Supported by tetfund

ASSESSMENT OF LEVELS OF PESTICIDE RESIDUES IN BEANS (*Vigna unguiculata* (L.)Walp.) IN WUKARI LOCAL GOVERNMENT AREA OF TARABA STATE

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Received: May 18, 2023 **Accepted:** July 10, 2023

Abstract:

This study investigated the levels of pesticide residues in beans (Vigna_*unguiculata)* in Wukari Local Government Area of Taraba State. Three samples of beans were randomly collected from Wukari township market (Yam, New and Old markets) and milled into powder form for pesticide residues concentrations analysis. The pesticide residue analysis was carried out using GC/PFPD after sample extraction, filtration and concentration. Thirty-four pesticide residues were detected at different concentrations and retention time, and were very significant across the different markets except for simazine. It was observed that Cypermethrin (0.0120309 mg/kg, 0.0142578 mg/kg and 0.0163723 mg/kg) and Simazine (of 0.0000034 mg/kg, 0.0000030 mg/kg and 0.0000043 mg/kg) have the highest and lowest concentrations respectively for all the three locations (Yam, New and Old markets). It was also observed that Cypemethrine and Aldrin had pooled mean pesticide residues concentration of 0.0142 mg/kg and 0.0003 mg/kg which are higher than their acceptable permissive limits of 0.0020 and 0.0001mg/kg respectively. All the detected pesticide residues belong to four major classes (Organochlorines, Organophosphates, Pyrethroids and Carbamates). This indicates the usage of out-of-date, illegal pesticides during bean growing and storage which suggest a specific range of non-carcinogenic risk connected to lifetime intake of beans marketed in this area.

Keywords: Beans, Cypemethrine, Organochlorine, Pesticides residues, Simazine, Wukari,

Introduction

Food is very essential to the survival of man and as such, food preservation is one of the oldest technologies used by human beings (Sharma *et al.*, 2022). Food preservation has undergone so much investigation and also some significant improvements and discoveries have been made, allowing for life to be healthier, more efficient and safer (Akinloye *et al.*, 2015). Pesticides have contributed significantly to food security in the world, for controlling and destroying various types of pests. Pesticides are poisons specifically produced to get rid of pests and other related insects (Muhammad *et al.*, 2023). Pesticides are important agricultural management tool; they increase yields and increase protection against insects at pre-harvest, post-harvest as well as during storage. It has continued to be the bedrock of agriculture in modern times because of its unquantifiable benefits, one of which include enhancement of shelf life of stored agricultural products (Saravanan, 2022). According to a study by Omokpariola *et al* (2023), the use of pesticides in Nigeria have been on the increase since their introduction in early 1950s. Its demand have equally continued to increase in the face of Nigeria's growing human population and increased agricultural activities (Omokpariola *et al*., 2023; Hassan *et al.*, 2018).

Beans (*Vigna unguiculata* (L.)Walp.) are legumes which are rich, water soluble vitamins and less expensive sources of dietary proteins (Abebe and Alemayehu, 2022). Beans are commonly known as the cowpea, black-eyed pea or beans, catjang, chinapeas, cowgram or southern peas and grown in tropics and subtropics used as food for human as well as for animal (Hassan *et al.*, 2018). They vary in color, shape, size and eye-patterns. They are predominantly hot-weather crop (preferring a temperature of 20 to 35^{o}C) and the seed ranges from 2 to12 mm (in length) with globular shape. The seed coat may be rough, smooth, or wrinkled and exist in various colors such as white, black, green, brown, red or purple (Abebe and Alemayehu, 2022). Hence, beans are always dried before taking to market for sales. Among various types of legumes, beans is the most widely grown, traded and distributed food commodity in Nigeria (Campos-Vega and Oomar, 2010), and also exported to various countries around the world. Due to its health benefits, Beans products can lower serum cholesterol levels (Arun *et al.*, 2017) and combining it with high-fibre diets is well tolerated and has no side effects.

