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Comparative Analysis of the Level of Pesticide Residues in Beef, Chevon and Internal Organs of Cows and Goats Slaughtered in Yola Abattoir of Adamawa State, Nigeria

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Abstract

This work examines the presence of pesticides residue levels in beef, chevon, and internal organs obtained from cows and goats slaughtered at Yola Abattoir in Adamawa State. Residues of organochlorines and organophosphorus pesticides were extracted from the meat, chevon and internal organs of the cows and goats using QuEChERS method, and analysed by GC-MS technique. The residue analysis revealed that beef and chevon samples had no traces of organochlorines whileorganophosphorus (chlorpyrifos, dichlorvos, dichlorpyrifos, diazinon, dimethoate, primifos-methyl, and malathion) pesticide residues detected were below threshold level of 0.01 mg/kg. The result of the animals' intestine showed the presence of chlorpyrifos (0.034 ±

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0.001 vs. 0.031 ± 0.001) and (0.027 ± 0.001 vs.0.023 ± 0.0014) above the standard values, whereas, the dichlorvos level were (0.059 ± 0.0014 vs. 0.050 ± 0.0007), (0.061 ± 0.0007 vs. 0.043 ± 0.0014) and (0.072 ± 0.0014 vs. 0.031 ± 0.001) below the maximum residual value of 1 mg/kg. The kidney residue revealed that dichlorpyrifos, diazinon, dimethoate, primi-methyl and malathion were below the maximum residue limit (0.001 mg/kg) in the cow samples while chlorpyrifos: (0.013 ± 0.001 vs. 0.012 ± 0.001 vs. 0.018 ± 0.001 vs. 0.053 ± 0.001) were above the standard value (0.01 mg/kg). Dichlorvos was detected in the kidney of the goats; (0.069 ± 0.0007 vs. 0.035 ± 0.0014) and (0.052 ± 0.0014) below the maximum residual limit (MRL). Residue analysis in the livers of the cows also showed the presence of chlorpyrifos at (0.011 ± 0.001), (0.014 ± 0.001), (0.08 ± 0.001) above the recommended value, while dichlorvos (1.012 ± 0.001 vs. 0.027 ± 0.001) and (0.029 ± 0.001 vs. 0.037 ± 0.001) were below MRL established by the international health regulation agencies. Residue analysis of all the samples studied shows no trace of organochlorine pesticides. These findings are alarming and are potential threats to the public health.

Introduction

Pesticide means any chemical substance or mixture of substances intended for preventing, destroying, repelling or mitigating the effect of pest on plants and animals. This includes herbicides, insecticides, rodenticides, insect growth regulators used in agriculture, public health, horticulture, food storage or any chemical substance used for similar purpose. Pesticides are mainly used in agriculture, veterinary, domestics and institutions. The toxicity of a pesticide is a measure of the capacity of such pesticide to cause injury; it is a property of the chemical itself. These include substances with high toxic effects and persistence in the environment.[1] Pesticide residues in livestock generally accumulate by two ways, either applied to animals as insecticide – impregnated ear tag, spray, self-treatment back rubber, dust bags, injectable or through pesticide spray on agricultural crops and fodder. These compounds are primarily designed to kill insects, fungi, and weeds but have been found to be toxic. These pesticidal properties are unique and pose a threat to human health and environment.[2] Pesticide exposure may be through inhalation, dermal or oral routes. Several studies have shown that children have high concentration of pesticide residues because of their body weights.[3,6] Pesticide storage, handling and usage are fraught with problems of undesirable side effects and food chain involvement. A natural survey by the US Geological Survey found pesticide residues in every stream monitored.[4] Pesticide residue are present in more than 70% of fruits and vegetables, more than 60% of wheat samples and 99% of milk samples analysed in United State Department of Agriculture.[5]

