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Comparative Analysis of the Quality of Petroleum Products from different Sources in Onitsha, Anambra State, Nigeria

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ABSTRACT

The adulteration of petroleum fractions has its attendant effect in combustion engines of vehicles, machines and for domestic purposes. Detection of adulterated petroleum fractions are experimentally determined by the analysis of physiochemical properties which is done in compliance with known regulatory standard. Three different petroleum fractions (Gasoline, Diesel, Kerosene) samples were collected from a major petrol station, individual/independent petroleum station, black market and local artisanal product within new market road, Onitsha, Anambra state. The physiochemical properties carried out were; Specific gravity, APIgravity, viscosity, flashpoint, fire point, pour point, and cloud point. The tests were carried out according to American society's standard process for testing and materials (ASTM). The results obtained indicates that most of the Gasoline and Diesel sample obtained from the individual petroleum station, black market and local artisanal product from the area under study were generally of good quality,except for the gasoline obtained from the individual petroleum station, which varied slightly from the ASTM standard. The physiochemical parameters for the kerosene samples obtained from the black market and artisanal product also show slight variation from the ASTM standard, suggestive of adulteration.

1. INTRODUCTION

The Crude petroleum consists of compounds that boil at different temperatures and can be separated by distillation into a range of generic fractions. The properties of crude petroleum vary greatly because the proportions in which the different constituents occur vary with origin (Speight, 2000). Hydrocarbons, which are hydrogen and carbon molecules with a wide range of molecular structures, are the most important components of petroleum. Alkanes, cycloalkanes, and aromatic hydrocarbons predominantly form hydrocarbons present in crude oil, while the other organic compound contain nitrogen, oxygen and sulfur with trace amounts of metals like iron, nickel, copper, and vanadium (Speight, 2000).

The quality of petroleum products plays key role in their efficiency and use in different engines. The processing, handling, transportation and storage of petroleum products can affect their quality. In some cases, petroleum products can be adulterated deliberately by using

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adulterants which are lesser in quality "partially refined products" (Onojake *et al*; 2012) and this has serious implications for their use in engines. Adulteration is defined as the illegal or unauthorized introduction of a foreign substance into fuel, resulting to products that are of low quality that does not meet the product's criteria and specifications (NNPC, 2008). Gasoline, kerosene, and diesel are the most commonly adulterated fuels in Nigeria. Adulteration of fuel is quite common in Nigeria, owing to the disparity in price between products of comparable volumes. The gasoline dealers do this (adulteration) to maximize profit from the product while ignoring the damage it causes to motor vehicles and other hazardous consequences on human life. For example, when kerosene is adulterated with petrol, it can be exceedingly dangerous due to its high flammability (Igbafe and Ogbe, 2005). Fuel adulteration has a number of consequences, particularly for vehicles that use it; it leads to damages of fuel pump, increases exhaust emissions thereby resulting to engine knock (Yadav *et al*, 2005). The increase in exhaust emissions mostly in densely populated areas has its own significant effects to fauna and flora (Ivwurie and Okorodudu 2022).

Successive governments in Nigeria have failed to build a monitoring system and penalties that may act as an effective deterrent to adulteration. Considering the densely populated area of research and since most of this petroleum products reaches point of sales (POS) without detection which in turn causes magnitude of damages to users, there is continual need to monitor the quality of these products. The objectives of this research work seeks to determine the physiochemical properties of diesel, kerosene, and gasoline obtained from major and individual petroleum stations, black market, and local artisanal product within New market road Onitsha, Anambra state, using (American Society for Testing Materials) ASTM standard. The quality of the different sources will also be compared using ASTM limit range with a view to determining whether adulteration has taken place and appropriate recommendations given.

2. MATERIALS AND METHODS

2.1 Collection of Samples

Three different samples of petroleum products (Gasoline, Kerosene & Diesel) were collected from a major oil marketing filling station, individual/independent oil marketing petroleum station, a black-market sales outlet and locally processed petroleum products in new market road Onitsha, Anambra State. The samples were preserved in clean, air-tight plastic containers before taken for analysis in the laboratory.

