ARTICLE TYPE: ORIGINAL RESEARCH ARTICLE

COMPARATIVE ANALYSIS OF KEROSENE GRADE FUEL FROMPYROLYSIS OF HDPE AND LDPE WASTE PLASTICS.

Abstract:
To curb the menace of plastic waste and energy crisis, this study investigated the conversion of high-density polyethylene (HDPE) and low-density polyethylene (LDPE)grades of plastics to kerosene.Plastics sourced from dumpsites within Port Harcourt metropolis in Rivers State, Nigeria were shredded and pyrolyzed (thermally degraded under inert condition at a temperature range of 350-400 ^{o}C). The obtained hydrocarbon liquid was distilled using distillation columnat a temperature range of 150-270^{o}C and characterised to evaluate the physico-chemical parameters such as flash point, density, copper corrosion, and calorific value and compared against the acceptable standard. The result showed that these properties were within the permissible limit. However, the sulphur content and smoke point of HDPE and LDPE were above and below the limits, respectively. The GC-MS and GC-FID results of kerosene samples obtained from both grades of plastics indicates that the product comprised C_9 to C_{17} grades.

Keyword: Waste management, plastics, Kerosene, Physico-chemical properties, Pyrolysis

INTRODUCTION

The world population is approximately 7.87 billion as of July 1, 2021, and according to the medium-variant projection, the world's population will increase by 2.2 billion people between 2017 and 2050, reaching 9.8 billion people in 2050. Most of this population increase will be evident in developing countries like Africa. Nigeria is currently the most populous country in Africa and the seventh most populous in the world, and the population, by projection, is still exponentially increasing. This increase in human population is associated with a change in lifestyle, production, and consumption patterns that transcend to an increase in resource consumption and waste generation (Asase *et al.,* 2009; Brunner &Rechberger, 2015).

Plastics are used for most of our everyday products and, as such, have remained inevitable due to their light weight, durability and ease of manufacture.Hassanpour and Unnisa (2017) reported that plastic production had increased significantly, approximately 299 Mt of plastic was generated in 2013, which represents a 3.9% increase from 2012. Out of the 280 Mt of plastics that were released in 2012, 90% of these were low-density polyethylene (LDPE), high-density polyethylene (HDPE), polypropylene (PP), polyvinylchloride (PVC), polystyrene (PS) and polyethylene terephthalate (PET) grades of plastics.
Globally, plastic resin production has risen exponentially with the increase in population and urbanisation; about 300 MMT of plastics have been produced annually in recent years. According to Statista, in 2015, the production volume of plastic in Nigeria reached around 411,000 metric tons, and the figure is estimated to increase to some 513,000 tons by 2020, while Nigeria's plastic consumption reached around one million tons, which is estimated to increase to

some 1.5 million tons by 2020. Nodim (2022) discussed Nigeria's plastic waste and reported that the increase in plastic consumption across the country has resulted in an accelerated increase in plastic waste in Nigeria. Plastic consumption in Nigeria has increased by 116.2% within the last 15 years. Furthermore, the per capita plastic consumption has grown by five per cent (5%) annually from 4 kg to 6.5 kg. It is also estimated that each citizen would consume about 7.5 kg of plastic annually. With a population of about 206.1 million Nigerians, Nigerians consume approximately 1.545 million tonnes of plastic annually.According to Jambeck *et al.,* (2015), Nigeria contributes 0.13–0.34 million tonnes of plastic waste to the marine environment. It is ranked ninth globally regarding marine plastic pollution.

Waste management has become a severe concern in world cities, including Nigeria (Anyanwu& Adefila,2012; Babatunde& Uche,2018). The generation of waste globally far exceeds the management rate (Nnaji, 2014); despite the application of waste management principles and the emphasis on adopting the 4 R's, the presence of waste has remained a significant concern (Chandler *et al.,* 1997; Abdel-Shafy and Mansour, 2018).

Plastic waste management can be done by applying the 4 R" of the waste management concept (reducing, reusing, recycling and recovery techniques)Evode*et al.,* 2021. Ragaert et al., (2017) reported that plastic recycling can be grouped into mechanical, energy and chemical processes. The mechanical process converts plastic to an entirely different product or item without alteration of its chemical structure. The energy process involves generating thermal and electric energy from plastic, usually leveraging processes like incineration. In contrast, the chemical process alters the chemical structure of the plastic to produce entirely new materials. The pyrolysis process is a chemical recycling process where plastics of high molecular weight thermally decompose or crack to produce primary volatiles in the absence of oxygen or inert conditions to generate products known as end products of pyrolysis that include solid residual (ash or char), non-condensable gases and condensable liquids (pyrolysis oil, pyrolytic oil, bio-oil or wax) (Aguado *et al.,* 2006; Miandad *et al.,* 2016; Wong *et al.,* 2013; Shah *et al.,*1999).

