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Potentials Of *Musa Sapientum, Solanum Tuberosum* and *Elaeis Guineensis* as Additive to Water Base Mud

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ABSTRACT

Oil and gas sector plays vital roles in global economy and energy, and drilling operation is undoubtedly a critical component as drilling fluid is essential during drilling operations. In order to achieve safe and successful drilling operations, optimal drilling fluid is required. Drilling fluids are complex heterogeneous fluid having diverse functionality with chemical additives to enable ultimate performance. Though, these additives expensive, but none-biodegradable. This led to search for environment-friendly additive. This study explored locally sourced degradable agricultural wastes form Banana (*musa sapientum*) Potato,(*solanum tuberosum*) and Palm head (*elaeis guineensis*) as alternative to conventional additives in enhancing the properties of a simple water-based mud. The agricultural wastes were characterized using the FTIR and SEM-EDS, for chemical and elemental composition, respectively. Varying concentration (1g, 2g, 3g, 4g and 5g) of these additives were used at temperature 25 ^oC, 40 ^oC, 60 ^oC, and 80 ^oC and aging time of 24hours, 48 hours and 72 hours to were determine rheological and filtration properties, using the API Recommended Practice 13B-1. Results revealed that rheological and filtration properties of water-based mud improved as the concentration of additives increases. The use of these additives is not only environmentally friendly but also economically efficient than other chemical-based additives.

Keywords: Carboxymethyl Cellulose (CMC), Fluid loss control, Rheological properties control, Banana peel, Potato peel, Palm head sponge,

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1. INTRODUCTION

The Increasing demand for energy can be linked to the increase in human population and industrialization. As a result, the need for a safe and efficient exploitation of petroleum is key, and drilling fluid plays an important role as it not only used to circulate the cuttings generated by the drill bit as it cut through the subsurface rock matrix, but also perform other activities, including keeping the wellbore stable, chilling the drill bit, transporting drilling cuttings to the surface, and limiting the inflow of formation fluids. Drilling fluid can be classified based on a range of properties, including their composition, rheology, and mode of operation, and the various functions of drilling fluid largely depend on the properties of the fluid itself. Drilling fluid properties that must be closely observed are viscosity, gel strength, mud weight, mud pH, sand content etc.

The oil and gas industry are considered to be the second largest industry that generate waste as a result of drilling operations, hence the need to reduce the waste being generated by replacing, non-environmentally friendly drilling fluids with those which are environmentally friendly. Several ways to deal with this problem have been sought and one of these is by the use of agricultural waste and byproducts could lower production costs and contribute to the reduction in environmental damage Al-Saba(2018) . Crop waste is a type of Agricultural waste leftover after cultivating and processing agricultural products. Nishikant A. Raut (2023). The use of agro waste and some other organic materials as drilling fluid additives date back to the oil and gas industry, agro waste is typically used to produce local additives. (Almagro, et al, 2014).

Several investigations have been carried out in the prospect of agro waste as potential additives in drilling fluids. In 2015, Adebowale and Raji, investigated the use of banana peel ash (BPA) as a substitute for sodium hydroxide (NaOH) to pH and as corrosion inhibitor. From their result, significant enhancement in pH from mud samples treated with BPA was observed. Moslemizadeh and Shadizadeh (2017) examined the use of henna extract as biodegradable shale inhibitor in water-based muds . their finding shows that the henna could enhance the lubricity of the mud and decrease shale swelling. Joshi et al. (2021) investigated the use of tamarind kernel powder as an alternative additive in drilling fluids. From their it was observed that the density of the mud sample increased with the addition of tamarind seed powder and the combination of bentonite, and increasing the concentration of tamarind seed powder resulted in the increase in mud density.

