



Evaluation of Migrating Potentials of Phthalates from Plastic Packaging Materials into Cooked Food

Chukwuma Joseph Chukwu^{1*}, Anthony Bishop Alieze², Nduka Omaka Omaka¹, Esther O. Obenoh¹, Onyinyechi Njoku¹, Martin Ineke¹ and Idara Emmanuel Atiaetuk³

¹Department of Chemistry, Faculty of physical sciences, Alex Ekwueme Federal University, Ndufu Alike, Nigeria

²Department of Science Laboratory Technology, Federal College of Agriculture, Ishiagu Ebonyi state, Nigeria

³Department of Science Laboratory Technology, Akanu Ibiam Federal Polytechnic Unwana, Ebonyi state, Nigeria.

Email address:

*Corresponding author: maximchuma123@gmail.com

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ABSTRACT

Phthalic acid esters (PAEs) are one of the essential plastic additives also known as plasticizer which has varying harmful effects. Increasing attention has been paid to the migration of phthalates into packaged food products. In this study, cooked food samples Bambara nut (*Okpa*) obtained at different heating temperatures of 60 °C, 80 °C, and 100 °C for a period of one week were analyzed along with control. The result revealed that the food samples in plastic containers heated at 60°C (one hour) for one week showed methyl hydrogen phthalate with concentration of 0.060%, dimethyl phthalate, 0.056%, dibut-3-enyl phthalate, 0.096 %, phthalic anhydride, 42.678%, while sample in a plastic container heated at 80 °C (one hour) for one week also indicated the presence of phthalate and they include the following; dibutyl phthalate with the concentration of 0.060 %, diamyl phthalate, 0.060 %, butyl decyl phthalate, 0.147 %. However, the organics with their percentage total ion concentration (%tic) identified at 100 °C heat treatment includes: Ethyl iso-allochololate (1.984%), octadecanal,2- bromo (2.890 %), Dibutylphthalate (0.060 %), Diamylphthalate (0.0603 %), 4-methyl-1,3-Isobenzofuran dione (3.562 %), There were no Phthalates found in the control. This implies that Phthalate migration is temperature and time dependent. The migrating potential of phthalates and other organic compounds from plastic food packaging materials cannot be denied as they are used commonly in the packaging of local delicacies such as (*Okpa, fufu, Agidi* and *Moi moi*). Constant exposures to these endocrine disruptors are reported to lead to possible increase in the risk of testicular or prostate cancer. A new form of food packaging using nanonized aluminium sweet prayer leaf extract should be employed to avert the dangers associated with endocrine disrupting compounds.

1. INTRODUCTION

Food safety has gotten increasingly more attention as incidences involving it have become more regular. One of the biggest contributors to food contamination is the migration of hazardous and

dangerous compounds such as phthalate, that come into contact with food [1-3]. Phthalates are diesters of phthalic acid used as plasticizers in various plastic products [4-5]. They are used to make

plastics flexible but are not covalently bonded to the polymer, hence are able to migrate from the plastic food packages into food when heated or stored for a long time [6]. Lately there is an upsurge in the use of these packaging materials in Nigeria mostly by local food vendors called “mama put” [7-8]. Majority of foods, including *fufu*, *moi-moi*, and *okpa*, which were previously wrapped in leaves, are now wrapped in plastic, polyethylene materials and cooked at high temperatures for several hours. According to Li *et al.*, [9], there is a correlation between the leaching of chemicals from plastic packaging materials to food with increase in temperature. In Nigeria, plastic is the most widely used type of packaging material and phthalates are incorporated into plastics as plasticizer to make them flexible, pliable, and rigid [10;14]. Earlier research has demonstrated that plasticizer and BHA migrate into food, affecting its quality and safety [11-12]. Most disease conditions have also been linked to high levels of BHA and phthalates in the blood according to studies [9;13-15]. Some endocrine disruptors identified in cooked food as reported [12], include: Di-2 (ethyl hexyl) Phthalates (DEHP), Di Ethyl Phthalates (DEP), Benzyl butyl Phthalates (BBP), and Dibutyl Phthalates (DBP). It is therefore important to monitor the levels of phthalates in various kinds of packaged foods to provide data for human exposure assessment since a wide range of phthalates, especially DEHP, have been reported in high concentrations in some foodstuff [16].

2. MATERIALS AND METHOD

2.1. Materials

Crushed Bambara nut (*Okpa*), Red oil, Salt and pepper, Pot, Cooking gas, Plastic containers, Water bath, Thermometer, 5mL beaker, Conical flask, Funnel, Petri-dish, Spatula, Weighing balance, Filter paper, Sample bottles.

2.2. Sample Preparation

200g of ground Bambara nut was poured in a clean

and dried bowl, 25g of red oil was added to make a paste then other ingredients were added and 600mL of warm water was poured into it and was mixed thoroughly to make watery mixture or paste. The paste was poured into 100mL plastic container. After which it was put into pot and allowed to cook for 55 min. It was allowed to cool and thereafter kept in the refrigerator for 12 hours. The food samples were subjected to heat treatment in a water bath at 60 °C, 80 °C and 100 °C for 1hour respectively except control. Thereafter, 1g was taken from each sample at different temperatures and solubilized with a 5mL of ethanol. It was allowed to stand for 24 hours and the filtrate obtained after filtration was used for the analysis. The sample were classified as follows:

Sample from plastic container heated for 1hour for one week at 60 °C

Sample from plastic container heated for 1hour for one week at 80 °C

Sample from plastic container heated for 1hour for week at 100 °C

Sample of cooked Bambara nut (*Okpa*) for 55 minutes served as the control

This was repeated for one week for all the samples and the filtrate obtained were preserved and kept for analysis.