Manickavelan *et al.* (2022), in the simplest terms, defined pyrolysis as the thermal degradation of long-chain polymer molecules into smaller and simpler ones. Pyrolysis of plastic waste produces petrochemicals for new plastic, even from mixed and contaminated sources Achilias *et al.,* (2007); Park *et al.,* (1999). Pyrolysis of plastic waste products can be used as an alternative to traditional fuels or a source of valuable chemicals, making it crucial to utilize the resource wisely Lopez-Urionabarrenechea *et al.,* (2012). HDPE, LDPE, PP, and PS are hydrocarbons like LPG, petrol, and diesel. Plastics are derived from petroleum and have calorific values similar to LPG, petrol and diesel Khazaal and Abdulaaima, (2023).

According to Almeida & Marques (2016), residence time, temperature, and catalyst are the main factors that impact the process. In addition to residence and temperature, Al-Salem et al., (2017) included other operating factors such as type of reactor, pressure of operation, experimental conditions and type of feedstock material.

Singh and Ruj (2016) stated that cracking temperature and heating rate in pyrolysis are as important as the pyrolysis process because it is a complex process involving chemical reactions and physical stages like heat and mass transfer. When the temperature increases, the vibration of the molecules also increases and weakens the Van der Waals force between them. As a result, the molecules tend to evaporate away from the surface of the object, leading to the breaking of the carbon chain. The desired product from pyrolysis is mainly determined by the temperature. For example, to obtain char and gaseous products, the temperature needs to be maintained at a temperature higher than 500°C. However, for more liquid (oil), then the temperature should be between 300-500°C. At temperature of 400 to 650 °C, results to high bio-oil yield, with the maximum liquid yield being achieved between 450°C to 500 °C (Qureshi *et al.*, 2021; Prurapark*et al.,* 2020).

Residence time, also known as reaction time, is another critical factor that affects plastic pyrolysis. However, Lopez *et al.*, (2011) noted that time has a weaker effect than temperature, except for quick and short reactions. However, the ideal reaction residence time range is between 15 and 30 minutes since it leads to total conversion, and longer reaction times do not impact conversion or product characteristics. Shorter residence time promotes primary product formation, such as organic compounds, while long residence time enhances the yield of the carbonization process, resulting in a greater yield of tar and char (Buekens, 2006)

Pyrolysis technology is suitable for all kinds of plastic waste, whether clean, unwashed, or unsorted (Eze *et al.*, 2021).According to Manickavelan*et al.*, (2022), the composition and structure of plastics (feedstock) determine their pyrolysis productsbecause waste plastics are often contaminated before recycling, which can negatively impact the pyrolysis process and final products.

HDPE and LDPE are the most commonly wasted grades of plastics Kumar and Singh (2013). These plastics are predominant in dumpsites around the Port Harcourt metropolis; hence, they are a choice for this study. High-density polyethylene (HDPE) is a thermoplastic from the polyethylene family with a versatile application. It consists of a monomer called Ethylene. It has very high strength because of its high degree of crystallinity (70-95%), high molecular weight (941-965 kg/m3) Suhartono (2019), and low branching (Vijayakumar and Sebastian, 2018). Plastic is used in most industrial and domestic products due to its high strength-to-density ratio. HDPE is commonly recycled and has the number "2" as its resin identification code.
On the other hand, LDPE is a thermoplastic in high demand for commercial and other industrial products, such as parts of equipment, packaging, and greenhouses for agriculture. López *et al.,* (2011) stated that LDPE is the second largest plastic found in municipal waste in demand after polypropylene (PP). LDPE is one of the polyethylene polymers with a density between 0.915 and 0.930 g/cm3, with resin code "4."