2.2 Analysis of Samples

The physiochemical parameters analyzed for were; Specific gravity at 60°F and API gravity using ASTM D4052-11 method (Digital density analyser, Mettler Toledo, DA-100M), kinematic viscosity at 40°C using ASTM D445-06 method (Ubbeholde viscometer, anaka KV-4V/England DMO), Flashpoint and fire point were determined using ASTM D93-06 standard, Pour point and Cloud point were carried out according to ASTM D97-06 and ASTM D2500-05 method respectively (Tanaker pour point and flashpoint tester, Models MPC-102S). The reagents used were all analytical grades.

3. RESULTS AND DISCUSSION

3.1 Specific gravity and API gravity

The specific gravity and API gravity of gasoline, diesel, and kerosene collected from the different sales outlet is shown in Table 3.1 and figure 3.1a and 3.1b.

Table 3.1: Result of the specific gravity and API gravity of gasoline, kerosene and diesel from different collection points.

Sample Source	Specific Gravity @ 60ºF			API Gravity		
	Gasoline	Kerosene	Diesel	Gasoline	Kerosene	Diesel
Major petroleum station	0.75	0.82	0.85	57.17	41.06	34.97
Individual petroleum station	0.82	0.77	0.85	41.06	52.27	34.97
Black market	0.77	0.79	0.83	52.27	47.61	38.98
Local artisanal	0.76	0.79	0.89	54.68	47.61	27.49
ASTM standard	0.750-0.77	0.80-0.875	0.825-0.925	52.26-57.16	30.21-45.38	21.47-40.01

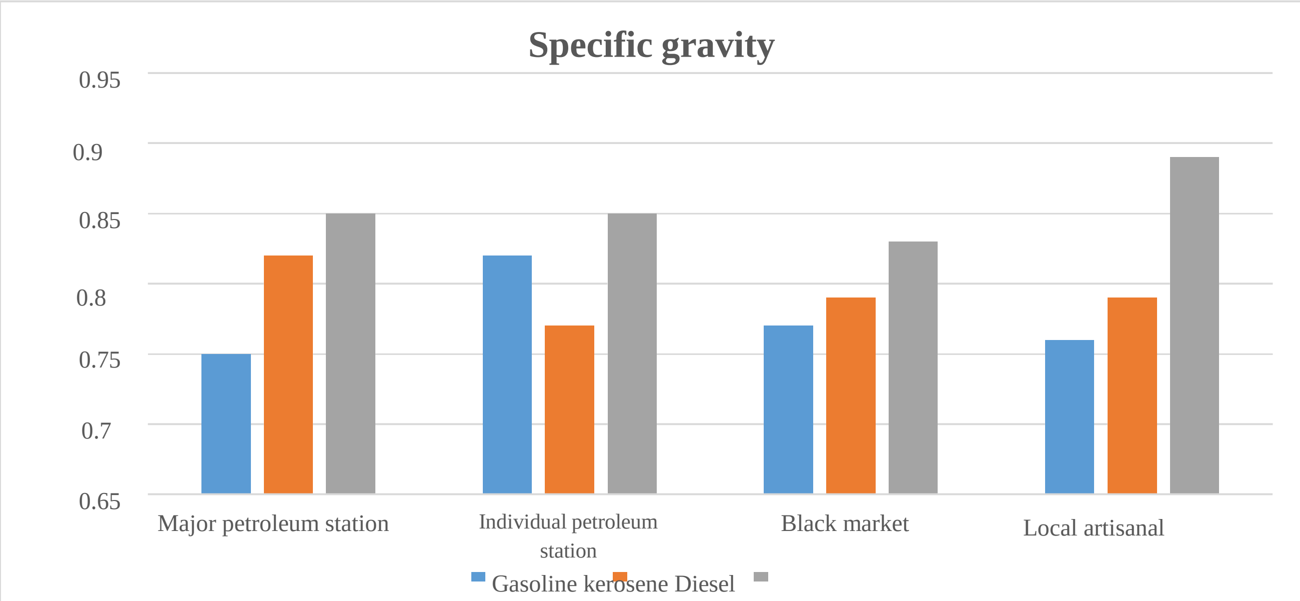

Figure 3.1a: Specific gravity distribution of petroleum products from their collection points.

