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Assessment of Pesticide Residue Levels in Beans, Maize, and Rice from Rivers State, Nigeria

***[1]Nwajideobi, I.C.O., & [1]Onye, C.C.**
[1]Ignatius Ajuru University of Education's Chemistry Department, Rumuluomeni, PMB 5047 Port Harcourt, Rivers State, Nigeria

***Corresponding author email**: comzy211@gmail.com

Abstract
Pesticide residues in grains are a significant public health concern due to their potential toxic effects. This study conducted a comparative analysis of pesticide residue concentrations in three common grains (beans, maize, and rice) sourced from markets within Port Harcourt Metropolis and farms in nearby rural areas. Using Gas Chromatography-Mass Spectrometry (GC-MS), A total of 22 pesticide residues were detected which include; aluminium phosphate, atrazine, tetra chloro iso-phthalonitrile, β-hexachloro cyclo hexane, Quintozen, Benzene (Hexa Chloro), α-Lindane, Perthane, Captan, Diazinone, Phenthoate, Malathion, Dichlorodiphenyl Dichloro Ethylene (DDE), Aldrin, Dieldrin, Dichlorodiphenyltrichloro Ethane (DDT), Ethiom, Methaxychlor, Primiphos Methyl, α-Endosulfan, Cis-Chlordane and Endosulfan Sulfate.The observed Pesticides mean concentrations for farm grains ranges From 0.04 mg/kg to 0.23 mg/kg for Beans, 0.04 mg/kg to 0.29 mg/kg for Maize,and 0.08 mg/kg to 0.37 mg/kg for Rice. The mean concentrations for creek road market grains ranged from 0.04 mg/kg to 2.77 mg/kg for Beans, 0.04 mg/kg to 0.53 mg/kg For Maize while residue in Rice ranges from 0.05 mg/kg to 0.72 mg/kg. The mean concentrations in mile one market grains ranges from 0.04 mg/kg to 0.83 mg/kg for beans, 0.05 mg/kg to 0.48 mg/kg for maize and 0.04 mg/kg to 3.65 mg/kg for rice. While the The observed Pesticides mean concentrations for oil mill market grains ranges From 0.04 mg/kg to 0.83 mg/kg for beans, 0.05 mg/kg to 0.48 mg/kg for maize and 0.04 mg/kg to 3.65 mg/kg for rice. This indicated significantly higher pesticide residue levels in market-sourced grains compared to farm-fresh samples. Comparing the detected residue levels with maximum residue limit (MRL) for standard given by WHO/FAO. The mean level for most pesticides exceeded FAO/WHO permissible limits, but market-sourced are comparably high than the farm-fresh grains. The Statistical analysis using ANOVA at 5% significant level, statically showed a degree of significant difference between the farm-sourced grains and the market grains likely due to higher variability introduced by post-harvest handling and storage practices.Analyzing contamination factors (CF) and pollution load index (PLI),Results revealed considerable contamination, particularly in rice, which exhibited the highest levels of residues, particularly for DDE (1.62 mg/kg) and Malathion (1.19 mg/kg).The contamination factor (CF) values also indicated that Quintozen and Benzene (Hexa Chloro) had the highest contamination in beans and rice with high contamination factors recorded for Quintozen (83 in Oil Mill beans) and Benzene (Hexa Chloro) (24 in Mile One beans and 60 in Oil Mill rice). The PLI values ranged from 2.32 to 4.8, indicated moderate to severe pollution across all grains with rice showing the highest pollution burden. The elevated residue levels in markets were attributed to post-harvest pesticides treatment and improper storage practices. The findings underscore the urgent need for stricter pesticide regulations, routine residue monitoring, and the promotion of sustainable agricultural practices to ensure food safety.

Keywords: Pesticide, Beans, Maize, Rice, Rivers State.

