Journal of Materials and Environmental Science
ISSN : 2028-2508
CODEN : JMESCN

J. Mater. Environ. Sci., 2020, Volume 11, Issue 12, Page 2084-2094

http://www.jmaterenvironsci.com

Assessment of Trace Organics in Tomatoes from Selected Markets in Ado-Ekiti, Nigeria

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Received 22 April 2020,
Revised 28 Dec 2020,
Accepted 29 Dec 2020

Keywords
- ✓ Gas chromatography,
- ✓ Trace organics,
- ✓ Tomatoes,
- ✓ Pesticide residues,
- ✓ polychlorinated biphenyls.

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Abstract

This study was to determine the levels of trace organics in tomatoes (Lycopersicum esculuntum**)** obtained from Ago-Aduloju and Sasha Markets in Ado-Ekiti, Nigeria. Tomato samples from each market, divided into three portions (one was unwashed; another was washed with distilled water; and the other was washed with warm distilled water), were analyzed for organic pollutants using standard procedures. The following ranges of results (mg/kg) were obtained for Ago-Aduloju and Shasha samples: organochlorine pesticides (OCPs) (0.013-0.144, 0.121-0.932); polychlorinated biphenyls (PCBs) (0.001 - 0.054, 0.006-0.172); and polycyclic aromatic hydrocarbons (PAHs) (0.447-12.5, 0.231-19.000). The results indicated that the samples exhibited varying degrees of contamination. Higher concentrations were observed in Sasha samples. The study revealed that washing of tomatoes with warm water is more effective in reducing the levels of contaminants. Moreover, the results were within the maximum residue levels (MRLs) of World Health Organization, thus making the vegetables suitable for human consumption.

1. Introduction

Consumption of fruits and vegetables has been on the increase, most especially in cities and urban areas, simply because of the awareness on the nutritional aspect as informed from general education and cross-cultural relationship [1]. Tomato (*Lycopersicum esculuntum*) is no doubt one of the major vegetables, largely grown and consumed in Nigeria. Tomato (*Lycopersicum esculuntum*) is ranked alongside potatoes and sweet potatoes. It is reported that consumption of tomatoes and their products plays a vital role in the reduction of carcinogenesis, most especially, prostate cancer. The active component in tomatoes in this regard is lycopene, which imparts red colour in tomatoes [2].

Pesticides residue is a major concern when it comes to human health, aquatics, organisms in the soil, and the environment at large [3, 4]. Persistent pesticides are observed in the soil, water bodies, and even foods. Baptist *et al.* [5] and Lazic *et al.* [6] reported that vegetables do contain pesticide residues when there is an uncontrolled application of pesticides to a farmland in order to maximize crop yields and quality. Pesticides residues can do so much harm to consumers of contaminated vegetables and crops, causing varying degrees of health disorder, among many other challenges. Since human diets are incomplete without incorporating vegetables and fruits, there is the need to investigate the levels of pesticide residues in consumable vegetables at a regular interval to safe-guard the health of the general populace. So, this study is aimed at determining the concentrations of pesticide residues in tomatoes collected from two major markets in Ado Ekiti, Ekiti State, Nigeria.

2. Material and Methods

2.1. Study area and sample collection

Ado-Ekiti, being the capital of Ekiti State is an urban town with increasing population. The population was 424,340 as at 2012 with an estimated area of 293 square kilometers [7] (World Gazetteer, 2012). The study areas are in two different parts of Ado Ekiti, Ekiti State, Nigeria: Ago-Aduloju (latitude 7°36′9.00″N; longitude of 5°19′40.44″E); and Sasha (latitude 7°34′18.12″N; longitude of 5°12′41.76″E). Tomato samples were collected from two different locations (Ago-Aduloju and Sasha markets) in Ado-Ekiti, Ekiti State, Nigeria. All tomato samples were packed into well labelled polythene bags and taken to laboratory for analyses. Tomato samples from each location were divided into three parts: one portion was left unwashed (UWS), another portion was washed with distilled water (WSD), and the last portion was washed with warm distilled water (WWW).

