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Safety Impact and Farmers' Awareness of Presence of Pesticide Residues in Tomatoes Cultivated with the Aid of Pesticides in Ethiope West Local Government Area, Delta State Nigeria

Dr. (Mrs.) Sogbaike, C[1]; Mr. Akpobire, O[2]; Mr. Aderha, O[3], Mr. Sogbaike, T[4]

[1,2,3]Department of Science Laboratory Technology, School of Sciences and Technology, Delta State Polytechnic Otefe-Oghara, Delta, Nigeria
[4]School of General Studies, Delta State Polytechnic Otefe-Oghara, Delta, Nigeria

ABSTRACT

This study investigated the safety of tomatoes cultivated with pesticides in Ethiope West Local Government Area, Delta State, Nigeria. A mixed-method approach was employed, incorporating field surveys with laboratory analyses. Purposive sampling was utilized to select 320 tomato farmers. The structured questionnaire utilized has high Cronbach's Alpha reliability coefficient of 0.963, indicating strong internal consistency. The results revealed a dominance of organophosphate and carbamate use by farmers, with over 54% (n=175) reporting using organophosphates and nearly 23% (n=75) utilizing carbamates. Cost and perceived effectiveness against pests were identified as the primary drivers for pesticide selection. Interestingly, consumer awareness of pesticide use in tomato cultivation was high, with over 81% (n=260) of respondents acknowledging this practice. However, a significant knowledge gap was evident, as farmers reported limited understanding of the potential health impacts associated with pesticide residues. This concern was further amplified by consumer reports, with over 35% (n=115) experiencing headaches and nearly 6% (n=20) suffering from mild stomach upset after consuming tomatoes. To objectively assess potential risks, laboratory analyses were conducted on tomato samples collected from various farms. The QuEChERS method was employed to detect pesticide residues. The analyses confirmed the presence of organophosphate and carbamate residues in some tomato samples. Furthermore, a concerning finding was that exceeding the established Maximum Residue Levels (MRLs) set for safe human consumption occurred in some samples. For instance, tomatoes from Ugbenu exhibited a carbamate residue (Carbaryl) concentration of 1.20 mg/kg, exceeding the MRL of 1.0 mg/kg. In conclusion, this study highlights potential safety issues associated with current pesticide use practices in tomato farming within the study area. The dominance of organophosphate and carbamate use, coupled with consumer reports of health concerns, suggests a need for intervention. The findings underscore the importance of improved regulations on pesticide application, along with educational programs for farmers to enhance their understanding of safe handling and application techniques. Additionally, increased consumer awareness campaigns are crucial to promote informed choices and encourage safer consumption practices. By implementing these measures, a more sustainable and secure tomato production system can be established, ultimately improving the overall tomato value chain not only in Delta State but across Nigeria.

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KEYWORDS: *pesticide residue tomato safety, consumer awareness, health impacts, Maximum Residue Levels*

INTRODUCTION:

Tomatoes are a vital part of a nutritious diet, abounding in vitamins, minerals, and antioxidants (Imran et al., 2020; Kumar et al., 2020). They are extensively grown throughout Nigeria, particularly in the Ethiope West Local Government Area of Delta State. Nevertheless, it is essential to guarantee their safety for eating. Pesticide application is a crucial factor in tomato cultivation as it safeguards the crops against pests and illnesses. Improper pesticide application might result in the presence of hazardous residues on tomatoes, despite its positive impact on yield. Some studies have expressed concerns regarding potential health issues linked to exposure to pesticides (Lozowicka *et al*., 2015; Chaudhary *et al*., 2018). These concerns encompass symptoms such as migraines, gastrointestinal discomfort, and potentially more grave health ramifications. Delta State, a prominent tomato grower in Nigeria, It is crucial to comprehend the existing methods of pesticide utilization in tomato cultivation in Ethiope West and evaluate the likelihood of residual contamination.

The aim of the present research examined the safety of tomatoes grown with pesticides in Ethiope West, Delta State, Nigeria. The study aims to provide significant insights on the safety of tomatoes cultivated in the region and assist efforts that will improve safe tomato cultivation practices by addressing these issues. The quality of agricultural products is closely related to pesticide residues. Pesticide residues have been increasingly linked to issues of safety and quality of agricultural products. The threat of pesticide residues not only depends on the quality and specificity of pesticides, but also on farmers' awareness of pesticide residues and their behaviour in applying these pesticides (Ojo, 2016).