Introduction

Pesticides have become indispensable in modern agriculture due to their role in mitigating crop losses caused by pests, diseases, and weeds. They are chemical substances or biological agents designed to incapacitate, or kill organisms deemed harmful to crops (World Health Organization, 2019).Chemical substances known as pesticides can either kill pests or stop their development and reproduction. Garcia et al. (2012) state that pesticides are chemicals used to eradicate, deter, or manage specific plant or animal species that are deemed pests and cause illnesses, especially in the fields of agriculture and human health. These are chemicals that shield crops from pests like fungus and insects. Any substance that is sprayed to a crop to prevent pest damage or disease infection is referred to as a pesticide; this includes substances that are obtained both naturally and synthetically. Common classes of pesticides include insecticides, fungicides, herbicides, and rodenticides, each targeting specific agricultural challenges. It is impossible to overestimate the importance of agriculture in Nigeria in maintaining livelihoods and guaranteeing food security. Grain staples in most households, including rice, maize, and beans, are among the main agricultural items consumed nationwide. However, there are drawbacks to using chemical pesticides to eradicate pests and boost agricultural productivity. Pesticides have helped to increase crop production by controlling the pests that destroy the crops. However, some of the pesticides have adversely affected the non-target species by inducing carcinogenic, teratogenic, mutagenic, neuro-toxic effects as well as alterations of re-productive processes or functions in experimental animals and in man (Akan et al., 2014). The health of consumers is at risk due to the presence of pesticide residues in food products, even if these chemicals increase production and decrease crop loss (WHO, 2019).

The preservation, processing and storage of agricultural product are vital for the continuous supply of foods during seasons and off-seasons and to areas where they are less available, these necessity to boost food production for a fast expanding population has led to a major increase in the usage of pesticides. many farmers apply pesticides to food crops without adequate knowledge of recommended dosages or safe handling practices. This practice increases the likelihood of residue contamination in crops, including grains. their use is frequently typified by inadequate enforcement of regulations, inappropriate storage, and an excessive dependence on artificial chemicals (Adeola & Olufemi, 2020). Furthermore, grains sold in urban markets like Port Harcourt may undergo additional pesticide treatments during storage to prevent spoilage and pest infestations. This raises critical questions about the safety of these grains for consumers. The levels of pesticide residues in grains sold in Port Harcourt market metropolis may be higher than those in farm-fresh grains, these levels may exceed the permissible limits established by regulatory bodies such as the World Health Organization (WHO) and the Food and Agriculture Organization (FAO) however this study seek to mitigate its effect on human and the ecosystem. Additionally, there is limited data on residue levels in grains from Port Harcourt metropolis markets, a major commercial hub in Nigeria.The study aimed to assess the concentration level of pesticide residues in beans, maize, and rice sold in Port Harcourt markets with those sourced directly from farms. It tends to compare pesticide residue levels in beans, maize, and rice sold in Port Harcourt metropolis with those sourced directly from farms. The findings will provide valuable insights for policymakers, regulatory bodies, and consumers, contributing to improved food safety and agricultural practices.

Materials and Methods

This study focuses on Port Harcourt Metropolis, the capital of Rivers State in southern Nigeria. As a major urban center, Port Harcourt serves as a hub for trade and commerce, with numerous markets where grains such as beans, maize, and rice are sold. The metropolis is surrounded by rural areas where farming activities are prominent. Port Harcourt Metropolis has a population density estimated between 1,148,655 – 3,637,000 as off 2024 with (Latitude: 4.8472° N, and Longitude: 6.9746° E). The fresh sample maize, beans and rice were randomly collected from Oil mill market, mile one market, and creek road market while the farm maize, beans and rice were harvested in Ogoni and Etche farm land. The samples collected were separately and packed in black polyethylene bags, labeled and transported to the laboratory for further study**.** The fresh samples was thoroughly ground into powdered form using agate mortar and pestle to ease extraction. Each of the powdered samples was then packed in Ziploc bags, labeled and then stored in a refrigerator at 4^oC prior for further study. The maize sample were dried using hot air oven to remove water, it was thoroughly ground into powdered form using agate mortar and pestle to ease extraction, the samples was then packed in Ziploc bags, labeled and then stored in a refrigerator at 4^oC prior for further study. The extraction of pesticide residue followed the multi-residue pesticide analysis technique consisting of the QuEChERS (Quick, Easy, Cheap, Effective, Rugged and Safe) sample preparation method by AOAC Method 2007.01 with slight modifications for number of analytes spiking was adopted in the work. Extraction of pesticides was carried out by weighing 15g each of the samples with 10 ml of solvent system containing n-hexane and acetone in the ratio of 9:1. The mixture was shaken for 1 min on vortex mixer to ensure proper mixing of the solution. An anhydrous sodium sulfate the vial was placed in an ultrasonic bath for 2 min, and then centrifuged at 3000 RPM for 5 min for effective extraction and were stored for further GC-MS analysis.