2.2. Sample Preparation and processing

Each sample was ground and homogenized using mortar and pestle. The homogenized sample (20 g) was treated with acetone (20 mL) and then with a 20 mL mixture of dichloromethane and cyclohexane (1:1) by sonication in ultrasonic bath for 30 min. The mixture was filtered through glass wool containing anhydrous sulphate, and then washed with dichloromethane and cyclohexane (1:1, 5mL). The extract was concentrated in rotary evaporator at 40°C and made up to 2 mL using cyclohexane. The clean-up procedure for the extracts was conducted using Akerblom [8] method with slight modifications. A chromatographic tube was plugged with a glass wool, packed with an activated florisil (3 g), and topped up with sodium sulphate (5 – 10 cm). The column was rinsed with cyclohexane (5 mL), and the extract (2 mL) was passed through the column and eluted sequentially with cyclohexane (20 mL) and cyclohexane: acetone (9:1, 10 mL). The collected portions were combined and concentrated in rotary evaporator to 2 mL in cyclohexane: acetone (9:1, 10 mL) after which it was subjected to analysis using Gas Chromatography (Agilent GC-7890A) coupled with a Flame Ionization Detector).

2.3 Chromatographic Conditions

The inlet temperature was set at 270°C. Helium was used as the carrier (1.2 mL/min) with nitrogen as the make-up gas. Initial column temperature was 60°C, held for 1 min. The temperature was ramped to 210°C at 12°C/min and finally ramped up to 320°C at 8°C/min, and then held at 5 min. Total time run was 32.25 min and the FID temperature was maintained at 325°C. A gas chromatograph equipped with a splitless injection inlet, electron capture detector for the OCPs and PCBs was fused with a silica capillary column DB17 (30 m x 320 um x 0.25 um) and an auto-sampler. Ultra-pure helium gas was used as a carrier gas at a flow rate of 2 mL/min and nitrogen as the makeup gas. The injector temperature was 250°C. Initial oven temperature of 150^{o}C, which was then increased to 250°C at 6°C/min. Total run time was 14 min.

3. Results and discussion

3.1. Organochlorine pesticides (OCPs) in tomato samples

The levels of OCPs residues in the tomato samples collected from Ago-Aduloju and Shasha markets are presented in Table 1. Also, WHO/FAO and EU guidelines for tomatoes are presented in Table 2. The results revealed the presence of seventeen OCP residues. Detectable compounds were β-BHC, δ-BHC, γ-BHC, α –BHC, heptachlor, aldrin, heptachlor epoxide, endosulfan I, p,p′-DDE, dieldrin, endrin, endosulfan II, p,p′-DDD, p,p’-DDT, endrin aldehyde, endosulfan sulphate and methoxychlor. For the

Ago-Aduloju samples, the concentration of the OCPs varied from ND - 0.054 mg/kg for the unwashed sample (UWS), ND - 0.007 mg/kg for the washed sample (WSD), and ND - 0.006 for the sample washed with distilled warm water (WWW). It was discovered that Alpha-BHC has the highest concentration (0.054 mg/kg). α-isomer of BHC among 8 isomers has been tagged a non-genotoxic cancer causing agent as it necessitates hepatocellular carcinomas in rats, yet needs mutagenicity in the Ames test [9]. Afful *et al.* [10] reported that the high OCPs cause health challenges in humans, animals, and the environment. The toxicological health effects of OCPs include disruptions in endocrine, reproductive issues, cancer, and immune system deficiency [11, 12].

Table 1: Concentrations (mg/kg) of OCPs in the tomato samples from Ago-Aduloju and Shasha market

Pesticides	Ago-Aduloju Market			Sasha Market		
	UWS	WSD	WWW	UWS	WSD	WWW
Alpha-BHC	0.054	ND	ND	0.055	0.049	0.030
Beta-BHC	0.003	ND	ND	0.003	0.002	0.002
Heptachlor	0.006	0.004	0.001	0.011	0.006	0.001
Aldrin	0.023	0.004	0.004	0.012	0.005	0.008
Gamma-BHC	0.003	0.002	0.002	0.002	0.003	0.004
Delta-BHC	0.003	0.001	ND	0.002	0.002	0.003
Heptachlor epoxide	0.001	ND	ND	0.012	0.002	ND
Endosulfan I	ND	ND	ND	0.009	0.008	ND
p, p'- DDE	0.009	0.001	ND	0.060	0.007	0.006
Dieldrin	0.007	ND	ND	0.080	0.045	0.015
Endrin	ND	ND	ND	0.019	0.007	0.006
p, p'- DDD	ND	ND	ND	0.009	0.007	ND
Endosulfan II	0.008	0.007	0.006	0.048	0.027	0.015
p, p'- DDT	0.007	ND	ND	0.068	0.004	ND
Endrin aldehyde	ND	ND	ND	0.532	0.040	0.031
Endosulfan sulfate	ND	ND	ND	0.010	ND	ND
Methoxychlor	0.02	ND	ND	ND	ND	ND
ΣOCPs	0.144	0.019	0.013	0.932	0.214	0.121