Moreover, the ultimate and proximate analysis of HDPE and LDPE gives its volatility within the range of 99-95%, far more significant than other parameters, making them suitable for pyrolysis. Abnisa *et al.,* (2014) confirmed that the higher the volatility of a polymer, the higher the oil production. Sharuddin *et al.,* (2018) stated that among the polyolefin thermoplastics, LDPE produced the highest liquid oil yield (93.1wt%), followed by HDPE (84.7wt%). Also, Seo *et al.,* (2003) reported the yield of liquid, gas and residue from thermal degradation of waste HDPE at 450oC to be 84.00wt%, 13.00wt%, and 3.00wt%, respectively. In addition, Kumar and Singh (2011), at a temperature of 550°C, reported the yield of plastic pyrolysis to be liquid 79.08 wt%, gas 18.42 wt%, and residue 2.5wt%. Furthermore, Ahmad *et al.*, (2015) reported that the thermal cracking of HDPE was investigated over a temperature range of 250– 400 °C. Total liquid yield, 80.88 %w/w, gaseous,17.24% w/w, and residue, 1.88 % w/w, was achieved at 350°C. Sharuddin. *et al.*, (2017) stated that plastic is to be pyrolyzed individually for high yield in pyrolytic oil. Unfortunately, there is limited literature on the chemical composition of kerosene from HDPE and LDPE, and this study seeks to investigate this.

MATERIALS AND METHODS

HDPE and LDPE plastics were sourced from a dumpsite in Port Harcourt metropolis, Rivers State- Nigeria, shredded and weighed. A fixed batch reactor pyrolysis plant was used separately to pyrolyze the HDPE and LDPE plastic. The plastics were loaded into the pyrolysis plant reactor, and nitrogen gas was introduced into the reactor using a determined flow rate for five minutes. A fixed batch pyrolysis plant was used to pyrolyze 7 kg of the waste plastic at a temperature range of 350- 450^{o}C and a residence time of 2hrs. At the optimal temperature, the plastics underwent thermal decomposition to generate organic vapour; the vapour moved into the condenser and condensed, and then the condensed liquid was collected with the non-condensable gas at the central collection tank.

The high calorific value non-condensable gas was sent into the burner to aid burning for pyrolysis, while at the end of each bath, the reactor was allowed to cool and the residue removed and weighed. The volume and weight of the pyrolytic liquid and residue were determined using measuring cylinders and scales respectively. The value of the non-condensable gas was calculated using the mass balance.

The recovered pyrolytic oil wasfurther distilled at a temperature range of 150-270°C, where the kerosene fraction is recovered. The kerosene was analyzed using GC-FID and GC-MS, and their physicochemical parameters ascertained. The kerosenewas compared with the regulatory standard for Household kerosene (HHK).

Results& discussion

Plate: 1a

Plate: 1b

Plate: 2a

Plate: 2b

Plates 1a and 1b represent the shredded Low-Density Polypropylene (LDPE) before pyrolysis and generated pyrolytic oil from pyrolysis of the LDPE plastic, respectively.

Plates 2a and 2b represent the shredded High-Density Polyethylene (HDPE) before pyrolysis and generated pyrolytic oil from pyrolysis of the HDPE plastic, respectively.

Product yield

Table 1: Percentage yield of hydrocarbon products from pyrolysis

Plastic grade	Liquid (%)	Solid (%)	Gas (%)
HDPE	82.87	9.52	7.61
LDPE	84.15	3.34	12.51

NB: Values are the average of a replicate of 3 experimental samples

The HDPE yielded a high pyrolytic liquid when compared with the LDPE (Table 1). The result agrees with the proximate and ultimate analysis of both plastics. However, both have the propensity to yield more pyrolytic liquid than other pyrolysis products although the LDPE plastic has a higher potential than HDPE plastics. The result is in agreement with the work of Sharuddin*et al.,* (2018), which reported that among the polyolefin, LDPE generates more pyrolytic liquid than HDPE.

Table 2: shows the % kerosene yield

HDPE	LDPE
33	26
26	30
19.5	29
34	31
31	3
28.7	**23.8**

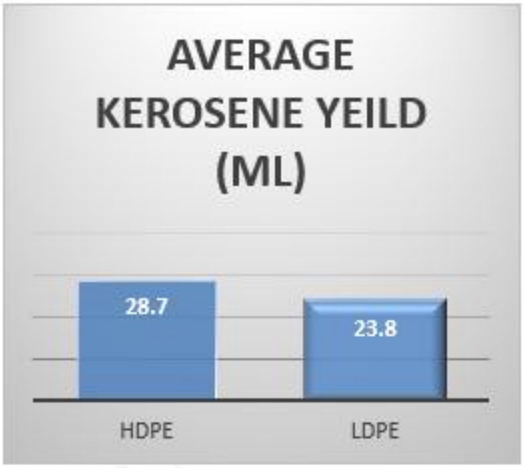

Figure1: Average % kerosene yield

Table 2: shows the kerosene yield from the distillation of 1000 ml of pyrolytic liquid each. A replicate of 5 experiments were carried out at 150-270^{o}C. The yield was also converted to a percentage value, and from the result, HDPE yielded more kerosene than LDPE, which is also shown in Figure 1.