Results

Table 1. Mean level of Pesticide residue in farm grains

S/N	Pesticide residue	Beans	Maize	Rice	MRLs
1	Aluminium Phosphate	0.16	0.13	0.16	0.1
2	Atrazine	0.23	0.05	0.14	0.2
3	Tetra Chloro Iso Phthalonitrile	0.11	0.1	0.08	0.1
4	β- Hexachloro Cyclo Hexane	0.1	0.19	0.2	0.01
5	Quintozen	0.13	0.05	0.17	0.01
6	Benzene (Hexa Chloro)	0.2	0.06	0.24	0.01
7	α- Lindane	0.12	0.19	0.19	0.01
8	Perthane	0.15	0.13	0.23	0.1
9	Captan	0.15	0.17	0.09	0.05
10	Diazinone	0.21	0.24	0.2	0.01
11	Phenthoate	0.13	0.15	0.32	0.05
12	Malathion	0.04	0.19	0.31	0.05
13	Dichlorodiphenyl Dichloro Ethylene(DDE)	0.18	0.25	0.09	0.01
14	Aldrin	0.16	0.06	0.25	0.1
15	Dieldrin	0.22	0.28	0.28	0.1
16	Dichlorodiphenyl Trichloro Ethane (DDT)	0.06	0.2	0.19	0.1
17	Ethiom	0.15	0.16	0.28	0.1
18	Methaxychlor	0.18	0.29	0.3	0.05
19	Primiphos Methyl	0.09	0.04	0.14	0.05
20	α-Endosulfan	0.04	0.18	0.15	0.1
21	Cis-Chlordane	0.08	0.13	0.37	0.02
22	Endosulfan Sulfate	0.21	0.17	0.25	0.05

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Table 2: Mean Concentration of pesticides in beans, maize and rice in Creek Road Market in Port Harcourt City

S/N	Pesticide residue	Beans	Maize	Rice	MRLs
1	Aluminium Phosphate	0.42	0.24	0.4	0.1
2	Atrazine	0.21	0.11	0.13	0.2
3	Tetra Chloro Iso Phthalonitrile	0.01	0.05	0.11	0.1
4	β- Hexachloro Cyclo Hexane	0.02	0.1	0.07	0.01
5	Quintozen	0.72	0.07	0.02	0.01
6	Benzene (Hexa Chloro)	0.18	0.08	0.05	0.01
7	α Lindane	0.07	0.19	0.21	0.01
8	Perthane	0.29	0.05	0.32	0.1
9	Captan	0.15	0.06	0.21	0.05
10	Diazinone	0.32	0.04	0.19	0.01
11	Phenthoate	0.11	0.76	0.13	0.05
12	Malathion	0.03	0.04	0.77	0.05
13	Dichlorodiphenyl Dichloro Ethylene (DDE)	0.34	0.1	0.48	0.01
14	Aldrin	0.06	0.14	2.77	0.1
15	Dieldrin	0.68	0.32	0.37	0.1
16	Dichlorodiphenyl Trichloro Ethane (DDT)	0.09	0.71	0.25	0.1
17	Ethiom	0.27	0.06	0.41	0.1
18	Methaxychlor	0.47	0.52	0.16	0.05
19	Primiphos Methyl	0.38	0.04	0.12	0.05
20	α-Endosulfan	0.04	0.1	0.22	0.1
21	Cis-Chlordane	0.08	0.04	0.53	0.02
22	Endosulfan Sulfate	0.23	0.05	0.31	0.05

Table 3 Mean Concentration of pesticides in beans, maize and rice sold in Mile one market in Port Harcourt metropolis