2.2.1. GC-MS analysis of the sample

Gas chromatography-mass spectrophotometer determination of the extracts was carried out using Perkin-Elmer Gas chromatograph, Clarus 500 system and GC interfaced to a mass spectrometer fitted with an Elite-1, fused silica capillary column (30mmX0.25mm1DXI μ Mdf, composed of 100 percent dimethyl polysiloxane). For gas chromatograph-mass spectrometric detection, an electron ionization system of 70 eV ionizing energy was utilized. Helium gas of 99.9% purity was used as the carrier gas at constant stream rate of 1mL per minute and a dose volume of 2 micro liter employed with splitting ratio of 10:1, injector temperature of 250 °C, and ion-source of temperature of 280 °C

were maintained. The oven temperature was set at 110 °C, isothermally for two minutes, with an increase of 10 °C per minutes, to 200 °C, then 5 °C per minute to 280 °C, culminating to a 9 minutes isothermal at 280 °C. Mass spectra were carried out at 70 electrons volt, at probe interval of 0.5 seconds and fragments from 40 to 450 Dalton atomic unit. Total gas chromatographic running time was determined and the comparative percentage amount of each component assessed by comparing its average peak area to the total areas. Analysis of mass spectrum GC-MS data was carried out using the database of the national institute standard and technology (NIST) having more than 62,000 patterns. The spectrum of the unidentified components related with the spectrum of the identified components stored in the NIST library. The names, Molecular weight and structures of the components of the test materials were established.

Components identifications

Components were identified in the food samples by comparing their mass spectra and linear retention indices with those of the reference standard and their respective structures confirmed by GC-MS spectra.

3. RESULTS AND DISCUSSION

3.1. Finding of research

The following compounds were identified from analysis of mass spectrometry coupled to gas

chromatograph with the results tabulated for the various samples. The organics with their retention time (RT), base peak, percentage ion concentration (% tic), molecular formula and molecular weight (MW) in the food samples are presented in Tables 1-3, and Table 4 shows the control. A total of fifteen (15) compounds were identified with their % tic in the food sample packed in plastic container and heated at 60 °C (one hour) for one week and they include: Methyl hydrogen phthalate (0.060 %), 1,1,2-trichloroethane (7.063 %), 10-Nonadecanoic acid Methyl ester (3.716 %), Cyclopentanetricanoic acid methyl ester (15.103 %), n-hexadecenonic acid methyl ester (19.286%), Estra-1,3,5(10)-trien-17b-ol (21.477 %), oleic acid (20.183 %), Dimethylphthalate (0.056 %), Cyclopropaneoctanoic acid 2-octyl-methyl ester (3.904 %), Ethyl iso-allocholate (4.456 %), Phthalic anhydride (42.678 %), Dibut-3-enyl phthalate (0.096 %), 1H-cyclopropa[3,4]benz[1,2-e]azulee-4a,5,7b,9,9a[1a7A] (3.901 %), 7,8, epoxylanostan-11-ol,3-acetoxy- (4.150 %), 9,10-secocholesta-5,7,10(19)-triene-3,24,25-triol[3b,5z,7e] (3.823%). Phthalic anhydride at 42.678 %, concentration is quite high and would pose a serious health challenge. The presence of phthalate in food has been reported elsewhere as an endocrine disruptor and a causative agent in kidney, liver, heart and lung diseases [17].

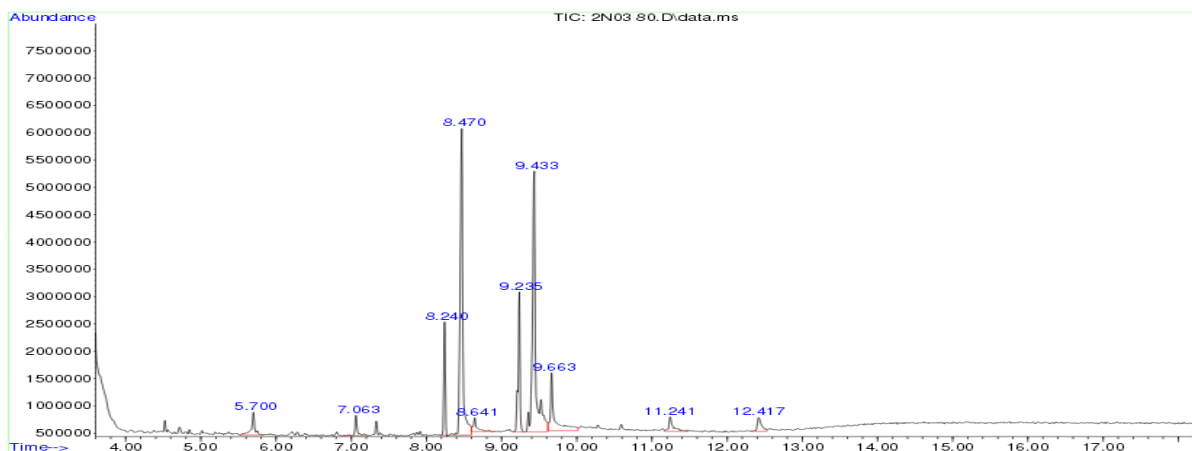


Fig 1. GC-MS profile of extract of food sample heated at 60 °C for One hour daily for one week

Table 1. Components detected in extract of food sample packed in a plastic container and heated at 60 °C (one hour) for one week.