Unfortunately, Nigeria's beans production has over the years faced major challenges. Among these challenges is the incidence of insect pests and diseases which has been recognized as one of major causes of declining yields in beans production. In order to increase beans yields, the use of synthetic pesticide has been a measure to control its pest and disease (Mohammad *et al*., 2023). The use of pesticides is becoming more widespread in Nigeria and its application is more concentrated on legumes, cereals, vegetables and fruits sectors. On the other hand, their use has often been associated with unintended environmental and human health consequences. Ignorance, lack of safety concerns and lack of effective regulations on chemical usage in most of the developing country have resulted in the misuse and overuse of the chemicals (Ezirigwe, 2019). This indiscriminate use of synthetic chemicals, such as organophosphates (such as DDVP), pyrethroids (such as Permethrin, Deltamethrin), and some already banned class of chemicals (organochlorides such as gammalin, etc.) for

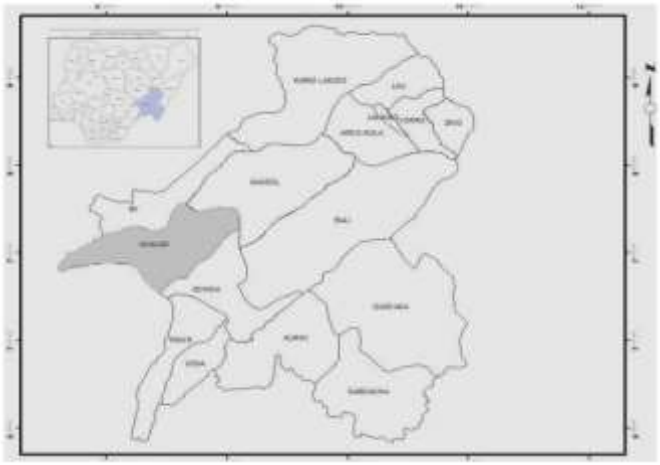
the storage of beans, had resulted in illnesses, diseases, and even consumer deaths (Adelagun *et al*., 2023). The most common of these synthetically made pesticides used in local Nigerian markets are the DD Force, Goodbye, Sharp shooter, Fiya-Fiya, etc. These synthetic products are made of dichlorvos, Cyhalothrin, Chlorpyrifos, Trichlorphon, Omethoate and Dimathoate (Omokpariola *et al*., 2023). Moreover, it is a fact that higher levels of these chemicals were discovered in dried-beans originating from Nigeria in the international market (WHO, 2013). The work of Hassan *et al.*, (2018), further observed that these synthetically pesticides were applied directly unto the dried-beans seed manually, and mixed to ensure thorough blending. Mixing of the dried-beans with the pesticide mostly happened within the market premises. These pesticides were exposed to open air causing health challenges of laborers, merchants, surrounding trees, passerby, storekeepers, consumers, food sellers within the market to great danger. This causes both direct effect and indirect effect on environment. The various technologies of crop preservation locally are grossly inadequate and most cases highly expensive in Nigeria. The instruction on synthetic pesticides user manual is never taking into consideration. With the dried-beans urge for maximum profit, adoption of the organic pesticides is the only immediate solution. Since infestation is imminent, the merchant and store keepers tend to adopt precaution measures of applying the synthetic pesticides to avoid any damage that may arise in order to maintain sustainable profit margin (Muredzi, 2013).

The quantity of chemicals in preserved beans sold across the country is unsafe for consumers, as its long term effects could lead to cancer and kidney-related diseases among others. Studies show that some of the pesticides have been banned in other countries but are freely used in Nigeria despite the fact that they portend grave danger to consumers (Mac-Leva *et al.,* 2020). Consequently, the need for check and monitoring of harmful chemical substance in beans is the aim of this study, to ensure human health and safety in beans. This work therefore is focused on the assessment of levels of pesticide residues in beans (*Vigna_unguiculata*) found in stores in Wukari township markets, Taraba State.