S/N	Pesticide residue	Beans	Maize	Rice	MRLs
1	Aluminium phosphate	0.25	0.34	0.38	0.1
2	Atrazine	0.29	0.14	0.09	0.2
3	Tetra chloro iso phthalonitrile	0.18	0.07	0.18	0.1
4	β - hexachloro cyclo hexane	0.1	0.53	0.26	0.01
5	Quintozen	0.28	0.43	0.05	0.01
6	Benzene (hexa chloro)	0.24	0.04	0.08	0.01
7	α - Lindane	0.11	0.28	0.43	0.01
8	Perthane	0.25	0.17	0.57	0.1
9	Captan	0.14	0.47	0.36	0.05
10	Diazinone	0.87	0.28	0.3	0.01
11	Phenthoate	0.33	0.08	0.16	0.05
12	Malathion	0.04	0.25	0.68	0.05
13	Dichlorodiphenyl dichloro ethylene (DDE)	2.13	0.35	0.72	0.01
14	Aldrin	2.77	0.18	0.05	0.1
15	Dieldrin	0.12	0.1	0.09	0.1
16	Dichlorodiphenyl trichloro ethane (DDT)	0.2	0.25	0.07	0.1
17	Ethiom	0.08	0.13	0.17	0.1
18	Methaxychlor	0.64	0.3	0.28	0.05
19	Primiphos methyl	0.19	0.27	0.05	0.05
20	α -Endosulfan	0.14	0.19	0.48	0.1
21	Cis-chlordane	0.06	0.28	0.31	0.02
22	Endosulfan sulfate	0.32	0.37	0.27	0.05

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Table 4: Mean Concentration of pesticides in beans, maize and rice in Oil Mill market metropolis

S/N	**Pesticides Residue**	Beans	Rice	Maize	MRLs
1	Alumnium phosphate	0.27	0.22	0.35	0.1
2	Atrazine	0.32	0.29	0.25	0.2
3	Tetra chloro iso phthalonitrile	0.09	0.09	0.04	0.1
4	β- hexachloro cyclo hexane	0.37	0.18	0.1	0.01
5	Quintozen	0.83	0.21	0.29	0.01
6	Benzene (hexa chloro)	0.29	0.22	0.6	0.01
7	α- Lindane	0.1	0.1	0.14	0.01
8	Perthane	0.25	0.27	0.07	0.1
9	Captan	0.19	0.06	0.05	0.05
10	Diazinone	0.64	0.48	0.04	0.01
11	Phenthoate	0.18	0.06	0.06	0.05
12	Malathion	0.09	0.37	2.13	0.05
13	Dichlorodiphenyl dichloro ethylene (DDE)	0.27	0.08	3.65	0.01
14	Aldrin	0.08	0.07	0.07	0.1
15	Dieldrin	0.17	0.05	0.52	0.1
16	Dichlorodiphenyl trichloro ethane (DDT)	0.27	0.26	0.21	0.1
17	Ethiom	0.04	0.25	0.13	0.1
18	Methaxychlor	0.39	0.29	0.1	0.05
19	Primiphos methyl	0.08	0.24	0.18	0.05
20	α-Endosulfan	0.17	0.18	0.08	0.1
21	Cis-chlordane	0.36	0.27	0.04	0.02
22	Endosulfan sulfate	0.28	0.23	0.13	0.05

Table 5: Contamination factor for pesticide residues in grains from farm and creek road market

		FARM			CREEK		
S/N	**PESTICIDE**	**BEANS**	**MAIZE**	**RICE**	**BEANS**	**MAIZE**	**RICE**
1.	Aluminium Phosphate	1.6	1.3	1.6	4.2	2.4	4
2.	Atrazine	1.15	0.25	0.7	1.05	0.55	0.65
3.	Tetra Chloro Iso Phthalonitrile	1.1	1	0.8	0.1	0.5	1.1
4.	β- Hexachloro Cyclohexane	10	19	20	2	10	7
5	Quintozine	13	5	17	72	7	2
6	Benzene(Hexachloro)	20	6	24	18	8	5
7	α- Lindane	12	19	19	7	19	21
8	Perthane	1.5	1.3	2.3	2.9	0.5	3.2
9	Captan	3	3.4	1.8	3	1.2	4.2
10	Diazinone	21	24	20	32	4	19
11	Phenthoate	2.6	3	6.4	2.2	15.2	2.6
12	Malathion	0.8	3.8	6.2	0.6	0.8	15.4
13.	Dichlorodiphenyldixhloro ethyleneI(DDE)	18	25	9	34	10	48
14	Aldrin	1.6	0.6	2.5	0.6	1.4	27.7
15	Dieldrin	2.2	2.8	2.8	6.8	3.2	3.7
16	Dichlorodiphenyltrichloro ethane(DDT)	0.6	2	1.9	0.9	7.1	2.5
17	Ethiom	1.5	1.6	2.8	2.7	0.6	4.1
18	Methaxychlor	3.6	5.8	6	9.4	10.4	3.2
19	Primiphosmethyl	1.8	0.8	2.8	7.6	0.8	2.4
20	α-Endosulfan	0.4	1.8	1.5	0.4	1	2.2
21	Cis-Chlordane	4	6.5	18.5	4	2	26.5
22	Endosulfan Sulfate	4.2	3.4	5	4.6	1	6.2
	PLI	**2.58**	**2.87**	**4.54**	**3.07**	**2.32**	**4.54**