*ND-Not Detectable; UWS-Unwashed sample; WSD-Washed with distilled water; WWW-Washed with warm distilled water

Table 2: WHO/FAO and EU guidelines for tomato (mg/kg)

Pesticides	**MRL (FAO 2013)**	**MRL(EU 2015)**
α-Endosulfan	0.5	0.5
β-Endosulfan	0.5	0.5
Aldrin	0.1	0.1
Dieldrin	0.1	0.1
Endrin	0.5	0.5
Heptachlors	0.1	0.1
DDT	0.5	0.5

Endosulfan II was present in all the tomato samples ranging from 0.006 - 0.008 mg/kg which is lower than 0.043 mg/kg reported by Essumang et al. [13]. The concentration is lower than 0.50 mg/kg of maximum residue levels (MRL), indicating that consumers are safe from any effects that might result from ingestion of these foods. However, endosulfan is not registered in Nigeria as a pesticide for use on vegetables, thus, their presence in tomatoes indicates misuse of agrochemicals among Nigerian farmers. The central nervous system is the key target by exposure to β-endosulfan. Inhaling, drinking, or eating high doses of endosulfan causes convulsions and could lead to death [14].

Concentrations of OCPs ranged from ND - 0.532mg/kg in Sasha samples. Concentrations of endrin aldehyde in UWS, WSD, and WWW from the Shasha samples were 0.532, 0.040, and 0.031 mg/kg, respectively, the highest concentration (0.532 mg/kg) of endrin aldehyde (higher than MRL value) was found in the unwashed sample (UWS), while the levels of endrin aldehyde in WSD and WWW were lower and within the MRL values stipulated by FAO [15] and EU [16]. Elbashir et al. [17] reported that the residues of pesticides were generally higher than the MRL values but washing once or several reduced the residues to values below the recommended MRL in most cases. Abou-Arab [18] reported that, washing tomatoes with tap water helped to reduce the loads of pesticide residues of HCB and p,p′-DDT by 9.62 and 9.17%, respectively. DDT and its derivatives were detected in samples but were lower than the MRL value. The presence of DDT residues in the samples could be due to the past use of the pesticides in the area of cultivation. Levels of endosulfan I and II in this study were lower than values (0.6 and 0.2 mg/kg) reported by Mahugija et al. [19], and were within the MRL values of FAO/WHO [15] and EU [16]. It was observed that the levels of pesticide residues in Shasha samples were higher than those in the Ago-Aduloju samples.

3.2. Polychlorinated Biphenyls (PCBs) in Tomato Samples

Resuilts of polychlorinated biphenyls (PCBs) in tomatoes collected from Ago-Aduloju and Shasha markets are presented in Table 3. The following congeners were found in the tomato samples from Ago-Aduloju market; PCB 8, PCB 18, PCB 28, PCB 44, PCB 52, PCB 60, PCB 126, PCB 156; with PCB 18 (UWS) having the highest concentration (0.010 mg/kg). The concentrations were however reduced upon washing with distilled water (ordinary and warm). The concentrations of PCBs from Shasha market ranged from ND – 0.020 mg/kg. Congeners 138 and 180 were not detected in Ago-Aduloju samples, but were found relatively low in samples from Shasha. Adeyemi *et al.* [20] reported that PCBs are easily volatilized from either soil or water and thereafter re-deposited on various media, the toxic potentials during exposure to humans are enormous, they affect the liver, thyroid, and cause reduced weight at birth and can induce cancer. Gonzalez *et al.* [21] reported that the concentration of PCBs at elevated levels could be due to the persistent and bio-accumulative tendencies of PCB congeners, linked to their structures as a result of the absence of un-substituted chlorine at *meta*- and *para*-positions of the biphenyl ring. Chlorinated congeners were however low due to their low bio-accumulative potentials. In this study, it was observed that washing of the samples with distilled water (ordinary and warm) reduced the levels of PCBs.

3.3. Polycyclic Aromatic Hydrocarbons (PAHs)

Polycyclic Aromatic Hydrocarbons (PAHs) in tomatoes from the two markets are presented in Table 4. The sums of the 16 PAHs in tomato samples collected ranged from 0.447 - 12.500 mg/kg for Ago-Aduloju samples and 0.231 - 19.000 mg/kg for Shasha samples, respectively. The results showed that PAHs in UWS were in higher concentration in samples collected from Shasha market than Ago-Aduloju market. It was observed that washing with warm distilled water reduced the levels of PAHs more than washing with ordinary distilled water.