AL-Hameedi et al (202) investigated the potential of using mandarin peels powder (MPP), as a drilling fluid additives. From the result of the study it was shown that MPP reduced the alkalinity by 20–32%, modified the rheological properties, reduced the fluid loss by 44–68% but had a negligible to minor impact on mud weight. Bagum et al.(2022) study result in the development of a drilling mud additive using Aloe Vera. Their investigation confirms the benefit of the use of Aloe Vera as a potential drilling fluid additive which is environmentally friendly. Adebayo et al. (2021), developed an eco-friendly drilling fluid using chitosan from their result they observed that the use of chitosan treated drilling fluid was a good fluid loss reducing agent and improved its rheological properties. Mohammed et al (2022) investigated the effect of Banana peel waste on the properties of a water a based mud, their study showed that the use of banana peel waste was not only suitable but was also cost effective and could be used as possible replacement for the regular conventional chemical additives.

Medved, et al. (2022) studied the effect of mandarin peel powder particle size on the properties of a water based drilling mud, using the dry powder mandarin peel divided into particle sizes between 0.1 mm and 0.16 mm., at different concentrations of Mandarin peel powder was added to a water-based drilling (0.5, 1, 1.5, and 2% by volume of water), observed that by increasing the mandarin peel powder concentration, the API filtration reduced up to 42%, PPT filtration significantly decreased up to 61.54%, while the rheological parameters although generally increased but remained were within acceptable limits.

Mohammad Jamal Awl et al. (2023) studied the performance of broad bean peel powder (BBPP) as a drilling fluid additive from the results, they observed that BBPP reduced the drilling fluid's alkalinity by 10–39% and enhanced plastic viscosity, gel strength, reduced the filter cake thickness and fluid loss from 1.75 mm and 20.4 mL to 1.0 mm and 13.3 mL, respectively. But had negligible effect on other properties such as the yield point and mud weight. Akintola et. al.(2024) investigated the effect of the treatment of a water based mud with Palm Kernel Shell Powder (PKSP) on the mud rheological and filtration properties. From the study, they observed that the mud samples treated with Palm Kernel Shell Powder (PKSP) not only proved to be a potential additive for water-based mud, it also showed improved performance in terms of reducing the filtrate volume as well as the cake thickness with increasing concentration of the additives. This study seeks to examine the potential of Banana peel powder, Potatoes peel powder or Palm head sponge as suitable replacement for CMC in a water- based drilling mud.

2. MATERIALS AND METHODOLOGY

The Banana bunch was obtained from Bodija fruit market in Ibadan, Oyo State, and the palm head sponge from a palm tree at the University of Ibadan Botanical Garden. The potato peel was collected from a restaurant kitchen in the university of Ibadan. The digital weighing Balance, Hamilton Multimixer, Woven metal wire mesh, Measuring Cylinder, spatula, Fann 35A, Ofite LPLT Filter press, thermometer, stopwatch, Baroid Mud Balance, was obtained from the laboratory of department of Petroleum Engineering, University of Ibadan. The Bentonite, Carboxyl Methyl Cellulose (CMC), Barite were donations from Mj Swaco.

2.1 Preparation of the Local Agro waste

Banana Peel Powder

The banana (Musa acuminata) peel was thoroughly washed in double-distilled water to remove all dirt. The washed peels were cut into smaller pieces, sun-dried for three weeks. The dried peels were pulverized, sieved (212micron sieve size), and packaged into an air tight labelled container.

Potato Peel Powder

The potatoes (Solanum tuberosum) peels were cut into small size and thoroughly washed in double-distilled water to remove all dirt. The washed peels were sun-dried for about three weeks, before it they were pulverized, sieved (212micron sieve size), and packaged into an air tight labelled container.

Palm Head Powder
4.83kg of palm (Elaeis guineensis) head sponge was shredded to get rid of palm seeds and debris. After three weeks of sun drying, it was grinded into fine powder using a grinding machine. The sundried palm head powder was pulverized and sieved (425 micron sieve size), 301.8g of powdered palm head sponge was obtained this was packed into a labelled container and sealed.

2.2 Sample Preparation
The mud samples were prepared in accordance with the Recommended API RP-13B-1, and left for 16 hours to hydrate before being treated with the different additives. 60 drilling mud samples were prepared to be tested. These mud samples were labelled as follows for Banana Peel Powder as BPP Potato Peel Powder as PPP, Palm Head Powder as HPP and Carboxymethyl Cellulose as CMC.