Materials and Methods

Study Area

This study was conducted in Wukari situated on longitude 9° 47'E and latitude 7° 51'N in Taraba State, Northeastern Nigeria. The vegetation of the area is predominantly characteristics of savannah zone and with major climatic seasons of wet or rainy seasons, which starts in March or April, and ends in October and the dry season, which starts in November and ends in March or April. Wukari covers an area of 4,308 km^2 and with a population of about 241,546 at the 2006 census, a traditional state rich with various cultures, norms and value. Fishing, farming and trading are the major occupation of the people (Otitoju and Lewis, 2020).



Map of Nigeria and Taraba showing the location of Wukari
Source: (Otitoju and Lewis, 2020).

Sampling Technique

Different samples of beans were collected randomly from different market points within Wukari Town which include Yam market, Wukari new and old market. These are the major markets in Wukari where large food items including beans, cereals and other grains are sold. Random collection of beans was done in each market, making a total of three (3) different samples. Samples were collected in sterile poly bags to protect them from moisture and contamination. The samples were then labeled and stored inside a covered container. The Bean samples were then cleaned by picking out stones, weevils and other non-essential materials. The different samples were then milled separately, first, using a mortar and pestle to mill to powder form. The bean samples were purchased in dry form and further drying was done. Precautionary measures were taken to avoid cross-contamination of the different samples during and after milling.

Extraction

The pesticide residue extraction and analysis were carried out by following the modified standard test methods of American Society for Testing and Materials (ASTM) international (1996), Menezes *et al.,* 2016 and United States Environmental Protection Agencies (USEPA), (1980). The test methods covered the capillary gas chromatographic determination of various pesticides, including some of their degradation and related compounds. The volume of the homogenized samples were measured and kept in the fridge/freezer at a temperature that was less than 4 degree centigrade until analysis. 5.0 ml of the measured sample was extracted after the addition of the surrogate standard solution to the sample and later transferred to the extracting bottle that was cooked with TFE-flourocarbon. 25 ml of the phosphate buffer was added, followed by the pH measurement with the addition of sodium hydroxide solution (400g/l) for pH adjustment to 7 when necessary. 5.0 percent (w/v) of the sodium chloride salt was added to the sample, sealed and shook so as to dissolve the salt. 10.0 ml of the redistilled analytical grade ethyl octanoate was measured and poured into the sample.

The sample was extracted for about 30 minutes in the centrifuging machine at 200 rpm. The solution was poured into the 500ml separatory funnel for the solvent-solvent extraction. The funnel with its content was hung on the retort stand and the content was allowed to settle for the organic and aqueous phase separation. The original phase containing the analysis of interest was recovered into the Erlenmeyer flask. The extraction was repeated two more times with fresh solvent and the filtrate was combined. The combined extract was dried by pouring through a drying column containing a 10-cm column of anhydrous sodium sulphate (previously rinsed with ethyl octanoate) and the filtrate was concentrated in the concentrator flask with a stream of nitrogen. The wall of the concentrator flask was rinsed with extracting solvent so as to bring the final volume of the extract to 5.0 ml.

Clean-up

The clean-up of the concentrated extract was followed by packing the column with the florisil. The concentrated extract was eluted with the hexane and later concentrated to the required final volume of 5ml.

GC/PFPD Injection, Separation and Detection

The GC equipped with pulse flame photometric detector was used for the chromatographic separation and was achieved by using a 30m x 0.25mm x 0.25µmHP 5MS column. The operating conditions were programmed as follows: For the oven - initial temperature 80°C for 1 minutes,10°C/min to 200 °C, 12 °C/min to 300°C constant at 1 min and a constant column flow rate of 1 ml/min; for the detector – injection temperature: 300 °C; carrier gas – hydrogen at a flow rate of 1 ml/min.

Results and Discussion

Concentrations of Pesticide residues detected in beans in Wukari township markets

Results presented in Table 4.1, 4.2 and 4.3 below shows the presence of thirty-four (34) pesticide residues that were detected in the sampled beans collected from the three sites (Wukari Yam, New and Old markets). From the results, it was observed that Cypermethrin has the highest concentration for all the three locations with a value of 0.0120309 mg/kg, 0.0142578 mg/kg and 0.0163723 mg/kg. Interestingly, it was equally observed that Simazine has the lowest concentration values of 0.0000034 mg/kg, 0.0000030 mg/kg and 0.0000043 mg/kg for Wukari Yam, New and Old markets respectively.