Table 3: Concentrations (mg/kg) of PCBs in tomato samples from Ago-Aduloju and Shasha markets

PCB Congeners	Ago-Aduloju market			Shasha market		
	UWS	WSD	WWW	UWS	WSD	WWW
PCB 8	0.009	0.005	ND	0.008	0.007	ND
PCB 18	0.010	0.004	ND	0.017	0.011	0.001
PCB 28	0.003	0.003	ND	0.004	0.004	ND
PCB 44	0.003	0.003	ND	0.006	0.006	ND
PCB 52	0.003	0.002	ND	0.010	0.003	0.001
PCB 60	0.014	0.002	ND	0.010	0.003	ND
PCB 77	ND	ND	ND	0.007	0.002	ND
PCB 101	ND	0.002	ND	0.010	0.009	0.001
PCB 81	ND	ND	ND	0.004	0.003	ND
PCB 105	ND	ND	ND	0.004	0.003	ND
PCB 114	ND	ND	ND	0.006	0.003	ND
PCB 118	ND	ND	ND	0.018	0.005	ND
PCB 123	ND	ND	ND	0.010	0.008	ND
PCB 126	0.002	ND	ND	0.004	0.003	ND
PCB 138	ND	ND	ND	0.004	0.004	ND
PCB 128	ND	ND	ND	0.004	0.003	ND
PCB 156	0.005	0.003	ND	0.020	0.011	0.001
PCB 153	ND	ND	ND	0.003	0.003	ND
PCB 157	ND	ND	ND	0.002	0.001	ND
PCB 170	ND	ND	ND	0.002	0.001	ND
PCB 167	ND	ND	ND	0.002	ND	ND
PCB 169	ND	ND	ND	0.003	0.002	ND
PCB 180	ND	ND	ND	0.007	0.003	ND
PCB 185	ND	ND	ND	0.003	0.000	0.000
PCB 189	ND	ND	ND	ND	ND	ND
PCB 195	ND	ND	ND	ND	ND	ND
PCB 206	ND	ND	ND	ND	ND	ND
PCB 209	ND	ND	ND	0.004	0.003	ND
ΣPCBs	0.049	0.024	ND	0.172	0.101	0.004

*ND-Not Detected; UWS-Unwashed sample; WSD-Washed with distilled water; WWW-Washed with warm distilled water

Naphthalene and dibenz (a,h) anthracene were not detected in the samples from the two locations. Acenaphthylene, acenaphthene, and anthracene were not detected in the samples from Ago-Aduloju market but were all present in the unwashed sample from Shasha market. It was also observed that washing the samples with distilled water (ordinary and warm) completely removed acenaphthylene, acenaphthene, anthracene from the samples. The presence of PAHs in foods revolves round the environmental concentrations of the pollutants, and the physiological and ecological features of the products [22]. In a study conducted by Ashraf and Salam [23], it was reported that the total PAH contents of the investigated root vegetables such as potato and carrots showed low concentration (0.011 mg/kg).

Table 4: Concentrations (mg/kg) of PAHs in tomatoes from Ago-Aduloju and Shasha market

PAH	Ago-Aduloju market			Shasha market		
	UWS	WSD	WWW	UWS	WSD	WWW
Naphthalene	ND	ND	ND	ND	ND	ND
Acenaphthylene	ND	ND	ND	0.187	ND	ND
Acenaphthene	ND	ND	ND	5.820	ND	ND
Fluorene	3.430	2.630	0.171	3.140	0.290	0.015
Phenanthrene	0.220	ND	ND	0.288	ND	ND
Anthracene	ND	ND	ND	0.308	0.006	ND
Fluoranthene	0.375	0.212	0.019	0.108	0.063	0.003
Pyrene'	0.960	0.861	0.048	1.040	0.310	0.016
Chrysene	0.310	0.026	0.016	0.160	0.073	0.004
Benzo (a) anthracene	1.100	0.273	0.055	1.560	0.545	0.027
Benzo (k) fluoranthene	1.220	0.237	0.061	0.570	0.220	0.011
Benzo (b) fluoranthene	0.178	0.175	0.009	1.500	0.194	0.010
Benzo (a) pyrene	1.360	0.364	0.068	1.580	0.737	0.037
Indeno (1,2,3-cd) pyrene	1.650	ND	ND	1.430	1.020	0.051
Dibenz (a,h) anthracene	ND	ND	ND	ND	ND	ND
Benzo (g,h,i) perylene	1.680	ND	ND	1.250	1.140	0.057
ΣPAHs	12.5	4.78	0.447	19.000	4.600	0.231