S/N	Name of Compound	Molecular weight	Molecular Formula	Base Peak	Retention Time(min)	Total Ion Conc. (%)
1	Methyl hydrogen phthalate	180	C ₉ H ₈ O ₄	76.00	0.771	0.060
2	1,1,2-trichloroethane	132	C ₂ H ₃ Cl ₃	97	1.563	7.063
3	10-Nonadecanoic acid methyl ester	310	C ₂₀ H ₄₀ O ₂	55	5.699	3.716
4	Cylopentanetriodecanoic acid, methyl ester	196	C ₁₉ H ₃₆ O ₂	97	8.245	15.103
5	n-hexadecenonic acid methyl ester	256	C ₁₈ H ₃₆ O ₂	73	8.454	19.286
6	Estra-1,3,5(10)-trien-17b-ol	257	C ₁₈ H ₂₄ O	57	8.454	21.477
7	Oleic acid	282	C ₁₈ H ₃₄ O ₂	55	9.417	20.183
8	Dimethylphthalate	194	C ₁₀ H ₁₀ O ₄	163	9.765	0.056
9	Cyclopropanoic acid 2-octyl methyl ester	310	C ₂₀ H ₃₈ O ₂	55	9.668	3.904
10	Ethyl iso-allocholate	436	C ₂₆ H ₄₄ O ₅	43	14.359	4.456
11	Phthalic anhydride	148	C ₈ H ₄ O ₃	104	8.405	42.678
12	Dibut-3-enyl phthalate	274	C ₁₆ H ₁₈ O ₄	149	11.732	0.096
13	1H-cyclopropa [3,4]benz[1,2-e]azulee-4a,5,7b,9,9a(1a7A)	718	C ₄₅ H ₅₀ O ₈	43	14.701	3.901
14	7,8, epoxylanostan-11-ol,3-acetoxy-	502	C ₃₂ H ₅₄ O ₄	44	14.942	4.150
15	9,10-secocholesta-5,7,10(19)-triene-3,24, 25-triol(3b,5z,7e)	416	C ₂₇ H ₄₄ O ₃	43	15.199	3.823

From the spectrum of methyl hydrogen phthalate (Figure 2), a strong peak is revealed at $m/z = 76$ which corresponded to the base peak with a total percentage ion concentration (% tic) of 0.060. The fragment peak at $m/z = 121$ was due to loss of a carbonyl (C=O) group of mass unit 28 (amu) while the peak at $m/z = 149$ is due to the elimination of a methoxy group with a mass unit of 31amu.

The peak at $m/z = 104$ is due to the loss of OH group with the mass unit of 17 amu and the base peak at $m/z = 76$ is due to the loss of C=O group with the mass unit of 28 amu. Other fragmentations of diagnostic importance are at $m/z = 163, 149, 136, 121, 104, 29,$ and 15.

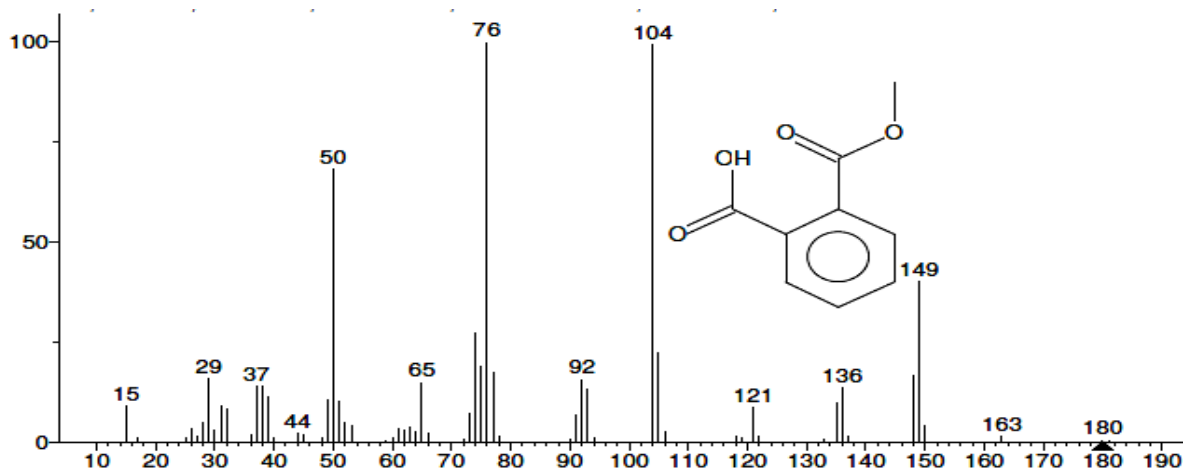


Fig 2. Fragmentation pattern of Methyl hydrogen phthalate

Others include the fragmentation pattern of Dibut-3-enyl phthalate, a phthalic acid derivative with base peak at m/z 149, which corresponds to peak with the highest percentage abundance. Fragment ion peaks of diagnostic value includes fragment ion peak at m/z 274 which is the molecular mass of the compound and the peak at m/z 221 which

corresponds to a loss of propylene molecule ($\text{CH}_3\text{CH}_2=\text{CH}_2$) with atomic mass unit of 43 amu. The peak at m/z 203 was due to the elimination of water molecule, 18 amu, while the peak at m/z 149 which is the base peak was due to the removal of a 1-butene fragment ion ($\text{CH}_2=\text{CH}-\text{CH}_2-\text{CH}_2^+$). Other important peaks are those at m/ 29 from loss of ethyl fragment ion (CH_3CH_2^+), m/z 55 from loss of but-1-ene fragment ion ($\text{CH}_2=\text{CH}-\text{CH}_2-\text{CH}_2^+$).

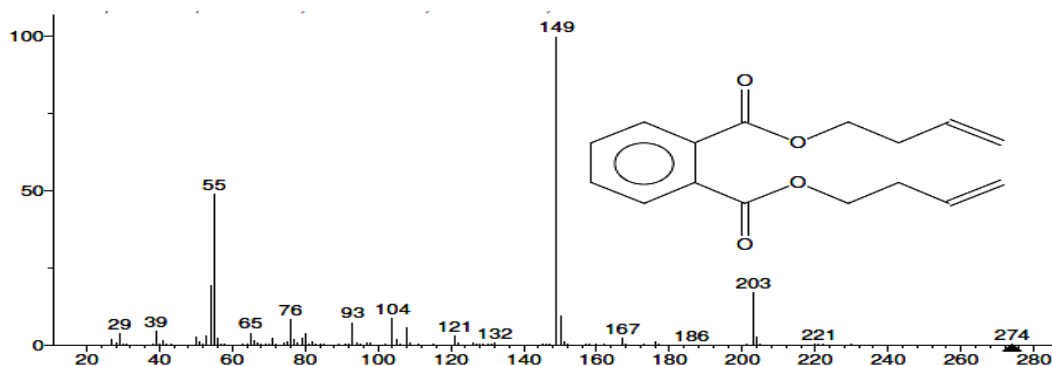


Fig 3. Fragmentation pattern of Dibut-3-enylphthalate

From the fragmentation pattern of dimethyl phthalate, (a phthalic acid derivative of a phthalic ester), the base peak is revealed at m/z 163 which resulted from elimination of a methoxyl group with

atomic mass unit of 31 amu. The peak at m/z 149 was due to the loss of an active methylene group of 14 amu, while those at m/z 15 and 29 were due to the loss of methyl and ethyl fragment ions.