Table 4.1: Mean concentrations of Pesticide residues (mg/kg) detected in beans (*V. unguiculata*) in Wukari Yam market

S/N	Retention time	Pesticides Residues	Amount (mg/kg)
1	7.011	Phosphine	0.0000172
2	8.341	Bromoethane	0.0002005
3	9.939	2,4,6 – Trichlorophenol	0.0002825
4	11.36	Simazine	0.0000034
5	12.367	Isoproturon	0.0000069
6	13.299	Chlorotoluron	0.0001788
7	13.976	Carbendazim	0.0002321
8	14.493	Mecoprop	0.0003049
9	15.499	Atrazine	0.0002250
10	16.248	2, 4 – D	0.0000077
11	16.784	Dichlorvos	0.0002044
12	17.469	Oxamyl	0.0001757
13	18.156	Carbofuran	0.0001573
14	18.766	Dichloroprop	0.0002425
15	19.627	Cyanazine	0.0003667
16	20.722	Pentachlorophenol	0.0002157
17	21.328	Fenoprop	0.0000794
18	21.822	Alachlor	0.0000710
19	22.602	Cypermethrin	0.0120309
20	23.355	Fenitrothion	0.0002113
21	23.968	Pendimethalin	0.0000520
22	24.272	Metolachlor	0.0000315
23	24.468	Phosphamidon	0.0002013
24	25.766	Primiphosmethyl	0.0001471
25	26.305	Fenvalerate	0.0003391
26	26.95	Pyriproxyfen	0.0001831
27	27.48	Endosulfan	0.0002140
28	28.05	Malathion	0.0001842
29	28.641	Methoxychlor	0.0001031
30	29.68	Chlorpyrifos	0.0002465
31	31.089	Aldrin	0.0002754
32	31.955	Dieldrin	0.0002910
33	33.254	Premethrin	0.0001362
34	33.984	Deltamethrin	0.0000206

Table 4.2: Mean concentrations of Pesticide residues (mg/kg) detected in beans (*Vigna unguiculata*) in Wukari New market

S/N	Retention Time	PesticideResidues	Amount (mg/kg)
1	6.996	Phosphine	0.0000151
2	8.322	Bromoethane	0.0001755
3	9.936	2, 4, 6 – Trichlorophenol	0.0002473
4	11.347	Simazine	0.0000030
5	12.365	Isoproturon	0.0000060
6	13.423	Chlorotoluron	0.0001565
7	14.06	Carbendazim	0.0002031
8	14.492	Mecoprop	0.0002668
9	15.498	Atrazine	0.0001969
10	16.248	2, 4 – D	0.0000067
11	16.784	Dichlorvos	0.0001788
12	17.472	Oxamyl	0.0001537
13	18.157	Carbofuran	0.0001377
14	18.767	Dichloroprop	0.0002122
15	19.628	Cyanazine	0.0003209
16	20.72	Pentachlorophenol	0.0001887
17	21.33	Fenoprop	0.0000695
18	21.823	Alachlor	0.0000621
19	22.605	Cypermethrin	0.0142578
20	23.305	Fenitrothion	0.0001849
21	23.967	Pendimethalin	0.0000455
22	24.467	Metolachlor	0.0000276
23	25.269	Phosphamidon	0.0001761
24	25.76	Primiphosmethyl	0.0001287
25	26.299	Fenvalerate	0.0002967
26	26.946	Pyriproxyfen	0.0001602
27	27.48	Endosulfan	0.0001873
28	28.01	Malathion	0.0001611
29	28.637	Methoxychlor	0.0000902
30	29.7	Chlorpyrifos	0.0002157
31	31.07	Aldrin	0.0002410
32	32.015	Dieldrin	0.0002546
33	33.339	Premethrin	0.0001192
34	34.001	Deltamethrin	0.0000179

Table 4.3: Mean concentrations of Pesticide residues (mg/kg) detected in beans (*Vigna unguiculata*) in Wukari Old market