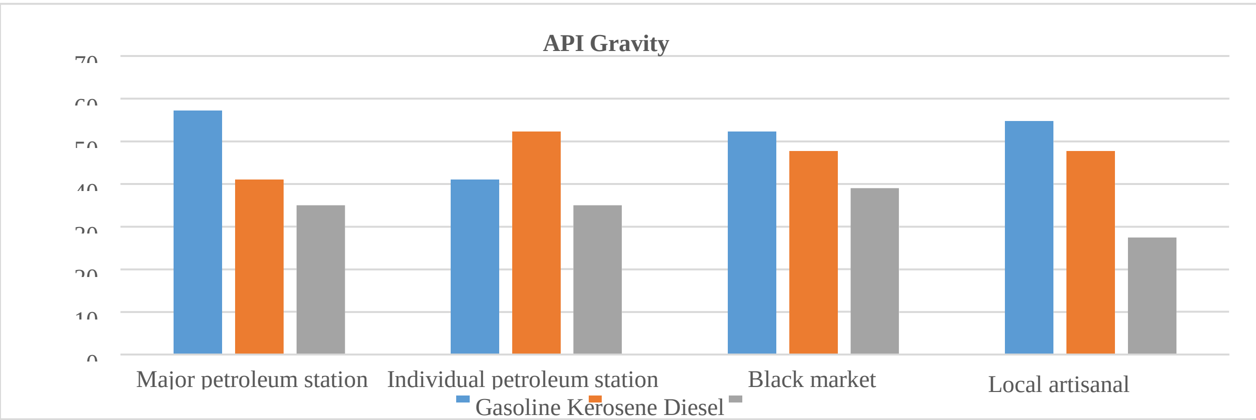

Figure 3.1b: API gravity distribution of petroleum products from their collection points.

The specific gravity of gasoline obtained ranged from 0.75 to 0.82, for kerosene; 0.77 to 0.82 and for diesel; 0.83 to 0.89 across the four sampling outlets respectively. They are all within the product specification ASTM standard, except in cases for gasoline sample obtained from the individual petroleum station, which has slightly higher specific gravity of 0.82 when compared to their ASTM standard; kerosene sample obtained from individual petroleum station, black market and local artisanal having specific gravity of 0.77, 0.79 and 0.79 respectively which are slightly lower than the ASTM standard. The API gravity for gasoline, kerosene and diesel ranged from 41.06-57.17, 41.06-52.27 and 41.06-52.27 for all sampling locations. The API gravity for gasoline sample obtained from individual petroleum station was below the ASTM standard just as that of kerosene obtained from all locations excluding major petroleum station have API gravity slightly higher than the ASTM standard. The Specific and API gravity of the samples when compared generally with the ASTM standard were either too heavy or too light (Okoye, 2009).

Table 3.2: Result of the viscosity of gasoline, kerosene and diesel from different collection points.

Source	Gasoline	Kerosene	Diesel
Major petroleum station	0.67	1.99	2.79
Individual petroleum station	1.56	1.16	4.45
Black market	0.67	1.01	4.37
Local artisanal	0.67	5.41	10.97
ASTM standard	0.5-0.84	1.0-1.9	1.6-5.5