2.3 Sample Characterisation
The BPP, PPP, and HPP were characterised using the FTIR and the energy dispersive X-ray spectroscopy (SEM-EDS).

2.4 Determination of Mud Samples Density and pH
The density of the mud samples was determined using the Bariod Mud balance. Before using the mud balance, it was calibrated using distil water, while the pH of the drilling mud was determined using a 1-inch universal pH paper strip.

2.5 Determination of Mud Samples Rheological Properties
The mud samples rheological property was determined using the Fann 35A. The dial reading was taken at each rotation speed when the rotation speed was steady or stabilized. The apparent viscosity, plastic viscosity, yield point was calculated mathematically using the equations 1.0, 2.0 and 3.0, respectively.

Apparent Viscosity, $\mu_a = \frac{600\ RPM\ Reading}{2}$ 1.0

Plastic Viscosity, $\mu_p = \theta 600\ RPM\ Reading - \theta\ 300\ RPM\ Reading$...............2.0

Yield Point. YP = $\theta 300 RPM\ Reading - Plastic\ Velocity$..................3.0

Where (θ) represents the 600rpm and 300rpm dial readings, respectively

For the Gel Strength (lb/100 ft^2), the maximum deflection of the dial before the gel breaks after 10 sec of drilling fluid at rest was recorded.

2.5.1 Determination of the Effect of Aging on the Rheological Properties Mud Samples
The effect of aging on the hydrated mud samples treated with different concentrations of the various additive, was determined at 24, 48 and 72 hours.

2.5.2 Determination of the Effect of Temperature on the Rheological Properties Mud Samples
The effect of change in temperature on the different concentration of mud samples was determined at varying temperatures of $25℃, 40℃, 60℃\ and\ 80℃$..

2.6 Determination of Filtration Properties of the Mud Samples

The filtration properties of a drilling mud is a measure of the ability of the solid components ofthe mud to form a thin, low-permeable filter cake. To determine the mud filtrate of a drilling mud sample, the standard Ofite LPLT (Low Press Low Temperature) filter press was used.

3. RESULTS AND DISCUSSION

3.1 Fourier-Transform Infrared (FTIR) spectroscopy

The FTIR was conducted at the laboratory of the department of Chemistry, University of Ibadan. The Figure 1.0 shows the peaks of the Banana Peel Powder predominantly in the range of Amines with N-H stretch and Amides with N-H stretch. The Potato Peel Powder spectroscopy in the Figure 2.0 indicates the presence of Alkyl and Aryl Halides, Amides, and sparing occurrence of Aldehydes and Ketones. With the Palm Head Songe Powder sample peaked into the carboxylic acids and anhydrides vibrations as shown in the Figure 3.0