The uses of pesticides have positive and dramatic effects on agriculture production through protection of crops against insects, pest and diseases. Also for pesticides to be effective against pests, they must be biologically active or toxic. Livestock reared on pesticides contaminated soils, crops and fodders may accumulate considerable pesticide residues in edible tissue. For example the accumulation of dieldrin residue in sheep from ingestion of contaminated feed was studied and it was concluded that dieldrin concentration in the fats of sheep that consumed dieldrin contaminated feed fall within ten days of removal from the source of contamination. However, dieldrin accumulates in the wool of sheep that consumed the dieldrin contaminated feed.[7] According to an industry estimate, insecticide usage has high growth potential in Nigeria as the use of agriculture pesticide is markedly low at 0.25 Kg/ha as against 0.54 Kg/ha in India, 3.7 Kg/ha in USA and 2.7 Kg/ha in China.[8] That notwithstanding, the fact that overall consumption in Nigeria is lower than that used in developed countries of the world, there is wider spread of pesticide poisoning among animals and products preserved with pesticides such as, grains, beans, fruits, vegetables etc. Few studies have shown the presence of pesticide residues in fruits and vegetables in some developing countries such as Pakistan,[9] pesticide residues in vegetable from Karachi, and in various tissue of fish in the local lakes.[10] Furthermore, pesticides also accumulate on cropland soil.[11] Animals accumulate these substances from contaminated feed and water. Also due to the lipophilic nature of these pesticides, milk and other fat-rich substances are the key items responsible for their accumulation.[12] Therefore an indirect source of pesticides accumulation can be represented by animal-derived products. Such pesticide contaminated animal foods are ultimately consumed by humans and therefore these toxicants represent a serious risk for human health. In order to avoid the toxic health hazards, it is necessary to determine the level of pesticides in edible tissues like meat, liver, intestine and kidney of common food animals (Cow and Goat) which are probably reared where pesticides are used in the environment. The indiscriminate or proliferation and usage of pesticides in agriculture, domestic, veterinary and institutions has brought about the increased consumption or their intake in crops and meat consumed. To this end, there are some un-investigated cases of threat to public health constituted by pesticide poisoning from milk, meat and other fat-rich organs of animal: liver, intestine and kidney. Despite the use of pesticides in agriculture and in residential environment, few studies have measured children exposure levels, while some have focused on pesticide residual level in agriculture products. There are little or no published studies identified to date that examined pesticide residue of meat products, its prevailing hazards and environmental control policy through continuous supervision and monitoring of these pesticides in water, sediments and the environment in the north east region of Nigeria. These increase in the proliferation and use of pesticide in agriculture produce, residential areas and the predisposing cases of pesticide usage; poisoning and its prevalence health hazard rekindle the quest for this research work.

Materials and Methods

Materials

The chemicals used for the analysis - acetonitrile, magnesium sulphate and sodium chloride (all pesticide grades) - were of analytical grades, purchased from Musbaco Chemical Ltd, Yola, Adamawa State, Nigeria. Other materials include distilled water, polythene zipper bag, electric chopper, and centrifuge.

Methods

The samples for pesticide analysis were collected from Yola Abattoir in polythene zipper bags/ containers. The beef, chevon and internal organs of the animals were collected during early morning working hour. The samples were labelled, parked and transported to the laboratory for pesticide residue analysis.

Study Area

This research work was carried out at Yola Abattoir in Yola North, Adamawa State, Nigeria. Naturally, this region is abundantly blessed with nomads who are predominantly peasant farmers. However, due to increase need for food as a result of the growing population of the state and for financial gains, the people have accepted mechanized and agrochemical farming.

Sample Collection

The beef and chevon of 10 different cows and goats were collected along with their intestine, kidney and liver. A total of eighty (80) samples were collected / purchased within a span of two months (March and April 2015). The samples were packed in polythene bags and transported to the laboratory for analysis.