Characterization

The characterization of the kerosene samples recovered from the distillation of the pyrolytic oil from both plastics was analyzed employing gas chromatography coupled with a mass spectrum (GC-MS) and Gas chromatography with flame ion detection (GC-FID) to carry out its quantification and qualification (chemical mass composition), while the physico-chemical properties analyzed utilizing the guide presented by The Nigerian Midstreamand Downstream Petroleum Regulatory Authority (NMDPRA) as shown in Table 3

Table 3: Physiochemical characterization of kerosene sample from HDPE and PP plastic

S/NO	PARAMETER	UNIT	HDPE	LDPE	NMDPRA LIMIT
1	Specific gravity	-	0.76	0.77	0.830 max
2	Acid value	mgKOH/g	0.68	0.65	0.01
3	Carbon residue	%wt.	0.21	0.14	-
4	Calorific value	Mj/kg	41750	40690	45000
5	Sulphur content	-	0.10	0.01	0.015max
6	Flash point	^{o}F	117.3	125.2	113 min
7	Smoke point	mm	23.1	20.7	22 min
8	API gravity	-	54.68	52.27	41.06 max
9	Colour	-	21.9	18.4	+18min
10	Water content	%wt.	0.10	0.18	0.05 max
11	Copper corrosion	2hr@100^{o}C	2a	1b	1b max

Table 3 summarizes the physico-chemical properties of the kerosene sample from HDPE and LDPE plastics. The specific gravity of the kerosene from both plastics shows that they are within the permissible limit of 0.820, the maximum value specified for cooking. The Calorific value of the plastic shows that the HDPE has a higher value than the LDPE; however, both have high values that can generate heat for cooking. The kerosene sample from HDPE has Sulphur above the permissible limit for cooking compared to the one from LDPE, which may affect its use indoors because of the danger associated with high-value Sulphur in fuel. This elevated value for the Sulphur content for HDPE kerosene can result from the high value of Sulphur in the HDPE plastic, as reported by Dubdub& Al-Yaari (2020) in the ultimate analysis of various plastics. Both plastics have flash points above the minimum limit. Therefore, both are safe for handling and storage since the higher the flash point of the fuel, the better. The smoke point value of both plastics shows LDPE below the minimum value, showing that it will likely undergo incomplete combustion. Finally, the copper content of both plastics showed HDPE above the permissible limit and LDPE within the permissible limit. Therefore, LDPE is primarily safe for metal or copper lamps since no corrosion problem exists. This result shows that the properties of kerosene from both plastics are close to that of commercial kerosene so that they can be used directly as their commercial counterpart.

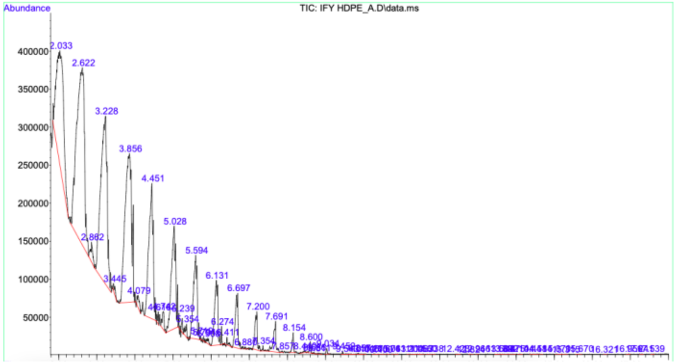

Figure 2a: GCMS result of High-Density Polyethylene (HDPE)