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Table 6: Contamination factor for pesticide residues in grains from mile one and oil mill market

		MILE	ONE		OIL MILL		
S/N	Pesticide	Beans	Maize	Rice	Beans	Maize	Rice
1.	Aluminium Phosphate	2.5	3.4	3.8	2.7	2.2	3.5
2	Atrazine	1.45	0.7	0.45	1.6	1.45	1.25
3	Tetra Chloro Iso Phthalonitrile	1.8	3.4	1.8	0.9	0.9	0.4
4	β- Hexachloro Cyclohexane	10	53	26	37	18	10
5	Quintozine	28	43	5	83	21	29
6	Benzene (Hexachloro)	24	4	8	29	22	60
7	α- Lindane	11	28	43	10	10	14
8	Perthane	2.5	1.7	5.7	2.5	2.7	0.7
9	Captan	2.8	9.4	7.2	3.8	1.2	1
10	Diazinone	87	28	30	64	48	4
11	Phenthoate	6.6	1.6	3.2	3.6	1.2	1.2
12	Malathion	0.8	5	13.6	1.8	7.4	42.6
13	Dichlorodiphenyl dichloro Ethylene(DDE)	213	35	72	27	8	365
14	Aldrin	27.7	1.8	0.5	0.8	0.7	0.7
15	Dieldrin	1.2	1	0.9	1.7	0.5	5.2
16	Dichlorodiphenyl trichloro Ethane(DDT)	2	2.5	0.7	2.7	2.6	2.1
17	Ethiom	0.8	1.3	1.7	0.4	2.5	1.3
18	Methaxychlor	12.8	6	5.6	7.8	5.8	2
19	Primiphosmethyl	3.8	5.4	1	1.6	4.8	3.6
20	α-Endosulfan	1.4	1.9	4.8	1.7	1.8	0.8
21	Cis-Chlordane	3	14	15.5	18	13.5	2
22	Endosulfan Sulfate	6.4	7.4	5.4	5.6	4.6	2.6
	PLI	4.8	4.63	4.55	4.2	3.57	3.42

Table 7: ANOVA of pesticide residues in grains (Beans, Maize and Rice) harvested from the farm

Source of variation	SS	df	Ms	F	p value	F crit
Between group	1.3684	2	0.6842	26.9876	0.00000157	0.05
within group	0.5324	21	0.025352			
Total	1.9008					

Table 8: ANOVA of pesticide residues in grains (Beans, Maize and Rice) harvested from the creek

Source of variation	SS	df	Ms	F	p value	F crit
Between group	53.471	2	26.7355	16.41524	0.0000037	0.05
within group	34.1834	21	1.6287			
Total	87.6544					

Table 9: ANOVA of pesticide residues in grains (Beans, Maize and Rice) sold in Oil Mill market, Port Harcourt metropolis

Source of variation	**SS**	**df**	**Ms**	**f**	**p value**	**F crit**
Group between	47.4012	2	23.7006	9.451199	0.00109	0.05
within group	55.169	22	2.507682			
Total	102.5702					

Table 10: ANOVA of pesticide residues in grains (Beans, Maize and Rice) sold in Mile One market, Port Harcourt metropolis

source of variation	SS	df	Ms	f	p value	F crit
group betwee	35.6858	2	17.8429	7.672176	0.00297	0.05
within group	51.1646	22	2.325664			
Total	86.8504					