Extraction of pesticide residue in meat/ organs

The meat, chevon along with their intestine, kidney and liver samples were collected and labelled as C_1M, C_1I, C_1K, C_1L, C_2M, C_2I, C_2K, C_2L, G_1C, G_1I, G_1K, G_1L, G_2C, G_2I, G_2K and G_2L accordingly. About 10 g of the beef sample was weight chopped and the homogenized ground beef was transferred into a 50-mL centrifuge tube. The sample was extracted using 2 mL water and 10 mL acetonitrile (ACN), followed by vigorous shaking for 1 minute. 4g $MgSO_4$ and 1g of NaCl was also added and vigorously shaken for 1 minute. Thereafter the sample was transferred to the centrifuge for 3 minutes at 4000 rpm where 1 mL aliquot of the supernatant (top layer) was taken for dSPEclean-up, other samples were sequentially treated accordingly.[13]

dSPEClean-up

The clean-up was when 1-mL aliquot of supernatant was transferred to a 2-mL dispersive solid phase extraction (dSPE)clean-up tube that contains 150 mg of magnesium sulfate, 50 mg PSA sorbent, and 50 mg C_{18} sorbent (p/n186004830). The content was shaken vigorously for 1 minute and a portion of the supernatant was transferred to the LCMS Certified Vial for GC/MS analysis.[14]

Analysis

The analysis was carried out using 1 mL aliquot of the supernatant which was transferred into a certified vial for gas chromatography-mass spectrometry where the pesticides (organochlorides and organophosphorus) residue levels in samples were determined with GC condition: system – Agilent 7890A agilent technologist inert MSD 5975CM Column; Agilent J and W GC columns HP-5MS30 (M) 0.250 DIAM (MM) 0.25 film (UM) Temp Limit 60 to 325 degree cel. gas – Helium, flow. The software CSW 32 was used to obtained peak of height and area under curve.

Statistical Analysis

The analysis of all the animals samples was carried out using the software CSW 32 for the GCMS instrumentation, the peak height, area under curve and the type of pesticide used were obtained. Statistical Packages for Social Sciences (SPSS) was used to arrive at the mean and standard deviation.

Results and Discussion

The concentration of pesticides residues levels were compared in beef and chevon samples of five Cows and five Goats. The mean ± S.D values (mg/Kg) of pesticide residue levels are given in the Table 1. The table shows no trace of organochlorines pesticide residues levels in all the animals. Organophosphorus pesticides are also relatively below the detection limit in all the samples of the cows and some of the goats analysed, while dichlorvos pesticide residue levels are detected at the chevon of goat 1,3 and 4: (0.021± 0.0014), (0.073 ± 0.0014), (0.043 ± 0.0007) below the MRL value respectively. No detection of organochlorines may be attributed to the environment where the use of pesticides is not prevalent. Other factors attributed to no detection of these studies might be gross error which has to do with the carelessness in analytical procedure, improper recording of analytical data, results and errors in calculations.

The values obtained, from other organophosphorus implies that the levels of the pesticides are non-significantly different from each other and are below the maximum residue limit (MRL) established by United States Food and Drug administration (USFDA).

Table 1. Comparison between the Samples of Beef and Chevon for Pesticides

PESTICIDE	STD MRL	C1	C2	C3	C4	C5	G1	G2	G3	G4	G5
Anthracene	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chlorpyrifos	0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Dichlorvos	1	<0.001	<0.001	<0.001	<0.001	<0.001	0.0021 ± 0.0014	<0.001	0.073± 0.0014	0.043± 0.0007	<0.001
Dichlorpyrifos	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Diazinon	0.02	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Dimethoate	0.05	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Primifos- Methyl	0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Malathion	2	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

Key: C1 = Cow 1, C2 = Cow 2, C3 = Cow 3, C4 = cow 4 and C5 = Cow 5
G1 = Goat 1, G2 = Goat 2, G3 = Goat 3, G4 = Goat 4 and G5 = Goat 5.
No trace of organochlorine detected