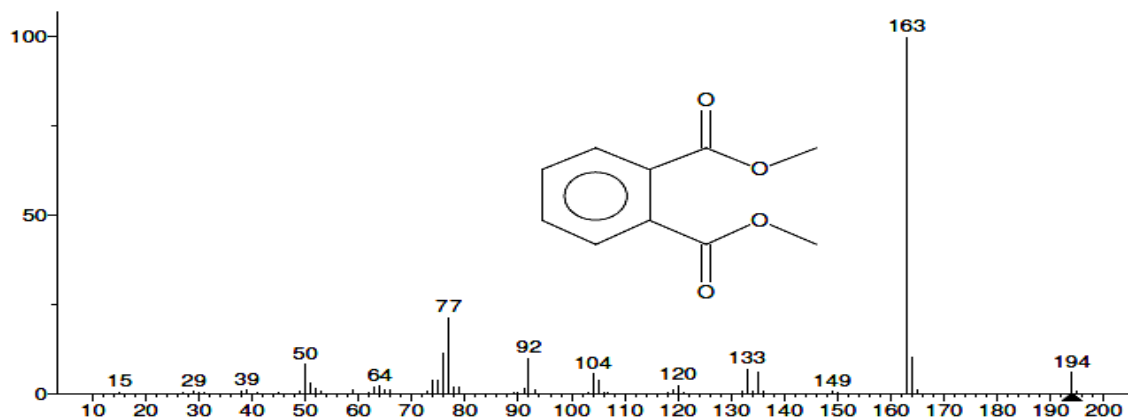


Fig 4. Fragmentation pattern of Dimethyl phthalate

A total of sixteen (16), compounds were tentatively identified in food sample packed in plastic container and heated at 80 °C (one hour) for one week (Table 2). The organics with their percentage total ion concentration (%tic) includes: 6-bromophthalazine (0.104 %), 2-amino-5-[(2-carboxy)vinyl-Imidazole (0.069 %), Octadecanal,2-bromo (2.911 %), 2-chloroethylheptyl phthalic acid (0.069 %), 2-chloropropyl dodecyl phthalic acid (0.237 %), 2-(2-methoxyethyl) hexyl nonyl- phthalic acid (0.251 %), Estra-1,3,5(10)-trien-17b-ol (1.900 %), 9,10-secocholesta-5,7,10 (19)-

triene-3,24,25-triol (0.183 %), Pentadecanoic acid 13-methyl,methylester (6.426 %), n-hexadecanoic acid (31.630 %), Ethyl isoallocholate (1.973 %), 9-octadecenoic(z)-methyl ester (9.978 %), Trans-13-octadecenoic acid (31.744 %), As-Indacen-(2H)-one, 3,6,7,8-tetrahydro-3,3,6,6-tetra methyl (8.684 %), (z)-icos-11-en- 1-yl oleate (2.455 %) and 2-butenic acid,2-methyl- 2-(acetyloxy)-1,1a,2,3,4,6,7, 10,11,11a,-decahydro-7,10-dihydroxy-1,1,3,6,9-penta methyl-4a,7-e 92.(2.98 %).

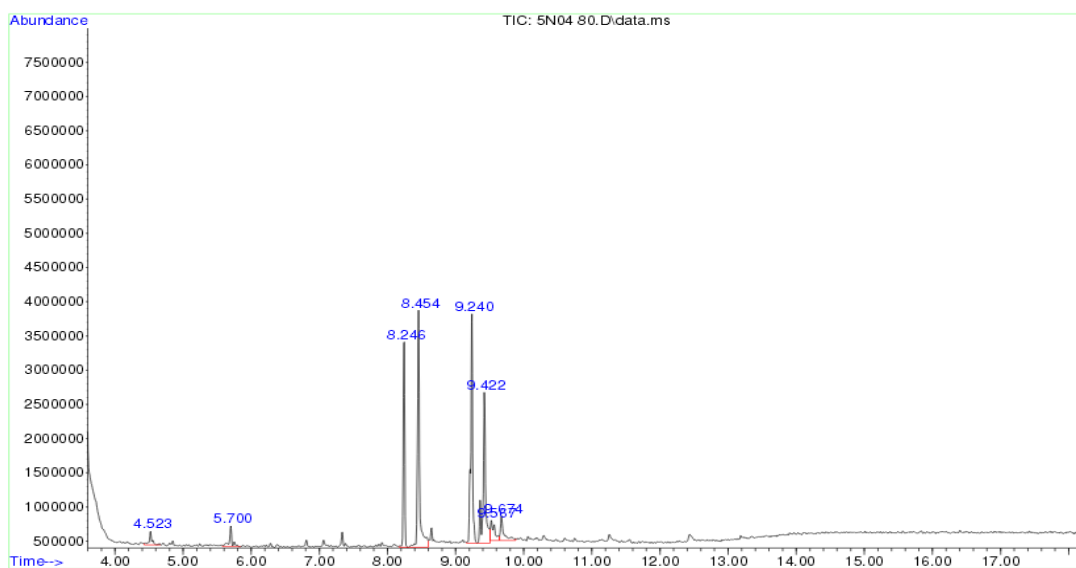


Fig 5. GC-MS profile of extract of food sample heated at 80 °C for one hour for one week

Table 2. Components detected in extract of food sample packed in plastic container and heated at 80 °C (one hour) for one week