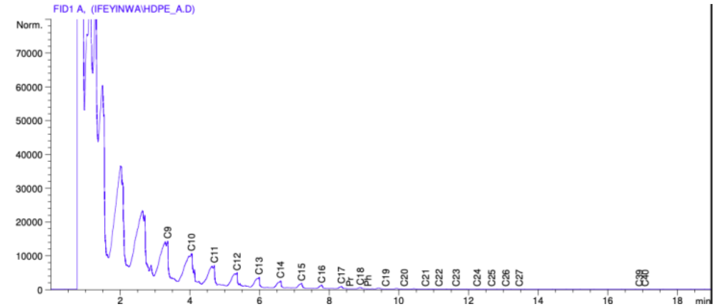

Figure 2b:GC-FID result of High-Density Polyethylene (HDPE)

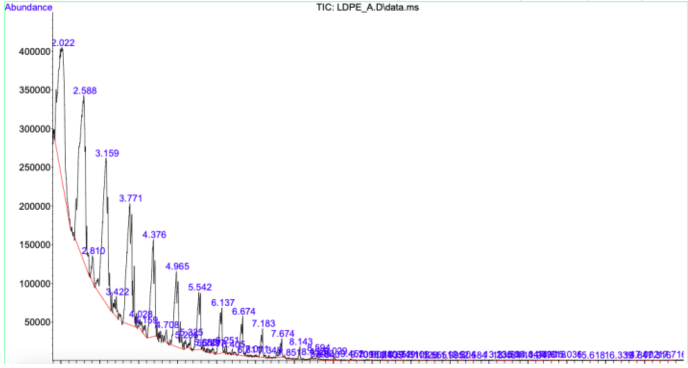

Figure 3a: GCMS result of Low-Density Polyethylene (LDPE)

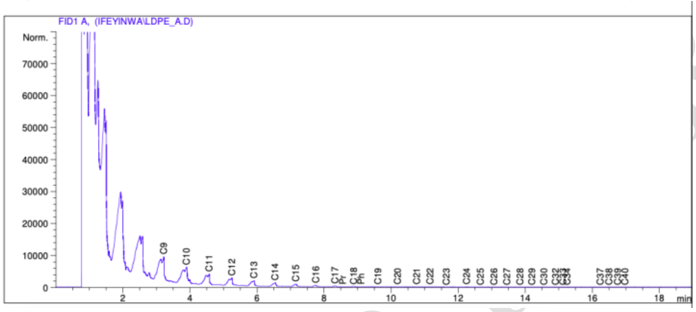

Figure3b: GC-FID result of Low-DensityPolyethylene (LDPE)

Table 4: Concentration of carbon in the HDPE and LDPE kerosene sample

NAME	SAMPLES CONC. (PPM)	
	HDPE	LDPE
C_9	3.25282e4	6138.04439
C_{10}	2.37071e4	1.12048e4
C_{11}	1.38058e4	2370.58398
C_{12}	8569.04285	4213.90389
C_{13}	5444.71725	2805.37978
C_{14}	3516.77104	1713.05238
C_{15}	2355.81227	675.38132
C_{16}	932.37955	415.69955
C_{17}	592.22209	260.83131
Pr	5.44395	4.70962
C_{18}	346.72881	135.88375
Ph	9.79756	4.67080
C_{19}	11.21237	4.79289
C_{20}	3.92935	3.81636
C_{21}	4.78862	5.00175
C_{22}	6.11661	8.86530
C_{23}	4.89621	5.35567
C_{24}	13.95069	14.52678
C_{25}	9.94804	11.61934
C_{26}	7.41228	10.52662
C_{27}	7.67942	9.90117
C_{28}	-	10.20746
C_{29}	-	10.29109
C_{30}	-	9.02073
C_{31}	-	-
C_{32}	-	7.16694
C_{33}	-	5.70927
C_{34}	-	3.97247
C_{35}	-	-
C_{36}	-	-
C_{37}	-	0.00000
C_{38}	-	1.80159
C_{39}	6.12610	7.10625
C_{40}	8.47482	8.97226