Comparison between the pesticide residual levels in the intestine samples

The concentrations of pesticides residue levels were compared for intestine samples of the animals and the mean ± S.D values (mg/Kg) are given in Table 2. The pesticide residues levels of Dichlopyrifos, Diazinon, Dimethoate, Primifos-methyl and Malathion are below the detection limit, which may be attributed to the environmental factors or where the use of the pesticides are not prevalent. Some pesticides detected are Chlopyrifos (0.034 ± 0.0007 vs. 0.031 ± 0.0007), (0.027 ± 0.0007 vs. 0.023 ± 0.0014) and Dichlorvos (0.059 ± 0.0014 vs. 0.050 ± 0.0007), (0.061 ± 0.0007 vs. 0.043 ± 0.0014) and (0.072 ± 0.0014 vs. 0.031 ± 0.001). This implies that the Chlorpyrifos pesticide residue levels in the cows and goats intestine are significantly above the maximum residue limit as recommended by USFDA. While, dichlorvos pesticides are below the MRL value.

Comparison between pesticide residual levels in kidney samples

The concentrations of pesticides residue levels in the Kidney samples were compared and the mean ± S.D values (mg/Kg) are given in Table 3.The organochlorines pesticide residue levels are not detected in the samples of the cows and goats analysed. Organophosphorus pesticides are found below detection limit in the cows while in the goat samples there was indication of Chlopyrifos in the kidney of goats 1, 2, 3 and 4 above the maximum residue levels of 0.01 mg/Kg and Dichlorvos was detected in all the goats analysed and are below the MRL value of 1 mg/Kg. The analysis further revealed the preferences of the pesticides in the internal organ with particular reference to the kidney which is an indication that the smaller animals: goats could be predisposed to the pesticides than the bigger animals: cows.

Comparison between pesticide residual levels in liver samples

The concentrations of pesticides residue levels in the liver were compared and mean ± S.D values (mg/Kg) are given in Tables 3. The concentration of pesticide residue levels of organochlorinesis not detected in all the samples of animals analysed while, the pesticide residues levels of Anthracene, Dichlopyrifos, Diazinon, Dimethoate, Primifos-methyl

Table 2. Comparison between the Samples of Intestine in the Animals for Pesticides

PESTICIDE	STD MRL	C1	C2	C3	C4	C5	G1	G2	G3	G4	G5
Anthracene	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chlorpyrifos	0.01	<0.001	<0.001	0.034±0.001	<0.001	0.027 ± 0.001	0.031 ± 0.001	0.023±0.0014	0.021±0.001	0.051±0.001	<0.001
Dichlorvos	1	<0.001	0.059± 0.0014	0.061±0.001	<0.001	0.072±0.0014	0.050± 0.001	0.043± 0.0014	0.031±0.001	<0.001	0.035±0.0014
Dichlorpyrifos	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Diazinon	0.02	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Dimethoate	0.05	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Primifos- Methyl	0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Malathion	2	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

Key: C1 = Cow 1, C2 = Cow 2, C3 = Cow 3, C4 = cow 4 and C5 = Cow 5

G1 = Goat 1, G2 = Goat 2, G3 = Goat 3, G4 = Goat 4 and G5 = Goat 5.

No trace of organochlorine.

Table 3: Comparison between the Samples of Kidney of the Animals for Pesticides

PESTICIDE	STD MRL	C1	C2	C3	C4	C5	G1	G2	G3	G4	G5
Anthracene	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chlorpyrifos	0.01	<0.001	<0.001	<0.001	<0.001	<0.001	0.013± 0.001	0.018± 0.001	0.012±0.001	0.053± 0.001	<0.001
Dichlorvos	1	<0.001	<0.001	<0.001	<0.001	<0.001	0.069± 0.001	0.035± 0.0007	0.052 ±0.0014	0.045 ±0.0014	0.025 ± 0.001
Dichlorpyrifos	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Diazinon	0.02	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Dimethoate	0.05	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Primifos- Methyl	0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Malathion	2	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

Key: C1 = Cow 1, C2 = Cow 2, C3 = Cow 3, C4 = cow 4 and C5 = Cow 5
G1 = Goat 1, G2 = Goat 2, G3 = Goat 3, G4 = Goat 4 and G5 = Goat 5.
No trace of organochlorine.