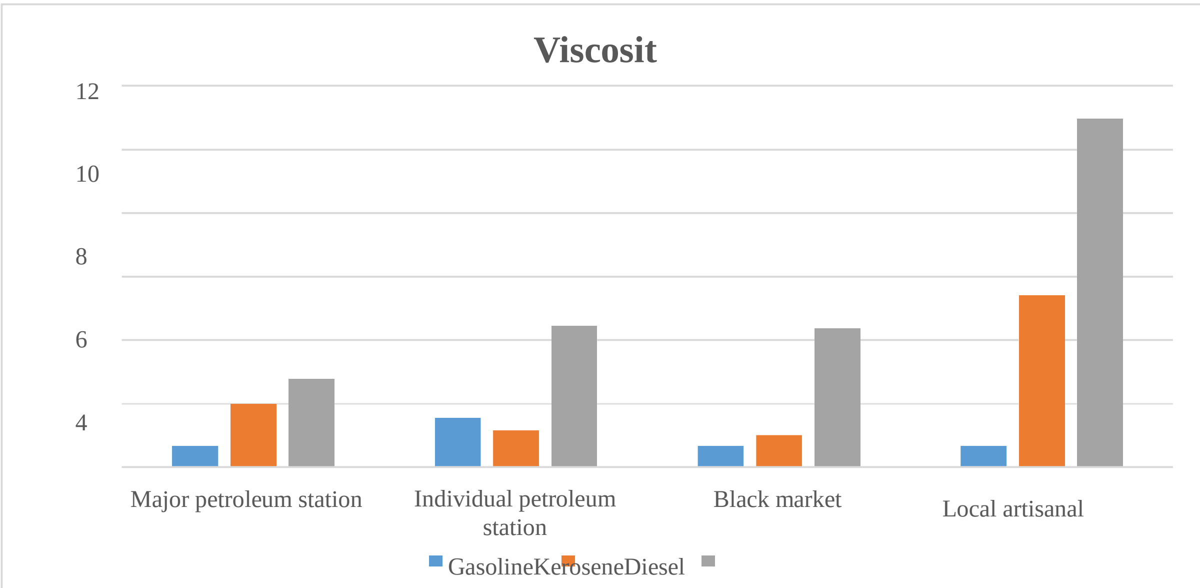

Figure 3.1b: Viscosity distribution of petroleum products from their collection points.

3.2 Viscosity

The viscosity of gasoline, diesel, and kerosene is shown in Table 3.2 and Figure 3.2.

The kinematic viscosity ranged from 0.67 to 1.56 for gasoline; 1.01 to 5.41 for kerosene, 2.79 to 10.97 10.97 for diesel across all sampling outlets. The kinematic viscosity for all sample locations excluding the kerosene and diesel gotten from artisanal products sales outlet were within the ASTM standard range of 0.5-0.84 for gasoline; 1.0-1.9 for kerosene and 1.6- 5.5 as shown in Table. 3.2. The kerosene and diesel from artisanal products sales outlet suggest presence of adulterants which may give rise to pump resistance, damage of filter and poor engine combustion for the diesel (Godwin *et al;* 2015); however, the kerosene may not be of a risk for domestic uses.

3.3 Flash point and Fire point

The flash point and fire point of diesel and kerosene are shown in Table 3.3 and Figure. The flash point and fire point of kerosene and diesel were generally within the ASTM standard except for the individual petroleum station and local artisanal outlet which has a lower flash point 18ºC(21ºC) and fire point 20ºC (24ºC) for kerosene samples when compared to the ASTM standard range respectively. The lower flash and pour point of kerosene portend danger in storage and handling, as its easily ignitable (Boadu,2019).

Table 3. 3: Result of the flash point and fire point of kerosene and diesel from different collection points.

Sample Source	**Flash point (ºC)**		**Fire point (ºC)**	
	Kerosene	**Diesel**	**Kerosene**	**Diesel**
Major petroleum station	49	59	51	65
Individual petroleum station	18	78	20	81
Black market	63	81	65	85
Local artisanal	21	65	24	68
ASTM standard	>38	>52	>42	>60

Table 3. 4: Pour point and cloud point of diesel from different collection points

Source	**Pour point (ºC)**	**Cloud point (ºC)**
Major petroleum station	-7.4	2.6
Individual petroleum station	-7.4	2.6
Black market	-6.1	4.6
Local artisanal	-6.6	4.8
ASTM standard	>-7	<4.4

Cloud point is the temperature at which wax (paraffin) begins to separate when oil temperature is lowered or chilled, while pour point of a liquid is the temperature below which the liquid seizes to flow (i.e looses its flow capability) (Jones and Pujado, 2006). These physiochemical parameters serve as an important indicator of practical performance in automotive applications in low temperature (Klein and Zachmann, 2004). Following the ASTM standard from Table 3.4, the results obtained for this analysis indicates that the cloud and pour point of diesel samples obtained from the major and individual petroleum station falls within the ASTM standard. However, there are infinitesimal low flash point at major petroleum station and individual petroleum station as well as slightly high cloud point at black market and local artisanal sales point respectively.

4. CONCLUSION

This research has shown that most of the gasoline, kerosene and diesel sample obtained for analysis from the area under study are not adulterated except from the gasoline obtained from the individual petroleum station which was not of good quality when compared to ASTM standard. The samples of the kerosene and diesel obtained from the black market and local artisanal are not of excellent quality. Those petroleum products that have great deviation from the ASTM standard may be as a result of poor refining process or may contain adulterants which might be deliberately adulterated or through improper handling of the petroleum products.

Recommendation

To curb fuel adulteration, oil companies and government could use mobile laboratories to conduct surprise and routine inspections of retail outlets. Stiff penalties on the sale of adulterated products should also be imposed.

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