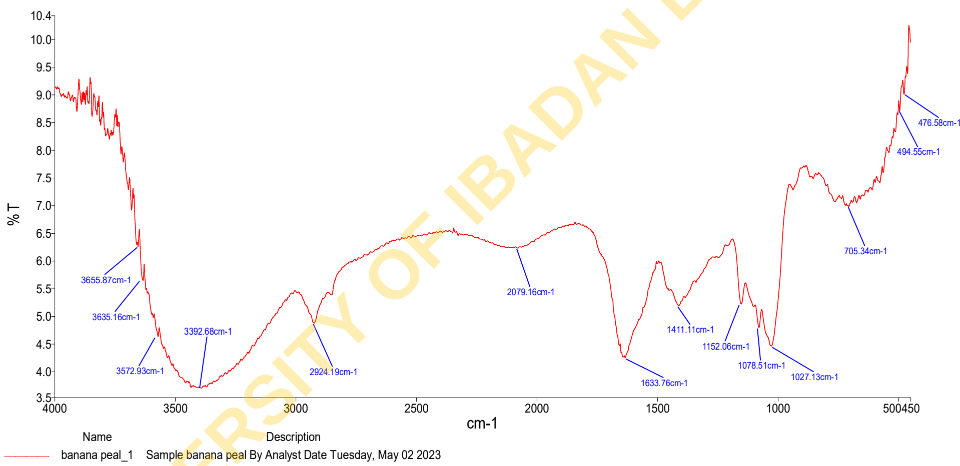

Figure 1.0: Banana Peel Powder Spectroscopy

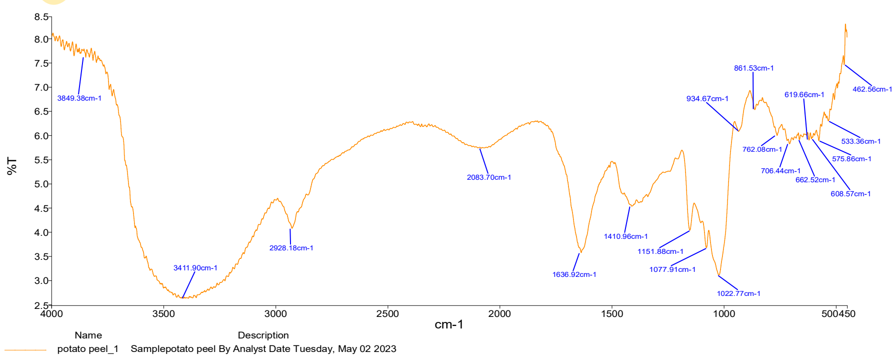

Figure 2.0: Potato Peel Powder Spectroscopy

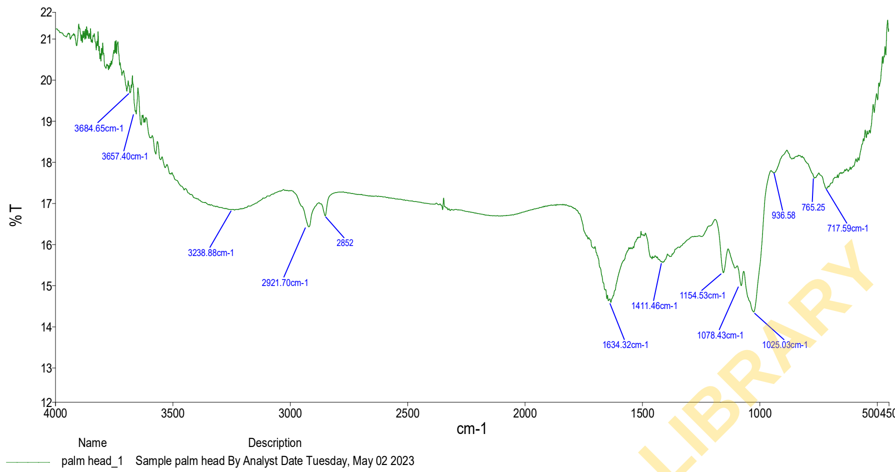

Figure 3.0: Palm Head Sponge Powder Spectroscopy.

3.1.2 Scanning Electron Microscopy (SEM-EDX)

The Scanning Electron Microscopy (SEM-EDX) was carried out at the Covenant University Laboratory, Ota, Ogun State. It was done for imaging and analyzing the composition of samples at a microscopic level. All the three samples were analyzed in three spots. The results analyzed shows Plantain Peel Powder (Figure 4.0) to contain predominantly of potassium and oxygen, similarly the Potatoes Peel Powder (Figure 5.0), contained a large proportion of potassium and oxygen, with traces of silicon. Finally, Palm Head Sponge Powder (Figure 6.0) contained Oxygen, Silicon, Carbon with traces of calcium, magnesium and potassium

