSSAI and state- appointed inspectors. They have the authority to test food products for adherence of MRL If food safety inspectors discover that the products are not in compliance, they can impose penalties on the processor, trader, or retailer.[30] Imported food products must adhere to the MRLs specified in the 2010 Food Safety and Standards Regulations. At the port of entry, FSSAI-nominated officials work with Customs officials. The Ministry of Agriculture uses the Plant Quarantine Office at the port as a conduit to check for the presence of banned pesticides. [31] Despite these strong regulatory and supervision methods unauthorised pesticides are still a continuing public health concern.

Pesticide drift could increase the risk of exposure and poisoning to people beyond the area of application, and contamination of the ecosystem. To avoid this, The Pesticide Management Bill 2020 (PMB2020) can declare buffer zones at least for sensitive areas like anganwadi, schools, health care facility, community gatherings, housing, etc. The power to declare pesticide-free buffer zones should be given to the state governments and local units. Provisions for reducing and mitigating risks of pesticide use are lacking in the PMB 2020. Life cycle management of pesticides, including proper collection and disposal of expired products and empty pesticide containers, has to be brought

into the PMB 2020. To achieve sustainable farming, safe food production and safe working place as well as unpolluted environment, critical amendments to the PMB2020 are needed.[32]
India must address pesticide misuse in a number of ways, but outlawing the use of Class I pesticides is the most important first step. The government's current actions are out of step with the severity and urgency of the issue, and the Verma committee's recommendations are insufficient. There is no legislation or policy that addresses pesticide poisoning in India, a nation with a higher population and extensive pesticide use. Due to gaps in poisoning surveillance and a lack of government action to prevent poisoning, this lack of prioritization results in rights violations. The government must set up a thorough pesticide poisoning surveillance system and make sure that pesticide poisoning prevention is mainstreamed into law and policy using a human rights framework in order to fully protect the rights. The proposed pesticides ban may help lower the number of pesticides poisoning cases in India. In order to address acute toxicity in farmers and chronic toxicity brought on by pesticide residues in food, it must also guarantee strict enforcement.

5. CONCLUSION:

Pesticide overuse, which leads to the buildup of pesticide residues in food products, is linked to a number of health risks for humans, such as immune system disruption, reproductive issues, allergies, hypersensitivity reactions, liver, lung, and thyroid cancers, as well as non-Hodgkins's lymphoma, intestinal cancer, and liver adenoma. To prevent these cancers, strict preventive measures like consuming organic fruits and vegetables, by usage of biopesticides should be implemented. Our study may serve as a basis for the national regulatory authorities to take proper measures to certify that pesticide residues on vegetables are within the acceptable limits for safe consumption and that the occupational exposure is reduced. Fundamental research into public perceptions of risk assessment and analysis will help facilitate widespread adoption and deployment. India needs a new pesticide control law to address issues surrounding the unsafe use of pesticides.

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