With tomatoes being a staple in Nigerian diets, demand is high, especially during festive periods, attracting both local farmers and investors. Pesticide residues left on harvested crops pose health challenges for consumers, prompting the establishment of Maximum Residue Limits (MRLs) to regulate pesticide levels. MRLs are set by national or international authorities to ensure food safety in accordance with Good Agricultural Practice (GAP) (Livermore, 2006). If the levels of these residues surpass the prescribed Maximum Residue Levels (MRLs), they can potentially endanger the health of consumers (Warra et al., 2020; Handford et al., 2015).

Methodology

The research used the methodology of Field Survey as well as Laboratory experiments/assessment of samples of tomatoes and soil form the study area.

Study area

Ethiope West Local Government Area of Delta State, Nigeria, is located between latitude 5°35′1″N and longitude 5°51′16″E. Selected communities for the study from the local government area include Ogharefe, Oghareki, Ijomi, Otefe, Ovade, Ugbenu, and Mosogar communities within the Local Government aea.

Sampling

tMajor tomatoes producing areas in the Ethiope West Local Government Area would be used for the study. Areas selected included Ogharefe, Oghareki, Ijomi, Otefe, Ovade, Ugbenu, and Mosogar communities. A total of 320 respondents consisting of tomato farmers was be selected from the communities using the purposive sampling technique which is a non-probability sampling method. The questionnaires were pre-tested on a small sample of respondents in three tomato producing communities in Ethiope East Local government area for content validity. To assess pesticide residues in tomatoes, samples were collected from various farms and homogenized for consistency. These samples underwent solvent extraction to isolate the pesticides from the tomatoes. An optional clean-up step might follow to remove interfering substances. Pesticide residue analysis work was carried out using the Quick Easy Cheap Effective Rugged and Safe (QuEChERS) Mini- Multi residue method which is for the analysis of pesticide residue in low-fat products.

Data Analysis

Data collected would be analyzed using two sample t-test at 5% significant level using Statistix (version 9) statistical software.

RESULTS AND DISCUSSION

Table 1: Reported Pesticide Usage by Tomato Farmers in Ethiope West

Pesticide Type	Frequency of Use (Number of Respondents)	% of Respondents
Organophosphates	175	54.69
Carbamates	75	23.44
Pyrethroids	24	7.50
Others pesticide brands	46	14.38

Source: Field survey

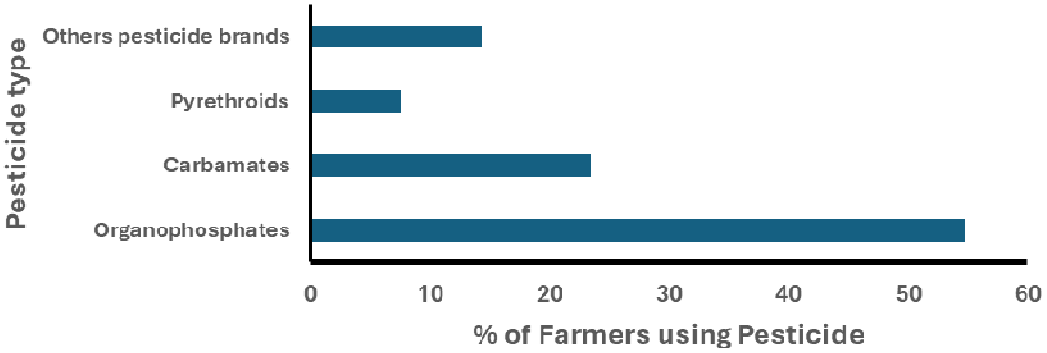

Figure 1: Types of Pesticides and Percentage of Farmers using them.

A field survey revealed the types and prevalence of pesticides used by tomato farmers in Ethiope West, Delta State, Nigeria (Table 1). The dominant classes of pesticides employed were organophosphates (54.69%) and carbamates (23.44%). Pyrethroids were used by a smaller proportion of farmers (7.50%), while a category encompassing "Other pesticide brands" accounted for 14.38% of respondents.