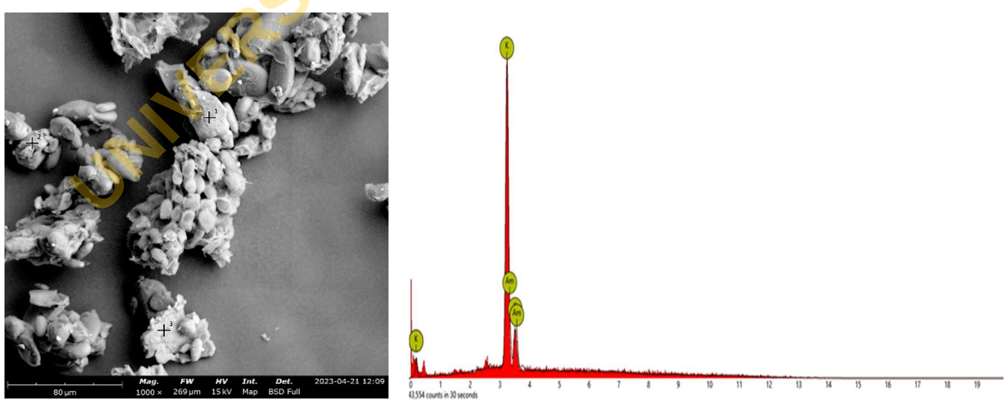

Figure 4.0: The SEM spectrum and EDX image of the distribution of Plantain Peel Powder

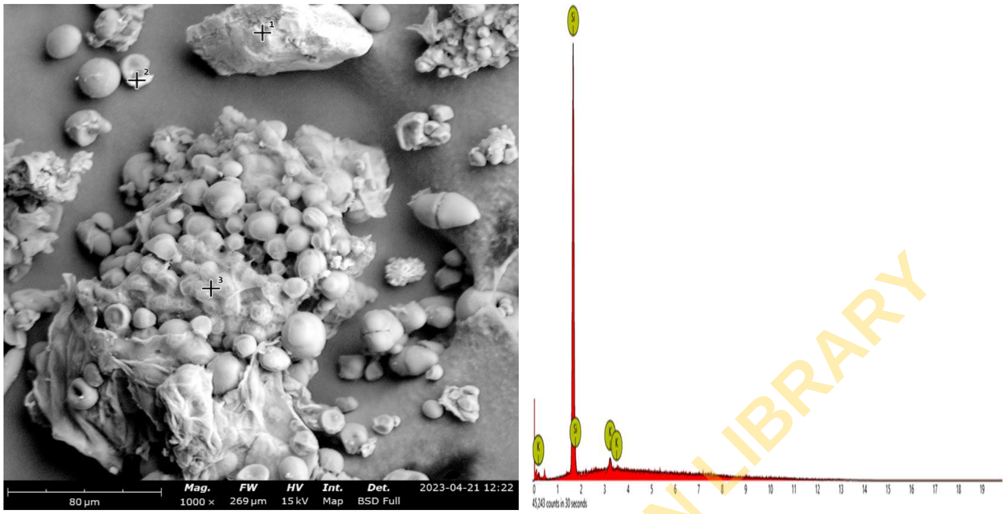

Figure 5.0: The SEM spectrum and EDX image of the distribution Sweet Potatoes Powder