Table 4. Comparison between the Livers of the Animals for Pesticides

PESTICIDE	STD MRL	C1	C2	C3	C4	C5	G1	G2	G3	G4	G5
Anthracene	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chlorpyrifos	0.01	<0.001	<0.001	0.011± 0.001	<0.001	0.014 ± 0.001	<0.001	0.008 ± 0.001	<0.001	0.050 ± 0.001	<0.001
Dichlorvos	1	<0.001	1.012±0.001	0.027 ± 0.001	<0.001	0.029 ± 0.001	<0.001	0.028 ± 0.001	<0.001	0.037 ±0.001	<0.001
Dichlorpyrifos	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Diazinon	0.02	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Dimethoate	0.05	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Primifos- Methyl	0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Malathion	2	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

Key: C1 = Cow 1, C2 = Cow 2, C3 = Cow 3, C4 = cow 4 and C5 = Cow 5
G1 = Goat 1, G2 = Goat 2, G3 = Goat 3, G4 = Goat 4 and G5 = Goat 5.
No trace of organochlorine.

and Malathion were below the detection limit in the cows and goats in the liver samples analysed. Chlopyrifos was detected at; (0.011 ± 0.001 vs. 0.008 ± 0.0001), (0.014 ± 0.007 vs. o.050 ± 0.001) and Dichlorvos: (1.012 ± 0.001 vs. 0.028 ± 0.001), (0.027 ± 0.001 vs. 0.037 ± 0.001) respectively. The values of chlorpyrifos are significantly above the MRL 0.01 mg/Kg whereas the values of dichlorvos are below MRL value of 1 mg/Kg. Tables 1 to 4 shows the levels of preference of the pesticide residues in the internal organs of these animals than the beef and chevon samples as analysed in the study. The attribute to none detect ability of the pesticide residues could be due to, personal error or operative error which arises mainly from operators showing some personal prejudices and preferences in the analysis which might lead to an error. An example is the habitual filling of the calibrated volumetric glassware above the indicated mark; operators with blurred vision for colour changes are prone to introduce errors in visual titration. The variability in replicate analysis, irregular and unpredictable forms of observation affect the accuracy that might be achieved from this study. Other factor may be attributed to none detect ability of these study might be gross error which has to do with the carelessness in analytical procedure, improper recording of analytical data, results and errors in calculations. The errors affect accuracy and provide results that are precise but not accurate.

Conclusions

The findings of this study show the none detectability of organochlorine pesticide residues in all the samples analyzed whereas, organophosphorus pesticides - Chlorpyrifos and Dichlorvos - concentration are relatively high with chlorpyrifos and low with dichlorvos in the intestine, kidney and liver analysed respectively. Dichlorpyrifos, Diazinon, Dimethoate, Primifos-methyl and Malathion are below detection limit or below the threshold of MRL. The differences may be attributed to environmental factors or where these pesticides are used by farmers. Through water and feeds, the animal may have access to the fodder and thus ingest the pesticides. The concentrations of pesticide residual levels of chlorpyrifos in the internal organs are generally higher than the available MRL in the literature. The concentration of Dichlorvos residues are below the detection limit in the animals as established by United States Food and Drug Administration (USFDA). The concentration of Anthracene, Dichlorpyrifos, Diazinon. Dimethoate, Primifos-methyl and Malathion in all the samples analysed were below detection limit while, and this study further revealed that no trace of organochlorine pesticides was detected.

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