S/N	Retention Time	Pesticide Residues	Amount (mg/kg)
1	7.066	Phosphine	0.0000224
2	8.302	Bromoethane	0.0002510
3	9.928	2, 4, 6 – Trichlorophenol	0.0003536
4	11.36	Simazine	0.0000043
5	12.365	Isoproturon	0.0000086
6	13.422	Chlorotoluron	0.0002235
7	14.059	Carbendazim	0.0002901
8	14.492	Mecoprop	0.0003811
9	15.497	Atrazine	0.0002813
10	16.246	2, 4 – D	0.0000096
11	16.782	Dichlorvos	0.0002555
12	17.468	Oxamyl	0.0002196
13	18.766	Carbofuran	0.0001967
14	18.155	Dichloroprop	0.0003031
15	19.627	Cyanazine	0.0004584
16	20.718	Pentachlorophenol	0.0002696
17	21.328	Fenoprop	0.0000993
18	21.822	Alachlor	0.0000887
19	22.604	Cypermethrin	0.0163723
20	23.355	Fenitrothion	0.0002642
21	23.968	Pendimethalin	0.0000650
22	24.47	Metolachlor	0.0000394
23	25.268	Phosphamidon	0.0002516
24	25.762	Primiphosmethyl	0.0001839
25	26.299	Fenvalerate	0.0004239
26	26.947	Pyriproxyfen	0.0002289
27	27.479	Endosulfan	0.0002675
28	28.04	Malathion	0.0002302
29	28.63	Methoxychlor	0.0001289
30	29.477	Chlorpyrifos	0.0003081
31	31.146	Aldrin	0.0003443
32	31.962	Dieldrin	0.0003637
33	33.309	Premethrin	0.0001703
34	33.919	Deltamethrin	0.0000256

Table 4.4: Pooled Mean concentrations of Pesticide residues (mg/kg) detected in beans (*Vigna unguiculata*) in Wukari town markets

PESTICIDES RESIDUES	YAM MARKET	NEW MARKET	OLD MARKET	POOLED MEAN
Phosphine	0.0000172	0.0000151	0.0000224	0.0000182
Bromoethane	0.0002005	0.0001755	0.0002510	0.0002090
2, 4, 6 – Trichlorophenol	0.0002825	0.0002473	0.0003536	0.0002945
Simazine	0.0000034	0.0000030	0.0000043	0.0000036
Isoproturon	0.0000069	0.0000060	0.0000086	0.0000072
Chlorotoluron	0.0001788	0.0001565	0.0002235	0.0001863
Carbendazim	0.0002321	0.0002031	0.0002901	0.0002418
Mecoprop	0.0003049	0.0002668	0.0003811	0.0003176
Atrazine	0.0002250	0.0001969	0.0002813	0.0002344
2, 4 - D	0.0000077	0.0000067	0.0000096	0.0000080
Dichlorvos	0.0002044	0.0001788	0.0002555	0.0002129
Oxamyl	0.0001757	0.0001537	0.0002196	0.0001830
Carbofuran	0.0001573	0.0001377	0.0001967	0.0001639
Dichloroprop	0.0002425	0.0002122	0.0003031	0.0002526
Cyanazine	0.0003667	0.0003209	0.0004584	0.0003820
Pentachlorophenol	0.0002157	0.0001887	0.0002696	0.0002246
Fenoprop	0.0000794	0.0000695	0.0000993	0.0000827
Alachlor	0.0000710	0.0000621	0.0000887	0.0000739
Cypermethrin	0.0120309	0.0142578	0.0163723	0.0142203
Fenitrothion	0.0002113	0.0001849	0.0002642	0.0002201
Pendimethalin	0.0000520	0.0000455	0.0000650	0.0000541
Metolachlor	0.0000315	0.0000276	0.0000394	0.0000329
Phosphamidon	0.0002013	0.0001761	0.0002516	0.0002097
Primiphosmethyl	0.0001471	0.0001287	0.0001839	0.0001532
Fenvalerate	0.0003391	0.0002967	0.0004239	0.0003532
Pyriproxyfen	0.0001831	0.0001602	0.0002289	0.0001908
Endosulfan	0.0002140	0.0001873	0.0002675	0.0002229
Malathion	0.0001842	0.0001611	0.0002302	0.0001918
Methoxychlor	0.0001031	0.0000902	0.0001289	0.0001074
Chlorpyrifos	0.0002465	0.0002157	0.0003081	0.0002568
Aldrin	0.0002754	0.0002410	0.0003443	0.0002869
Dieldrin	0.0002910	0.0002546	0.0003637	0.0003031
Premethrin	0.0001362	0.0001192	0.0001703	0.0001419
Deltamethrin	0.0000206	0.0000179	0.0000256	0.0000214
TOTAL	**0.0176392**	**0.0191650**	**0.0233840**	**0.0200627**