*ND-Not Detectable; UWS-Unwashed sample; WSD-Washed with distilled water; WWW-Washed with warm distilled water

The concentrations of acenaphthylene, fluorene, phenanthrene, anthracene, and fluoranthene in Shasha samples were lower than values of 24.53, 5.40, 7.51, 5.16, and 4.50 mg/kg reported for acenaphthylene, fluorene, phenanthrene, anthracene, and fluoranthene, respectively by Tuteja *et al.* [24]. The higher concentration of PAHs in tomatoes could be attributed to their greater surface areas to the atmosphere during growth. The accumulation of low molecular weight PAHs in vegetables may be as a result of their high solubility in water, volatile nature, and bioavailability [25]. The mean concentrations of pyrene, chrysene, benzo (a) anthracene, benzo (b) fluoranthene, benzo (a) pyrene, dibenzo (a, h) anthracene, indeno (1, 2, 3-cd) pyrene and benzo (g, h, i) perylene were relatively high in both locations. The high molecular weight PAHs have lower water solubility compared to the low molecular weight compounds, and their potentials to be translocated from the soils by the roots is also low. Burning of wood could contribute significant amount of PAHs in the generated ashes [26]. Uncontrolled burnings of materials are considered a major source of high molecular weight PAHs. In this study, it was observed that washing with distilled water (ordinary and warm) reduced the concentration of the samples. Contamination of the tomato samples by PAHs may be due to fall-out and deposition from PAHs polluted environment. Phenanthrene, chrysene, benzo (a) anthracene, benzo (k) fluoranthene, benzo (a) pyrene, Indeno (1,2,3-cd) pyrene, Indeno (1,2,3-cd) pyrene showed high dispersion while the remaining PAHs showed less dispersion in the samples from Ago-Aduloju market.

3.4 Statistical Analysis

Simple correlation analysis was conducted among various components to show the level of significance from the two locations, and the results are presented in Tables 5-7. The correlation matrix for detected OCPs for Ago-Aduloju samples is presented in Table 5.

Table 5. Correlation coefficient of detected OCPs in the tomato samples from Ago-Aduloju market

	α-BHC	β-BHC	Heptachlor	Aldrin	γ-BHC	Delta BHC	Heptachlorepoxide	p,p′ DDE	Dieldrin	Endosulfan II	p,p′ DDT	Methoxychlor
α	1											
β-BHC	**1.000****	1										
Heptachlor	.803	.803	1									
Aldrin	**1.000****	**1.000****	.803	1								
γ-BHC	**1.000****	**1.000****	.803	**1.000****	1							
Delta BHC	.945	.945	.954	.945	.945	1						
Heptachlor epoxide	**1.000****	**1.000****	.803	**1.000****	**1.000****	.945	1					
p,p′ DDE	.995	**.995***	.859	**.995**	**.995**	.973	.995	1				
Dieldrin	**1.000****	**1.000****	.803	**1.000****	**1.000****	.945	**1.000****	.995	1			
EndosulfanII	.866	.866	**.993***	.866	.866	.982	.866	.912	.866	1		
p,p′ DDT	**1.000****	**1.000****	.803	**1.000****	**1.000****	.945	**1.000****	.995	**1.000****	.866	1	
Methoxychlor	**1.000****	**1.000****	.803	**1.000****	**1.000****	.945	**1.000****	.995	**1.000****	.866	**1.000****	1

**. Correlation is significant at the 0.01 level (2-tailed). *. Correlation is significant at the 0.05 level (2-tailed).

Table 6: Correlation coefficient of PCBs in the tomato samples collected from Ago-Aduloju market

	PCB8	PCB18	PCB28	PCB44	PCB52	PCB60	PCB101	PCB126	PCB156
PCB8	1								
PCB18	.986	1							
PCB28	.955	.892	1						
PCB44	.912	.829	.992	1					
PCB52	.991	.953	.987	.959	1				
PCB60	.906	.964	.740	.652	.839	1			
PCB101	.993	**.999***	.912	.854	.966	.951	1		
PCB126	.845	.923	.650	.551	.764	.992	.904	1	
PCB156	**.999***	.980	.964	.924	.994	.892	.988	.828	1

*. Correlation is significant at the 0.05 level (2-tailed).