Table 5: GC-MS analysis of HDPE Kerosene sample

Percentage contribution of PIONA in HDPEkerosene sample

Name of compound	**Molecular formula**	**R. time (min)**	**% of total**
2-Heptene, 5-methyl-	C_8H_{16}	2.033	13.062
5-Octadecene,	$C_{18}H_{36}$	2.622	21.566
Bicyclo[3.1.1]heptane, 2,6,6-trimethyl-	$C_{10}H_{18}$	2.862	0.673
Cycloheptane, methyl-	C_8H_{16}	3.228	16.611
5-Dodecene,	$C_{12}H_{24}$	3.856	15.664
3,4-Octadiene, 7-methyl-	C_9H_{16}	4.079	0.378
7-Tetradecene,	$C_{14}H_{28}$	4.451	9.023
1-Docosene	$C_{22}H_{44}$	5.028	6.882
Cyclopentane, hexyl-	$C_{11}H_{22}$	5.239	0.259
3,4-Octadiene, 7-methyl-	C_9H_{16}	5.354	0.286
1-Cyclohexylnonene	$C_{15}H_{28}$	5.719	0.021
1-Docosene	$C_{22}H_{44}$	6.131	3.301
Hexacosane	$C_{26}H_{54}$	6.697	2.292
Cyclopentane, 1-pentyl-2-propyl-	$C_{11}H_{22}$	6.880	0.035
Heneicosane	$C_{21}H_{44}$	7.200	1.375
3-Octadecene,	$C_{18}H_{36}$	7.354	0.092
Octacosane	$C_{28}H_{58}$	7.691	1.169
Heptacosane	$C_{27}H_{56}$	8.154	0.417
Tetratetracontane	$C_{44}H_{90}$	8.600	0.214
Nonane, 4-ethyl-5-methyl-	$C_{12}H_{26}$	9.857	0.021

Table 6: GC-MS analysis of LDPEKerosene

Percentage contribution of PIONA in LDPE kerosene sample

Name of compound	**Molecular formula**	**R. time (min)**	**% of total**
(Z)-5-Decene	$C_{10}H_{20}$	2.022	18.485
Cyclopropane, 1-heptyl-2-methyl	$C_{10}H_{20}$	2.588	21.916
Bicyclo[3.1.1]heptane, 2,6,6-trime thyl-	$C_{10}H_{18}$	2.810	1.047
Cyclopentane, 1-hexyl-3-methyl-	$C_{12}H_{24}$	3.159	16.301
4-Tridecene, Z	$C_{13}H_{26}$	3.771	13.483
Bicyclo[3.1.1]heptane, 2,6,6-trime thyl-, [1R-(1.alpha.,2.alpha.,5.al pha.)]-	$C_{10}H_{18}$	4.028	0.414
Bicyclo[3.1.1]heptane, 2,6,6-trime thyl-, [1R-(1.alpha.,2.alpha.,5.al pha.)]-	$C_{10}H_{18}$	4.159	0.425
4-Tridecene, (Z)-	$C_{13}H_{26}$	4.376	7.666
3,4-Octadiene, 7-methyl-	$C_{9}H_{16}$	4.708	0.365
5-Octadecene, (E)-	$C_{18}H_{36}$	4.965	6.375
3-Octadecene, (E)-	$C_{18}H_{36}$	5.205	0.297
1-Methyl-2-(4-methylpentyl)cyclopentane	$C_{12}H_{24}$	5.325	0.228
5-Octadecene, (E)-	$C_{18}H_{36}$	5.542	3.925
1-Cyclohexylnonene	$C_{15}H_{28}$	5.685	0.018
10-Methylnonadecane	$C_{20}H_{42}$	6.137	2.664
10-Methylnonadecane	$C_{20}H_{42}$	6.674	1.762
Tetratetracontane	$C_{44}H_{90}$	7.183	1.102
Heptadecane	$C_{17}H_{36}$	7.674	0.798
Hexadecane	$C_{16}H_{34}$	8.143	0.371
10-Methylnonadecane	$C_{20}H_{42}$	8.594	0.164
Undecane, 5,6-dimethyl-	$C_{13}H_{28}$	9.452	0.033

Kerosene is one of the middle distillates of petroleum containing lighter fractions of primarily saturated aliphatic hydrocarbon and low concentrations of aromatic hydrocarbons. The carbon molecules of kerosene are between C9 and C16 (Shepherd *et al.*, 2000). The GC-FID was used to show the concentration of each carbon atom within the kerosene sampled; the GC-FID of both samples gave their carbon concentrations. The chromatogram of both samples in Figures 2b and 3b showed a concentration of carbon molecules from C9 to C40; below C8, they were not detected because they are the lighter fractions and very volatile, and interference can occur. The carbon concentration of both samples, as shown in Table 4, showed the peak value of carbon concentration per time at C9 to C17 and is within the carbon range of standard kerosene.