Results presented in Table 4.4 reveals the pooled mean of all the pesticide residues observed in Wukari township market (Yam, New and Old markets). From Table 4.4, it was observed that Old market has the highest concentration value with a total of 0.0233840 mg/kg followed by New market (0.0191650 mg/kg) and Yam market (0.0176392 mg/kg)**.** Results also reveal that all the pesticide residues detected between the three markets (Yam, New and Old Market) had significant effects along the locations except for the concentrations of Simazine which had no positive effect on the locations. Generally, the result shows that all the detected pesticide residues belong to four (4) major classes, which are Organochlorines, Organophosphates, Pyrethroids and Carbamates.

Selected pooled mean of present study in comparison with Acceptable permissive limit

The results presented in Table 4.5 shows the pooled mean concentrations of some of the pesticide residues in the present study compared with acceptable permissive limit. The results showed that Chlorpyrifos and Endusulfan had pooled means of 0.0003mg/kg and 0.0002 mg/kg which are lower than their acceptable permissive limit of 0.001mg/kg and 0.002 mg/kg respectively, which means there is no negative effect with their consumptions. On the contrary, Aldrin (0.0003 mg/kg), Dieldrin (0.0003 mg/kg) and Cypermethrin (0.0140 mg/kg) all had, pooled mean higher than their corresponding acceptable permissive limits of 0.0001 mg/kg, 0.0002 mg/kg and 0.0020 mg/kg accordingly. This implies that their daily consumptions will affect the human being since their concentrations are higher than their acceptable permissive limit according to European Commissions Pesticide Database (2019).

Table 4.5: Selected pooled mean of present study in comparison with Acceptable permissive limit
Source: European Commissions Pesticide Database (2019)

Pesticides Residue	Pooled mean (mg/kg)	Acceptable Permissive Limit (mg/kg)
Chlorpyrifos	0.0003	0.001
Endusulfan	0.0002	0.002
Aldrin	0.0003	0.0001
Dieldrin	0.0003	0.0002
Cypermethrin	0.0140	0.0020

Pesticide residues of present study in comparison with related work

Table 4.6 shows a comparison of some pesticide residues in the present study with a related work. The result of this study which reported the presence of thirty-four (34) pesticide residues in Wukari agrees with the work of Otitoju and Lewis (2020), as some of pesticide residues observed were also present in their work. They earlier reported the presence of 29 different pesticide residues in all samples in beans from the same Wukari Local Government Area of Taraba State. The increase from the previous twenty-nine (29) different pesticide residues in beans observed in Wukari (Otitoju and Lewis, 2020) and the thirty-four (34) recorded in the present study shows that the use of pesticide residues are in the increase yearly. It was also observed that five (5) pesticide residues have been added from 2020 to 2023 and will continue to increase, if necessary steps are not taken which will have adverse effects on both human beings and the environment.