Table 11: Comparison Table: Degree of Significant Difference

Source	Farm	Creek Market	Oil Mill Market	Mile One Market
F-Statistic	26.9876	16.41524	9.451199	7.672176
p-value	0.00000157	0.0000037	0.00109	0.00297
Significance Level	Yes	Yes	Yes	Yes

Discussion

The study aimed to conduct an analysis of pesticide residue concentrations in grains (beans, maize, and rice) sold in urban markets within Port Harcourt Metropolis and those sourced directly from farms in nearby rural areas. Total of 22 pesticide residues was detected in the grains, along with their mean concentration levels (in mg/kg) and their Maximum Residue Limits (MRLs). The Tables (1 to 4) present the mean concentrations of pesticide residues in beans, maize, and rice harvested directly from farm and those from Creek Road Market, Mile One Market and Oil Mill Market. Table 1 shows the mean concentrations of pesticide residues in beans, maize, and rice harvested directly from farm ,the result indicated that some pesticides exceeded their Maximum Residue Limits (MRLs),with highest pesticide levels found in β-Hexachloro Cyclohexane (0.2 mg/kg in rice), Quintozen (0.17 mg/kg in rice),Benzene (Hexa Chloro) (0.24 mg/kg in rice),Diazinone (0.2 mg/kg in rice),DDE (Dichlorodiphenyl Dichloro Ethylene) (0.25 mg/kg in maize),Dieldrin (0.28 mg/kg in maize & rice) indicating possible contamination from direct application of pesticides on farms, soil contamination, or improper pre-harvest activities.

Table 2 (pesticide residue levels in beans, maize, and rice purchased from Creek Road Market) shows higher pesticide levels than farm grains with notable exceed in β-Hexachloro Cyclohexane (0.4 mg/kg in maize).Quintozen (0.72 mg/kg in beans),DDE (0.48 mg/kg in rice),Dieldrin (0.68 mg/kg in beans), Malathion (0.77 mg/kg in rice), Cis-Chlordane (0.53 mg/kg in rice) indicating contamination increases during post-harvest handling, preservations or storage and environmental contamination in the market. The pesticide residue levels in beans, maize, and rice purchased from Mile One Market (table 3) showed Significantly higher contamination than farm and Creek Road Market samples with DDE levels in beans (2.13 mg/kg) and rice (0.72 mg/kg) dangerously high, others includes β-Hexachloro Cyclohexane (0.53 mg/kg in maize), Malathion (0.68 mg/kg in rice),Dieldrin (0.12 mg/kg in beans). The pesticide residue levels in beans, maize, and rice from Oil Mill

Market(Table 4) indicated the most highest pesticide contamination among all samples with notable higher value in β-Hexachloro Cyclohexane (0.37 mg/kg in beans),Quintozen (0.83 mg/kg in beans), DDE (3.65 mg/kg in rice), Malathion (2.13 mg/kg in rice), Dieldrin (0.52 mg/kg in rice).Post-harvest contamination is at its worst here, indicating possible illegal and excessive use of banned pesticides

Generally Farm Samples has Lower pesticide levels, with some exceeding MRLs (e.g., β-Hexachloro Cyclohexane, Quintozen, and Diazinone), Creek Road Market revealed Moderate contamination, but still exceeded MRLs for DDE, Dieldrin, and Endosulfan in some cases,Mile One Market indicated higher contamination in DDE(2.13 mg/kg in beans, 0.72 mg/kg in rice), Malathion(0.68 mg/kg in rice),β-Hexachloro Cyclohexane (0.53 mg/kg in maize)Quintozen(0.83 mg/kg in beans)Methaxychlor(0.64 mg/kg in beans),Diazinone(0.87 mg/kg in beans). and Dieldrin (0.12 mg/kg in beans), While Oil Mill Market were the most heavily contaminated, especially DDE (3.65 mg/kg in rice) Dieldrin (0.52 mg/kg in rice).,Cis-Chlordane(0.36 mg/kg in beans) and Malathion (2.13 mg/kg in rice). Comparing Findings with Existing Literature, The results of this study were consistent with Adeola and Olufemi (2020) report that market-sourced grains in Lagos frequently exceeded MRLs, emphasizing the role of post-harvest contamination, Okeke et al. (2021) highlighted the relatively lower residue levels in farm-fresh grains compared to those sold in urban markets. The higher pesticide residue levels in market-sourced grains also align by Okrikata et al. (2022) on the assessment of the levels and risks associated with the consumption of selected pesticides in watermelon fruits in Wukari and its health risks. Results showed that, all (100%) samples contained organochlorine residues while approximately 81% and 61% of the samples were contaminated with organophosphate and pyrethroid pesticides, the Total pesticide residue ranged from 0.000310.0006 to 0.0117±0.0161mg/kg for organochlorines; 0.0009 0.0008 to 0.0110±0.0082mg/kg for organophosphates; and 0.0001±0.0002 to 0.0037±0.0012mg/kg for pyrethroids.