S/No	Name of Compound	Molecular weight	Molecular formular	Base Peak	Retention Time (min)	Ion Conc. (%)
1	6-bromophthalazine	208	C ₈ H ₅ BrN ₂	208	1.094	0.104
2	2-amino-5-[(2-carboxy) vinyl-Imidazole	153	C ₆ H ₇ N ₃ O ₂	44	1.130	0.069
3	Octadecanal,2-bromo	346	C ₁₈ H ₃₅ BrO	43	2.705	2.911
4	2-chloroethylheptyl phthalic acid	326	C ₁₇ H ₂₃ ClO ₄	149	3.705	0.069
5	2-chloropropyl dodecyl phthalic acid	410	C ₂₃ H ₃₅ ClO ₄	149	3.853	0.237
6	2-(2-methoxyethyl) hexyl nonylphthalic acid	434	C ₂₆ H ₄₂ O ₅	149	4.401	0.251
7	Estra-1,3,5(10)-trien-17b-ol	257	C ₁₈ H ₂₄ O	57	7.063	1.900
8	9,10-secocholesta-5,7,10(19)-triene-3,24,25-triol	416	C ₂₇ H ₄₄ O ₃	136	7.586	0.183
9	Pentadecenoic acid-13-methyl methyl ester	242	C ₁₇ H ₃₄ O ₂	74	8.240	6.426
10	n-hexadecanoic acid	256	C ₁₆ H ₃₂ O ₂	73	8.470	31.630
11	Ethyl iso-allocholate	437	C ₂₆ H ₄₄ O ₅	43	8.641	1.973
12	9-octadecenoic(z)-methyl ester	296	C ₁₉ H ₃₆ O ₂	55	9.235	9.978
13	Trans-13-octadecenoic acid	282	C ₁₈ H ₃₄ O ₂	55	9.433	31.744
14	As-Indacen-(2H)-one,3,6,7,8-tetrahydro-3,3,6,6-tetra methyl	228	C ₁₆ H ₂₀ O	213	9.663	8.684
15	(z)-icos-11-en-1-yl oleate	560	C ₃₈ H ₇₂ O	69	11.241	2.455
16	2-butenic acid, 2-methyl- 2-(acetyloxy)-1,1a,2,3,4,6,7,10,11,11a-decahydro-7,10-dihydroxy-1,1,3,6,9-penta methyl-4a,7-e	490	C ₂₇ H ₃₈ O ₈	44	12.417	2.298

From the spectrum of 2-chloropropyl dodecyl phthalic acid (Fig 6), the fragmentation pattern revealed that the peak at m/z 149 corresponded to the base peak of the compound, while the peak at m/z 243 is due to the loss of dodecane fragment ion with the mass unit of 168 amu and the peak at m/z

225 is due to the loss of a water molecule with a mass unit 18amu. However, the elimination of chloride ion (Cl⁻) with the mass unit of 35 amu was shown at m/z 190. Usually, the presences of halide ion fragments are depicted by a buried peak. Other fragmentation peaks of diagnostic importance

include: the peak at m/z 121, 104, 55 and 41.

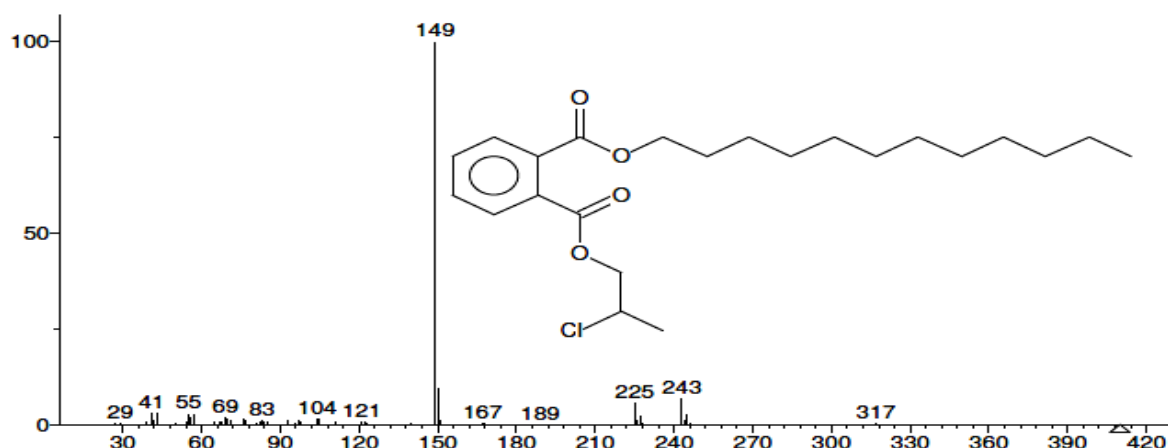


Fig 6. Fragmentation pattern of 2-chloropropyl dodecyl phthalic acid

However, the fragmentation pattern of 2-chloroethyl heptyl phthalic acid (Figure 7), revealed a strong peak at m/z 149 corresponding to the base peak of the compound. The peak at m/z 225 is due to the loss of water molecule with the mass unit of

18 amu and the peak at m/z 150 is due to the elimination of hydroxyl group with the mass unit of 17 amu. Other fragmentation peaks of diagnostic importance include: the peak at m/z 243, 121, 104, 55 and 41.