Table 2: Factors Influencing Pesticide Choice by Tomato Farmers

Factor	Frequency (Number of Respondents)	% of Respondents
Reported effectiveness against pests	130	40.63
Cost	120	37.50
Availability in the market	25	7.81
Recommendation by others (sellers, etc.)	45	14.06

Source: Field survey

(Table 2) Show the primary considerations reported by farmers were reported effectiveness against pests (40.63%): This finding highlights the farmers' prioritization of pest control efficiency when choosing pesticides. Cost (37.50%). Economic considerations play a significant role in pesticide selection, potentially leading farmers to opt for less expensive options, even if they have higher health or environmental risks. Availability in the market (7.81%) Limited access to a wider range of safer alternatives could restrict farmers' choices. Recommendation by others (sellers, etc.) (14.06%)

Table 3: Respondents report on Consumers' Awareness of Pesticide Use in Tomatoes cultivation

Level of Awareness	Frequency of Selection (Number of Respondents)	% of Respondents
Very Aware	260	81.25
Somewhat Aware	40	12.50
Not Aware	20	6.25

Source: Field survey

Table 3 presents the findings on consumer awareness of pesticide use in tomato cultivation. A high proportion of respondents reported being: Very Aware (81.25%); Somewhat Aware (12.50%). Only a small percentage indicated they were "Not Aware" (6.25%). The high level of consumer awareness regarding pesticide use in tomato cultivation (81.25% and 12.50% "Very Aware" and "Somewhat Aware", respectively) suggests a potential demand for safer tomato production practices.

Discussion:

The results show relatively high prevalence of organophosphate and carbamate use in tomato cultivation. While these pesticides effectively control pests, they have also been linked to potential health risks for humans if not handled and applied appropriately (Rani *et al.*, 2021). Having an understanding of the specific types of organophosphates and carbamates being used is crucial for the planning of any targeted assessment of potential health risks. This information can inform recommendations for safer alternatives and guide training programs for farmers on safe handling and application techniques.

Tomatoes, rich in nutrients and antioxidants, are extensively cultivated in Nigeria, particularly in the Ethiope West Local Government Area of Delta State. Pesticide application is vital for protecting crops, but improper use can leave hazardous residues on tomatoes, posing health risks if they exceed Maximum Residue Levels (MRLs). Studies have raised concerns about health issues related to pesticide exposure, including migraines and

gastrointestinal discomfort. Understanding pesticide use methods in Ethiope West is crucial for assessing contamination risks.

The relatively low utilization of pyrethroids is significant. These pesticides are generally considered to have lower mammalian toxicity compared to organophosphates and carbamates. Further research is needed to explore the reasons behind this observation.

The influence of sellers and advisors on farmers' choices emphasizes the need for training and education programs to ensure these recommendations promote safe and sustainable practices.

The superiority of "reported effectiveness against pests" (40.63%) as a driving factor aligns with the observed high prevalence of organophosphates and carbamates, which are known for their effectiveness in pest control. However, this focus on efficacy should be balanced with considerations for human health and environmental safety. The substantial influence of "cost" (37.50%) on pesticide selection necessitates interventions that address affordability. Providing farmers with access to cost-effective, safer alternatives or financial incentives for adopting such alternatives could be explored. The limited role of "availability in the market" (7.81%) suggests that the current pesticide market might not be adequately stocked with safer options.

Promoting the availability of effective and affordable safer alternatives through collaboration with agricultural extension services and input suppliers is crucial. The influence of "recommendation by others" (14.06%) underscores the importance of ensuring that sellers and advisors promoting pesticides possess adequate knowledge about safe handling, application techniques, and potential health risks associated with different products. Training programs and certification for sellers and advisors can help mitigate this issue.

Results from Table 3 indicates that awareness can be leveraged to promote educational campaigns that empower consumers to make informed choices when purchasing tomatoes. However, it is important to acknowledge that awareness does not necessarily equate to knowledge about the potential health risks associated with pesticide residues.

Generally, the findings from Tables 2 and 3 highlight the need for a multi-pronged approach that addresses both farmer practices and consumer awareness. By promoting the adoption of safer alternatives, ensuring the availability of these options, and educating both farmers and consumers, a more sustainable and secure tomato production system can be established in Ethiope West.