The GC-FID was able to determine the carbon concentration of the sample, but for the chemical composition of the sample, a GC-MS was used. From The MS, each sample was characterised correctly, and all the compounds in the samples were identified in addition to their percentage abundance. The chromatograms of both samples are shown in Figures 2a and 3a. From the chromatogram, the sample type can be identified to some extent. The chromatogram peaks of the different compounds are well-defined and show almost the same pattern as a typical kerosene chromatogram, agreeing with the fingerprint pattern of the GC-FID. The highest peak height and abundance percentage were recorded at 233167: 21.5666%, 220844: 16.611%, 195294: 15664 and 178169: 9.023% for HDPE and 214034: 21.916%, 169622:18.485%, 187466:16.301%, 156433:13.483% for LDPE.

The GS-MS results of both samples showed that the samples contain several different compounds. Since the investigation was on kerosene, the compounds that were of interest were selected out of the many compounds and are listed in Tables 5 and 6. The selection of the compound was based on if the compound falls within the already established groups of compounds in kerosene. Standard kerosene is made up of *n*-Paraffin, Iso-Paraffin, Naphthene and Aromatics. The measured compounds from the samples contain hetero-containing compounds of nitrogen, halogen, oxygen and sulphur. However, the emphasis was on the PIONA groups, so therefore the several compounds of interest were grouped into the paraffin (*n*-alkanes), Iso-paraffin (isoalkanes), Olefins (alkene), Naphthene (Cycloalkanes) and Aromatics hydrocarbons.

The Tables showed the concentrations of the PIONA available in both samples; from the tables, the HDPE comprises 1, Paraffin within the concentration range of 0.214% to 2.295%; this figure comprises straight chain alkanes of high carbon range. 2. Iso-Paraffin of 0.021%, this figure was from Nonane, 4-ethyl-5-methyl-. 3. Olefin, which includes different forms of alkene groups, both the mono-alkene and di-alkenes, has the highest concentration abundance in the range of 0.092% to 21.560%. 4, The Naphthene comprising of the cycloalkanes was also present in the sample at the range of 0.035 % to 16.611%; there was also a cycloalkene with a concentration of 0.021% observed. The LDPE kerosene also showed several compounds as listed in Table 6, and these compounds were also grouped based on PIONA hydrocarbons and their concentrations also listed: 1. Paraffins comprises of the concentration range of 0.371% to1.102%, and the figure contains alkanes of high carbon atoms range. 2. Iso Paraffin in the sample are Iso-alkanes in the range of 0.033% to 2.644%. 3. Olefins in the LDPE kerosene are also the highest, with a concentration range from 0.297% to 18.485%, comprising mono alkenes and di-alkenes. 4.

Naphthene present in the sample was only the cycloalkanes, and of the range 0.018% to 21.916%, the highest value was registered by Cyclopropane, 1-heptyl-2-methyl.

Table 7: Composition of distilled products

Samples	Paraffin (%)	Iso Paraffin (%)	Olefin (%)	Naphthene (%)	Aromatics (%)
HDPE Sample	5.467	0.021	70.254	17.599	-
LDPE Sample	2.279	4.623	50.596	40.349	-
Kerosene	55.2	-	-	40.9	3.9

In general, as shown in Table 7, the chemical composition of the samples from the HDPE and LDPE plastics was grouped and compared with that of the standards for kerosene. From the results, the HDPE kerosene sample contains Paraffin (5.467 %), Iso-paraffin (0.021%), Olefin (70.254%), Naphthene (17.599%) and no aromatic hydrocarbon. The LDPE sample contains Paraffin (2.279 %), So-paraffin (4.623%), Olefin (50.596%), Naphthene (40.349%) and also no aromatic hydrocarbon. The olefins were the highest in abundance in both samples though not in the standard kerosene. The Naphthene of the LDPE (40.349%) sample was higher than the HDPE (17.599%) and the same as the standard limit (40.9%). The paraffin of both samples is less than the standard limits of 55.2%, and aromatics were absent.

CONCLUSION

This study has shown the feasibility of the production of HHK from HDPE and LDPE. The study also showed that HDPE plastic produces more kerosene than LDPE plastic. Both types of plastic meet the Household kerosene (HHK) standards set by the NMDPRA, except for some minor differences in sulphur content and smoke point. The GC-FID analysis showed that both plastics have the highest abundance of carbon molecules in C9 to C16. Additionally, GC-MS analysis showed that both plastics have a chemical composition similar to standard kerosene, with the absence of aromatic compounds and olefin compounds, which can be attributed to their polymerization. Overall, the resulting kerosene has similar properties to commercial kerosene and can be a suitable alternative for domestic use.

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