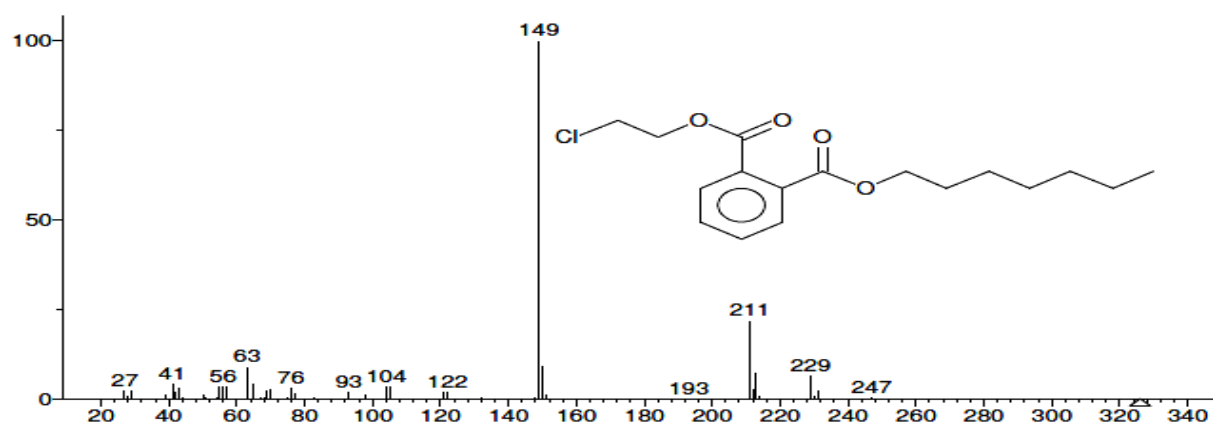


Fig 7 Fragmentation pattern of 2-chloroethyl heptyl phthalic acid

Table 3 shows the compounds tentatively identified in the food sample packed in plastic container and heated at 100 °C (one hour) for one week. A total of seventeen (17) compounds were detected. The organics with their percentage total ion concentration (%tic) includes: Ethyl iso-allocholate (1.984%), octadecanal,2- bromo (2.890%), Dibutylphthalate (0.060 %), Diamylphthalate (0.0603%), 4-methyl-1,3-Isobenzofuran dione

(3.562 %), 4-methyl-1,3-Isobenzofuran dione (0.147 %), 1,8-Nonadien-3-ol (0.083%), Hexadecanoic acid methyl ester (16.188%), n-hexadecenonic acid (26.760%), 9-octadecenoic acid methyl ester (23.305%), oleic acid (7.557%), Phthalic anhydride (4.825 %), oleic acid ,eicosylester (4.020%), n- butyl ricinoleate (4.276%), 1-(5-oxopyrrolidin-2-yl)amino)-adamantine (0.148%), 1,2-dihydro-1-

thioxophthalazine (.105%) and Phenyl-3-deoxy- α - d-ribo-hexoside (0.148%).

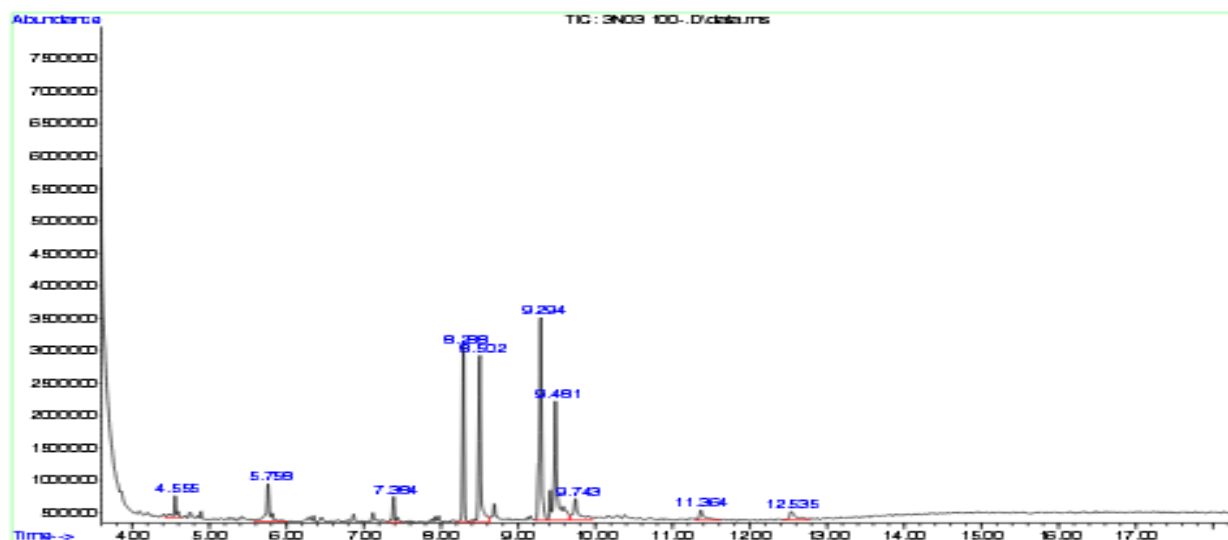


Fig 8. GC-MS profile of extract of food sample heated at 100 °C for one hour for one week.

Table 3. Components detected in extract of food sample packed in plastic container and heated at 100 °C (one hour) for one week

S/No	Name of Compound	Molecular weight	Molecular formular	Base Peak	Retention Time (min)	Total Ion Conc. (%)
1	Ethyl iso-allocholate	440	C ₂₆ H ₄₄ O ₅	43	4.528	1.984
2	2-bromo octadecanal	346	C ₁₈ H ₄₄ O ₅	43	5.700	2.890
3	Dibutylphthalate	278	C ₁₆ H ₃₂ O ₄	149	5.890	0.060
4	Diamylphthalate	306	C ₁₈ H ₂₆ O ₄	149	6.408	0.0603
5	4-methyl-1,3-Isobenzofuran dione	162	C ₉ H ₆ O ₃	162	6.810	3.562
6	Butyl decyl phthalate	362	C ₂₂ H ₃₄ O ₄	149	7.114	0.147
7	1,8-Nonadien-3-ol	140	C ₉ H ₁₆ O	57	7.873	0.083
8	Phthalic anhydride	148	C ₈ H ₄ O ₃	104	8.280	4.825
9	Hexadecanoic acid methyl ester	270	C ₁₇ H ₃₂ O ₂	74	8.246	16.188
10	n-hexadecenonic acid	256	C ₁₆ H ₃₂ O ₂	55	8.454	26.760
11	9-octadecenoic acid,methyl ester	296	C ₁₉ H ₃₆ O ₂	55	9.240	23.305
12	Oleic acid	280	C ₁₈ H ₃₄ O ₂	55	9.422	7.577
13	Oleic acid, eicosylester	562	C ₃₈ H ₇₄ O ₂	57	9.567	4.020
14	n- butyl ricinoleate	354	C ₂₂ H ₄₂ O ₃	55	9.674	4.276
15	1-(5-oxopyrrolidin-2-yl amino)- adamantane	243	C ₁₄ H ₂₂ N ₂ O	94	10.818	0.148
16	1,2-dihydro-1-thioxo phthalazine	162	C ₈ H ₆ N ₂ S	162	11.002	0.105
17	Phenyl-3-deoxy- α -d-ribo-hexoside	240	C ₁₂ H ₁₆ O ₅	94	11.088	0.148