Six (6) pesticide residues from the present study namely, Aldrin, Diedrin, Endosulphan, Pyriproxyfen, chlorpyrifes, Cypermethrin and Fenitrothion were also noticed in the work of Otitoju and Lewis, (2020), though the pesticide residues concentrations were higher in some pesticide residues and lower in others in this study and this may be due to time of sample collection and type of pesticides used for the preservation. For example, Cypemethrine had

0.0142 mg/kg which is slightly lower than 0.0275 mg/kg recorded by Otitoju and Lewis, (2020) but higher than 0.002 mg/kg recommended level (European Commissions, 2019), Similarly, Fenitrothion had 0.0002 mg/kg which is higher that the recommended level of 0.001 mg/kg. Also, Aldrin with 0.0001 against 0.0003 mg/kg, Diedrin with 0.0003 against 0.0002 mg/kg, Pyriproxyfen with 0.0002 against 0.005mg/kg and chlorpyrifeos with 0.0003 against 0.001 mg/kg (European Commissions, 2019).

Table 4.6: Pesticides residue detected in beans in Present study and related work

PESTICIDES RESIDUE	S	PESTICIDES RESIDUE
Present study		**Otitoju and Lewis, 2020**
Phosphine		**Aldrin**
Bromoethane		**α – BHC**
2, 4, 6 – Trichlorophenol		**β- BHC**
Simazine		**Delta BHC**
Isoproturon		**Aramite**
Chlorotoluron		**Dieldrin**
Carbendazim		**p,p'-DDT**
Mecoprop		**Endosulphan**
Atrazine		**Chlorthiophos**
2, 4 - D		**Iodofenphos**
Dichlorvos		**Bromophos-ethyl**
Oxamyl		**Pyriproxyfen**
Carbofuran		**Quizalofop**
Dichloroprop		**Phenthoate**
Cyanazine		**Prothiophos**
Pentachlorophenol		**Ethion**
Fenoprop		**Esfenalerate**
Alachlor		**Heptachlor**
Cypermethrin		**Pyriproxyfen**
Fenitrothion		**Fenitrothion**
Pendimethalin		**4,4-DDE**
Metolachlor		**Fenthionsulphon**
Phosphamidon		**Oxyfluorfen**
Primiphosmethyl		**Chlorpyrifos**
Fenvalerate		**Difenconazole**
Pyriproxyfen		**Oxadiazone**
Endosulfan		**Amitraz**
Malathion		**Flumioxazin**
Methoxychlor		**Cypermethrin**
Chlorpyrifos		-
Aldrin		-
Dieldrin		-
Premethrin		-
Deltamethrin		-

Pesticides are extensively used in agriculture. They are specifically designed to target the nervous systems of pests. For this reason, they are neurotoxic to non-target animals, including humans and other mammals (Bjorling-Poulsen *et al.*, 2008). The results revealed high level of cypemethrine mg/kg. This is in agreement with the findings of Claeys *et al.* (2011), Isegbe *et al*. (2016) and Otitoju and Lewis, (2020). Yuan *et al.* (2014), who reported that among many other pesticides cypemethrine, chlorpyrifos and aldrin are regularly detected in food. Various literature published between 2007 and 2014 suggests that legumes, leafy greens and fruits frequently contain the highest level of pesticides (Bempah *et al.*, 2012). There is consistent evidence that these substances are regularly present as mixtures of multiple residues and in many cases, at levels above the acceptable permissive limits in certain countries (Latifah *et al.*, 2011).

Conclusion

The study revealed that there are thirty four pesticides residues in beans found in Wukari Local Government Area of Taraba State with most of them occurring at concentrations higher than their recommended level or acceptable daily intake based on European commission report on pesticides use in 2019. The observed pesticides residues belong to four classes of pesticides (Organochlorines, Organophosphates, Pyrethroids and Carbamates). The presence of organochlorine pesticides point to ongoing usage of out-of-date, illegal pesticides during bean growing and storage which suggest a specific range of non-carcinogenic risk connected to lifetime intake of beans marketed in this area. Therefore, Nigerian regulatory organizations (including NAFDAC, SON, and NESREA) should intensify their efforts to guarantee that the prohibition on these substances is followed. Education about the risks of using products that are prohibited as well as the overuse of these pesticides is also necessary for farmers and other pesticide users.

Acknowledgement

The research has not received funding from any repository.

Conflict of interest

On behalf of all authors, the corresponding author declared that there is no conflict of interest.

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