Table 7: Correlation coefficient of PAHs in the tomato samples collected from Ago-Aduloju market

	Fluorene	Phenanthrene	Fluoranthene	Pyrene	Chrysene	Benzoaanthracene	Benzokfluoranthene	Benzobfluoranthene	Benzoapyrene	Indeno123cdpyrene	Benzoghiperylene
Fluorene	1										
Phenanthrene	.999**	1									
Fluoranthene	1.000**	1.000**	1								
Pyrene	1.000**	1.000**	1.000**	1							
Chrysene	.999**	1.000**	1.000**	1.000**	1						
Benzoaanthracene	1.000**	1.000**	1.000**	1.000**	1.000**	1					
Benzokfluoranthene	1.000**	1.000**	1.000**	1.000**	1.000**	1.000**	1				
Benzobfluoranthene	1.000**	1.000**	1.000**	1.000**	1.000**	1.000**	1.000**	1			
Benzoapyrene	1.000**	1.000**	1.000**	1.000**	1.000**	1.000**	1.000**	1.000**	1		
Indeno123cdpyrene	1.000**	1.000**	1.000**	1.000**	1.000**	1.000**	1.000**	1.000**	1.000**	1	
Benzoghiperylene	1.000**	1.000**	1.000**	1.000**	1.000**	1.000**	1.000**	1.000**	1.000**	1.000**	1

**. Correlation is significant at the 0.01 level (2-tailed).

At 99% confidence limit, there was strong correlation (1.000) between the following compounds: β-BHC/α-BHC; aldrin/α-BHC; γ-BHC/α-BHC; Heptachlor epoxide/α-BHC; dieldrin/α-BHC; etc. At 95% confidence limits, there was strong correlation (> 0.900) between the following pairs of compounds: p, p′ DDE/β-BHC (0.995) and endosulfan II/heptachlor (0.993). At 99% confidence limit, the following pairs of compounds showed strong positive correlation (>0.900): endrinaldehyde/β-BHC; emdosulfansulfate/β-BHC; endrinaldehyde/p,p′,DDE; and emdosulfansulfate/edrinaldehyde for detected OCPs for tomato samples from Sasha market. At 95% confidence limits, there was strong correlation (> 0.900) between the following OCPs: p,p′ DDD/α-BHC; p,p′ DDE/β-BHC; endrin/β-BHC; dieldrin/heptachlor; p,p′ DDT/p,p′ DDE; etc. However, negative correlation at 95% confidence limit was observed for dieldrin/γ-BHC pair.
Table 6 shows the correlation matrix between pairs of detected polychlorinated biphenyls (PCBs), there was positive strong correlation between the following pairs at 95% confidence limit: PCB156/PCB8 (0.999); and PCB101/PCB18 (0.999). For the correlation matrix of PCBs for Sasha samples. At 99% confidence limit, it was observed that there was strong correlation between the following pairs of PCBs: PCB123/PCB8; PCB77/PCB52; PCB118/PCB52; PCB118/PCB77; PCB128/PCB81; etc. At 95% confidence limit, strong correlation (>0.900) was observed among the following pairs of PCBS: PCB101/PCB8; PCB105/PCB8; PCB153/PCB8; PCB81/PCB18; PCB126/PCB18; PCB77/PCB52; etc.
In Table 7, the correlation coefficient among polycyclic aromatic hydrocarbon (PAH) compounds observed in the Ago-Aduloju samples showed positive and strong correlation at 99% confidence limit. Each pair showed a strong correlation of 1.000, except the pairs of phenanthrene/fluorene (0.999); and chrysene and fluorene (0.999). For Sasha tomato samples, the correlation matrix revealed that the pairs of PAHs displayed positive and strong correlation, with each pair, having the correlation value of 1.000 at 99% confidence limits.

Conclusion

The analysis of commercially available tomatoes at Ago-Aduloju and Shasha markets revealed that the levels of OCPs, PCBs, and PAHs were found lower when compared to the CODEX and WHO MRLs values except endrin aldehyde, which could be traced to excess application of the pesticides on farmland where the crops were raised. Based on these results, it is apparent that the tomatoes sold in both the Ago-Aduloju and Shasha markers at Ado-Ekiti, Nigeria contain pesticide residues at levels that are safe for consumption. However, there is still the need to have more data on the levels of pesticide residues in tomato and other food products consumed in Nigeria with a view to using the data to perform a risk assessment on the presence of pesticide residues in such samples. This will ensure permanent access to safe food products by all the consumers and protect them from health effects of pesticides.

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