The molecular ion peak of this compound, dibutyl phthalate is as seen at m/z 278 (Fig. 9), while the peak at m/z 223 was due to the elimination of butylene fragment ion of mass unit 55amu ($C_4H_7^+$). However, the peak at m/z 149 corresponds to the base peak of the compound while that at m/z 205 is

due to the loss of water molecule with the mass unit of 18 amu, and the peak at m/z 76 is due to the loss of hydroxyl group with the mass unit of 17 amu. Other fragmentation of diagnostic importance include: the peak at m/z 121, 104, 76, 43 and 29.

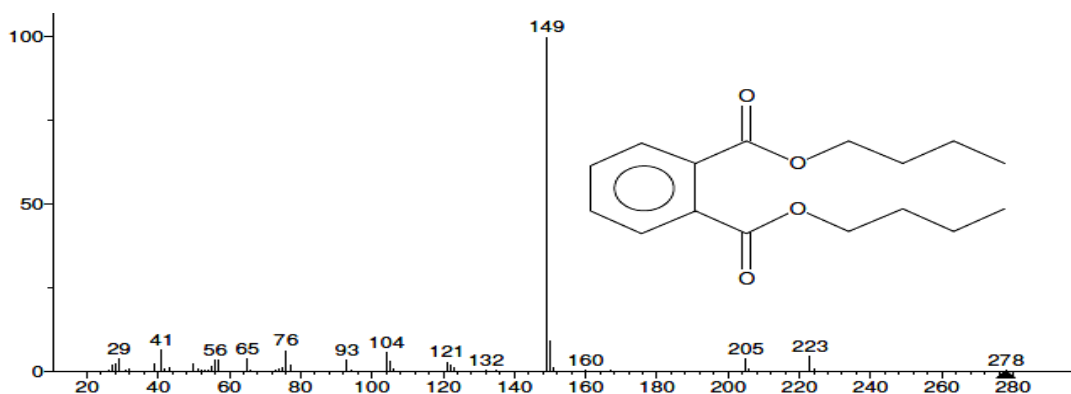


Fig 9. Fragmentation pattern of dibutyl phthalate

Another compound of interest Diamyl phthalate identified had a molecular ion peak at m/z 306 and base peak at m/z 149. The fragmentation peak m/z 264 was due to the removal of propyl fragment ion of mass unit 42 amu. The peak at m/z 219 is due to the loss of a water molecule with the mass of 18 amu while the peak at 150 and 140 is due to the loss

of hydroxyl group with the mass of 17 amu. However, the peak at 121 is due to the elimination of a carbonyl compound with the mass unit of 28 amu. Other fragmentation of diagnostic importance include: the peak at 95, 76, 55, 43 and 29 (Fig. 10).

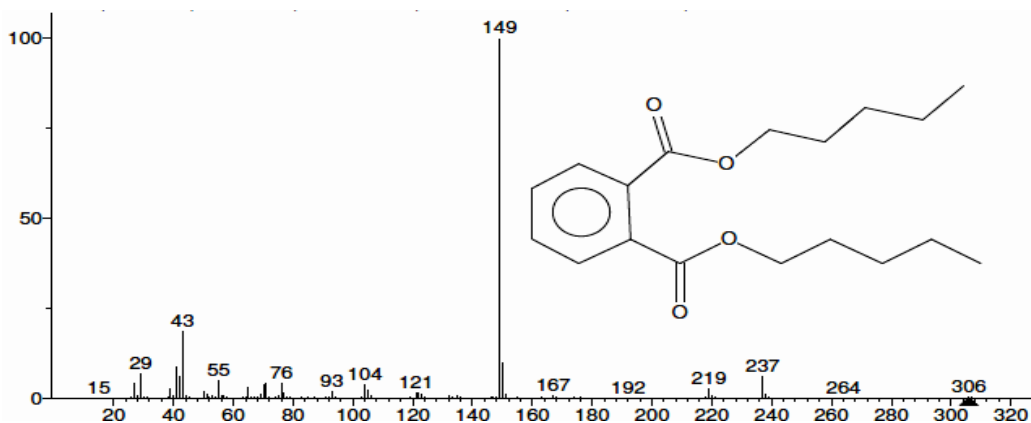


Fig 10. Fragmentation pattern of diamyl phthalate

However, from the fragmentation pattern of butyl decyl phthalate (Fig. 11), the peak at 149 corresponds to the base peak of the compound while the peaks at m/z 289 and 205 were due to the loss

of water molecule with the mass unit of 18 amu. The peak at m/z 105 is due to the loss of hydroxyl group with the mass unit of 17 amu, while the peak at m/z 93 is due to the loss of carbonyl compound. Other

fragmentation of diagnostic importance include: the peak at m/z 76, 65, 55, 41 and 29 [18].