Table 4: Reported Farmers' Pesticide Application Methods Used by Tomato Farmers

Pesticide Application Method	Frequency of Use (Number of Respondents)	% of Respondents
Spraying	145	45.31
Knapsack Duster	65	20.31
Other methods	110	34.38

Source: Field survey

A field survey investigated the methods employed by tomato farmers in Ethiope West for pesticide application (Table 4). The most frequently reported methods were: The dominance of spraying (45.31%) as an application method necessitates a closer look at potential inefficiencies and safety concerns. Spraying can lead to significant pesticide drift, resulting in wasted product, environmental contamination, and potential exposure risks for farmers and nearby communities. The use of knapsack dusters (20.31%) is a more targeted approach compared to spraying. However, proper training on safe handling and techniques for using dusters is crucial to minimize inhalation risks for farmers. The category of "other methods" (34.38%) encompasses a variety of potential application techniques. Further investigation is required to identify these specific methods and assess their associated safety considerations.

Table 5: Consumer Awareness of Pesticide Use in Tomatoes

Level of Awareness	Frequency (Number of Respondents)	% of Respondents
Very Aware	160	53.00
Somewhat Aware	40	12.50
Not Aware	120	37.50

Source: Field survey

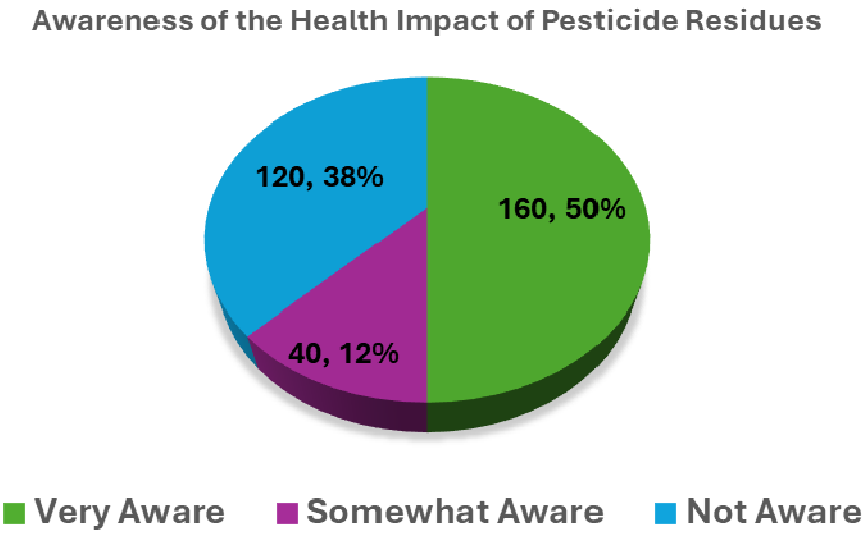

Figure 2: farmers' reported awareness of Health Impact of Pesticide residues in Tomatoes

Table 5 and Figure 2 show a lower proportion of consumers reporting "Very Aware" (53.00%) and a higher proportion reporting "Not Aware" (37.50%).Understanding farmers' awareness of potential health risks associated with pesticide residues is crucial. A lack of knowledge could lead to unsafe handling practices, potentially jeopardizing their own health and the health of those around them. Awareness of the potential constituents of any food item is crucial for consumers (Rahman, 2003).

Table 6: Respondents' Reports on Health Experiences after Consuming Tomatoes Cultivated with Pesticide Use

Reported Health Experience	Frequency of Reported cases (Number of Respondents)	% of Respondents
No Reported Issues	125	39.06
Mild Stomach Upset	20	6.25
Headache	115	35.94
Skin Irritation	60	18.75

Source: Field survey

A field survey investigated self-reported health experiences among consumers after consuming tomatoes (Table 6). Self-reported health experiences can be subjective and influenced by factors beyond tomato consumption. However, the high prevalence of headaches (35.94%) is concerning, especially considering the established potential for some organophosphates and carbamates to cause headaches as a symptom of acute exposure .The findings on stomach upset (6.25%) and skin irritation (18.75%) also warrant further investigation. While these symptoms can have various causes, some studies suggest potential links to organophosphate and carbamate exposure (Bardin *et al*., 1994). Future research should employ more objective measures to assess potential health impacts associated with pesticide residues. This could involve biological monitoring to measure pesticide metabolites in urine or blood samples of consumers.