The Anova analysis showed a degree of significant difference between the farm-sourced grains and the market grains likely due to higher variability introduced by post-harvest handling and storage practices.The Anova comparing table 11 showed that The Farm ($p = 0.00000157$) has the smallest p-value, reflecting extremely strong evidence for differences between grain types. Creek Market ($p = 0.0000037$) was very strong evidence for differences but slightly less significant compared to the farm. Oil Mill Market ($p = 0.00109$) and Mile One Market ($p = 0.00297$) indicated statistically significant, but with weaker evidence for differences compared to the farm and creek road markets.

The contamination factor and PLI was also used to check the level of contamination in grains (beans, maize and rice). Analyzing contamination factors (CF) and pollution load index (PLI),Results revealed considerable contamination, particularly in rice, which exhibited the highest levels of residues, particularly for DDE (1.62 mg/kg) and Malathion (1.19 mg/kg).The contamination factor (CF) values also indicated that Quintozen and Benzene (Hexa Chloro) had the highest contamination in beans and rice with high contamination factors recorded for Quintozen (83 in Oil Mill beans) and Benzene (Hexa Chloro) (24 in Mile One beans and 60 in Oil Mill rice).The pollution load index was also used to check the level of grains pollution by pesticide, it was observed that the pollution value is 2.58, 2.87 and 4.54 which indicated moderate degree of ($1 \leq CF < 3$) for farms in Ogoni and Etche while for creek road markets and oil mill had 3.07, 2.32 and 4.54 and 4.2, 3.57 and 3.42. for beans, maize and rice. This values are between ($3 \leq CF < 6$) indicating that markets grains has higher degree of contamination compare with farm grains..

Conclusion

The findings revealed significant differences in residue levels, with market-sourced grains exhibiting higher pesticide concentrations compared to farm-fresh grains.Across all three commodities, market-sourced samples generally exhibited higher residue levels.The mean level for most pesticides exceeded the maximum residue limit (MRL) for standard given by WHO/FAO. Most farm-fresh grains and markets exceeded FAO/WHO permissible limits, but market-sourced are comparably high than the farm-fresh grains. The results of this study showed that there is a high degree of pesticide residues in beans, maize and rice sold in markets. The observed residues level of grains sold in market were significantly higher than harvested grains. The values were found to be above the maximum residue limits with legal implications while aldrin and dieldrin had toxicological implications since their concentrations were above safety levels. Further monitoring studies on pesticide residues levels of OC pesticides and other pesticides used for beans, maize, rice grains storage and the dietary intakes from the pesticide levels should be evaluated to give an insight into likely health risks to livestock and humans.

Recommendations

1. Strengthening Regulatory Frameworks: Regulatory agencies such as NAFDAC and SON should intensify surveillance of grains in urban markets, ensuring compliance with residue standards.
2. Promoting Good Agricultural Practices (GAP) through Conducting training programs for farmers on the safe application of pesticides, emphasizing appropriate dosages, timing, and adherence to pre-harvest

intervals, Encouragement of Alternatives to Chemical Pesticides including biological control methods and the use of organic pesticides.

3. Public Awareness Campaigns through Raise awareness among consumers about the risks associated with pesticide residues and provide practical advice on reducing exposure, such as thorough washing, cooking, or soaking grains,Train market vendors on safe storage and fumigation practices to minimize contamination.
4. Encouragment of Further Research to conduct longitudinal research to track seasonal variations in pesticide residue levels in grains and investigate the health impacts of chronic exposure to pesticide residues among consumers.

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