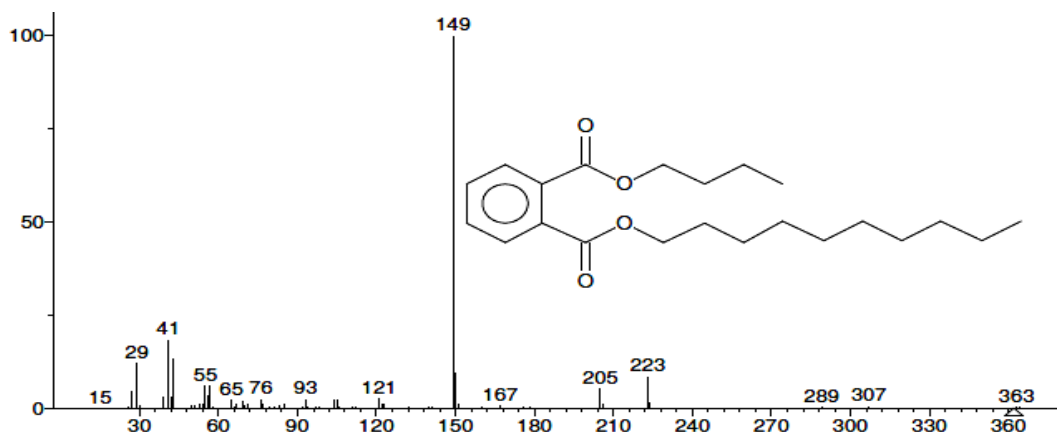


Fig 11. Fragmentation pattern of butyl decyl phthalate

From the spectrum of phthalic anhydride, the molecular mass ion was revealed at m/z 148, while the fragment ion peak at m/z 104 was seen as the

base peak. Other peaks of diagnostic value include, peak at m/z 76, 53, 52 and 29 (Fig. 12).

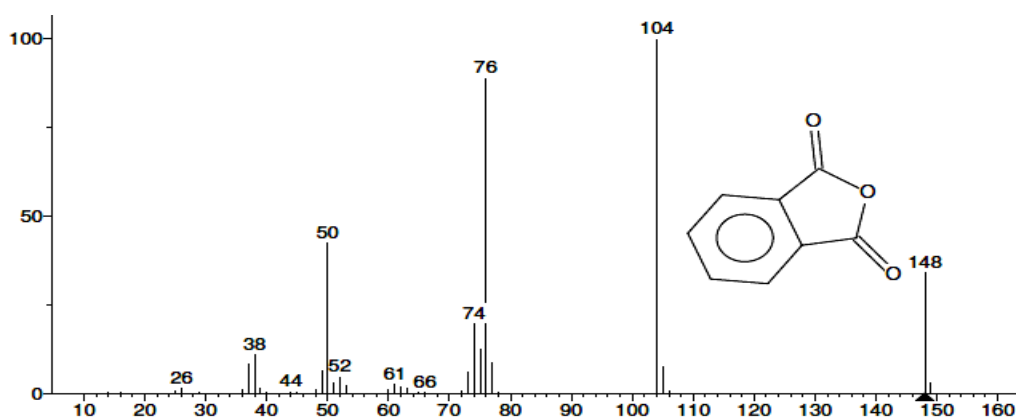


Fig 12. Fragmentation pattern of phthalic anhydride

Spectral data of organic compounds identified in food sample boiled at 100 °C for one day (control) : Table 4, revealed that the control sample had a total of Ten (10) compounds and they include: Cis-10-nondecenoic acid (2.544 %), tetradecanoic acid (1.830 %), hexadecenoic acid, methyl ester (5.465 %), n-Hexadecanoic acid (36.041 %), hexadecenoic acid, Ethyl ester (2.056 %), 9-octadecenoic methyl ester (7.633 %), cis-13-

octadecenoic acid (30.855 %), 3,6,7,8-tetrahydro-3,3,6,6-tetra methyl -As-Indacen-(2H)-one (7.633 %), Hexadecanoic acid,1-(hydroxymethyl)-1,2-ethandiyl ester (2.390 %), oleic acid, eicosyl ester (3.543 %). Most of the compounds identified were palmitic acid derivatives which could have resulted from the palm oil used in the formulation. There are no phthalates/ phthalic acid derivative identified in the control.

Table 4. Components detected in extract of food sample boiled at 100°C for one day (control)

S/No	Name of Compound	Molecular weight	Molecular Formula	Base Peak	Retention Time(min)	Ion Conc. (%)
1	Cis-10-Nondecenoic acid	297	C ₁₉ H ₃₆ O ₂	55	5.737	2.544
2	Tetradecanoic acid	228	C ₁₄ H ₂₈ O ₂	74	7.106	1.830
3	Hexadecenoic acid, methyl ester	270	C ₁₇ H ₃₂ O ₂	74	8.278	5.465
4	n-Hexadecanoic acid	256	C ₁₆ H ₃₂ O ₂	73	8.524	36.041
5	Hexadecenoic acid, ethyl ester	284	C ₁₈ H ₃₆ O ₂	88	8.679	2.056
6	9-octadecenoic methyl ester	294	C ₁₉ H ₃₆ O ₂	55	9.272	7.633
7	Cis-13-octadecenoic acid	282	C ₁₉ H ₃₆ O ₂	55	9.481	30.855
8	As-Indacen-(2H)-one,3,6,7,8-tetrahydro-3,3,6,6-tetra methyl	228	C ₁₆ H ₂₀ O	213	9.711	7.633
9	Hexadecanoic acid,1-(hydroxymethyl)-1,2-ethane diyl ester	568	C ₃₅ H ₆₈ O ₅	43	11.310	2.390
10	Oleic acid, eicosyl ester	562	C ₃₈ H ₇₄ O ₂	57	12.487	3.543

4. CONCLUSION

Phthalates were able to migrate into the food sample at varying temperature and time (60 °C, 80 °C and 100 °C) within the period of analysis but was not identified in the sample of food cook at 100 °C for 55 minutes for one day (control). It implies that freshly prepared local delicacy like *Okpa* and other products packaged in polyethylene materials may be classified as safe without prolonged heat treatment, since the migrating potentials of phthalates increased with increase in time of heat treatment.

The regulatory bodies (government) should enact legislation to help curb its use in the manufacturing process especially in the production of food contact materials as temperature and exposure time can contribute to the migration of these compounds into food product.

Conflict of Interest Declaration

We declare that there is no conflict of interest

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