Table 7: Detected Pesticide Residues in Tomato Samples

Sample ID	Location/ Community	Pesticide Detected	Concentration (mg/kg)	Maximum Residue Level (MRL)	Exceeds MRL?
Sample 1	Ogharefe	Organophosphate (e.g., Chlorpyrifos)	0.30	1.0	No
Sample 2	Oghareki	Carbamate (Methomyl)	0.10	2.0	No
Sample 3	Ijomi	Pyrethroid (Lambda-cyhalothrin)	Not Detected	0.5	No
Sample 4	Otefe	Organophosphate (Profenofos)	0.38	0.1	Yes
Sample 5	Ovade	ND	-	-	No
Sample 6	Ugbenu	Carbamate (Carbaryl)	1.20	1.0	Yes
Sample 7	Mosogar	Pyrethroid (Deltamethrin)	0.03	3.0	No

ND = None Detected

Pesticide Residues in Tomato Samples (Table 7): Six out of seven samples had detectable pesticide residues. Two samples (Sample 4 and Sample 6) exceeded the established Maximum Residue Levels (MRLs). Sample 4 from Otefe contained an organophosphate residue (Profenofos) at a concentration of 0.38 mg/kg, exceeding the MRL of 0.1 mg/kg. Sample 6 from Ugbenu contained a carbamate residue (Carbaryl) at a concentration of 1.20 mg/kg, exceeding the MRL of 1.0 mg/kg. The remaining five samples did not exceed their respective MRLs.

DISCUSSION

Generally, the findings on application methods highlight the need for promoting best practices among farmers. Educational programs can emphasize targeted application techniques that minimize waste, environmental impact, and potential exposure risks. The detection of pesticide residues in six out of seven tomato samples is concerning. These residues pose potential health risks to consumers if ingested. This raises issues of safety and health of potential consumers (Attrey, 2017; Ezirigwe, 2018).

The presence of Profenofos (Sample 4) is particularly worrisome as this organophosphate has been classified as a moderately hazardous pesticide by the World Health Organization (WHO). Carbaryl is also classified by the WHO as a moderately hazardous insecticide (Gunasekara, 2007). The findings from Table 7 highlight the potential safety hazard associated with current pesticide use practices in tomato farming within the study area. The presence of residues exceeding MRLs underscores the need for stricter regulations on pesticide application and improved enforcement mechanisms (Wang et al., 2018). Exposure to organophosphate and carbamate pesticides can cause health problems. In the short term (acute effects) this might include headaches, nausea, dizziness, and skin irritation - issues (King & Aaron, 2015) similar to that reported by some consumers in this study. Long-term exposure (chronic effects) can be even more serious, potentially leading to cancers, neurological problems, and developmental issues in children. The specific health risks depend on the type of pesticide, how much and for how long someone is exposed, and their individual sensitivity (Naughton, & Terry 2018).

CONCLUSION

This study investigated the safety of tomatoes cultivated with pesticides in Ethiope West Local Government Area, Delta State, Nigeria. It employed a mixed-method approach, combining field surveys with laboratory analyses of tomato samples.

The findings revealed that farmers in the region predominantly use organophosphates and carbamates, primarily driven by cost and perceived effectiveness against pests. While the farmers demonstrated a high awareness of pesticide use in tomato cultivation, their knowledge regarding potential health risks from residues might be limited. This is concerning, especially considering that self-reported health experiences among respondents after consuming tomatoes included headaches and stomach upset.

Laboratory analyses further amplified these concerns. Pesticide residues were detected in six out of seven tomato samples collected from various farms, with two exceeding the established Maximum Residue Levels (MRLs) set for safe human consumption. These findings highlight potential safety issues associated with current pesticide use practices in the study area. The dominance of organophosphates and carbamates, coupled with consumer reports of health concerns and the presence of residues exceeding MRLs, necessitates a multi-pronged approach to improve the safety of tomatoes cultivated in Ethiope West.

RECOMMENDATIONS

The study recommends promoting safer alternatives such as Integrated Pest Management (IPM) strategies that prioritize non-chemical control methods. Additionally, educational programs for farmers on safe handling, application techniques, and the potential health risks of different pesticides are crucial (Mayer & Wang, 2018). Strengthening regulations and enforcing them more effectively on pesticide use, storage, and disposal is also essential. Finally, increasing consumer awareness through targeted campaigns can empower them to make informed choices when purchasing tomatoes and promote safe handling practices at home.

By implementing these recommendations, a more sustainable and secure tomato production system can be established in Ethiope West local government area. This will ultimately protect consumer health and promote a thriving tomato value chain within the region. Further research is needed to explore the potential health impacts associated with pesticide residues and to evaluate the effectiveness of interventions aimed at improving safety practices in tomato production.

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