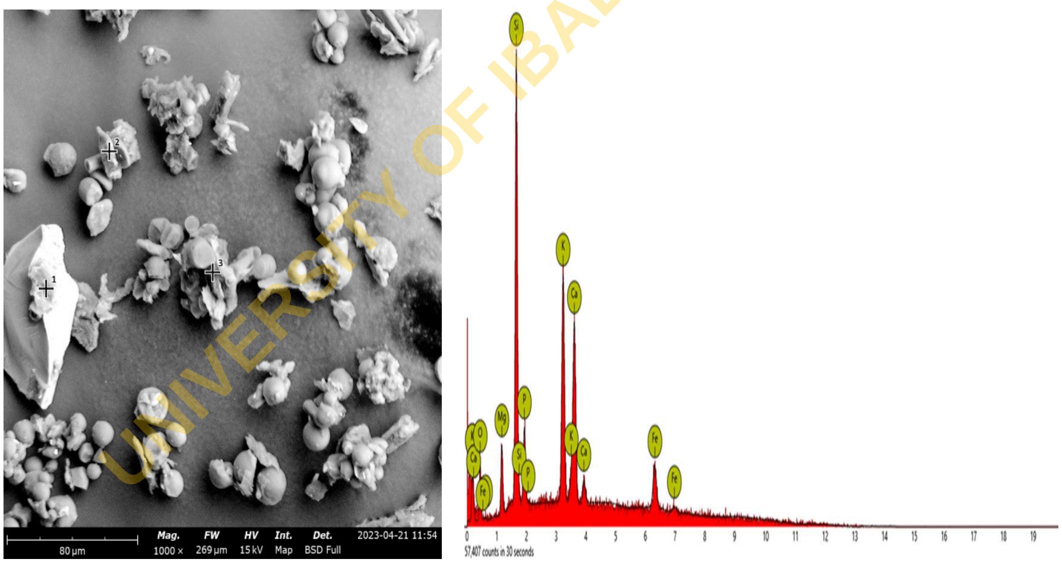

Figure 6.0: The SEM spectrum and EDX image of the distribution of Palm head sponge

3.2. Mud Sample Mud weight and pH

The mud weight is an important property of drilling fluids as this is needed prevent drilling problems. The weights of the samples were measured at 24 hours, 48 hours, and 72 hours. The figure 7.0 presents the density increased with increasing age for all samples apart from those of BPP. This implies that more weighing agents will need to be added as the mud spends more time in the formation. The mud sample treated with PPP had the highest variation.

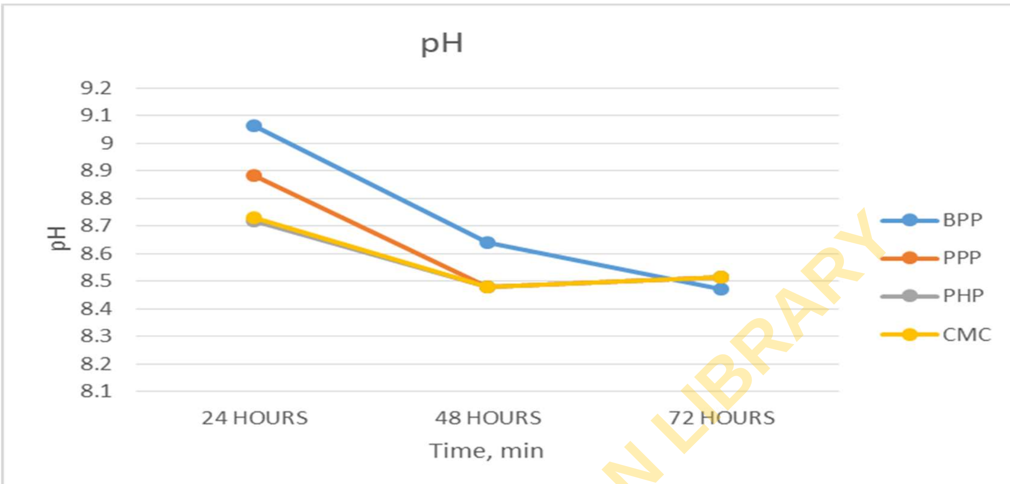

Figure 7.0: Mean Mud weight against Time (hrs.)

From the figure 8.0, the pH of the samples are between 8.5 to 9.1 this ensures that the requirement of 8.5 to 10for drilling fluid to ensure good hole stability, corrosion control, and control over the mud properties.

3.3 Effect of Aging on The Rheological Properties of the Mud Samples

The figures 9.0, 10.0, 11.0 and 12.0 presents the result of the effect of aging on the plastic viscosity, apparent viscosity, yield point and gel strength, respectively, for all the mud samples. For mud samples treated with BPP, an upward tendency for the plastic viscosity, apparent viscosity, and yield point throughout the course of the aging period was observed, but a decrease trend for gel strength was seen. While mud samples treated with PPP's yield point experienced a little shift over the aging time, with plastic viscosity and apparent viscosity both slightly decreasing, but the gel strength experienced a significant increase.

The mud samples treated with PHP had plastic viscosity and apparent viscosity showing a similar trend while gel strength dropped and a sudden increase was observed. The yield showed an almost steady trend throughout. Finally, samples treated with CMC, had apparent viscosity and plastic viscosity raising over the aging period, despite the fact that the gel strength decreased. Throughout the aging period, the yield point steadily increased.

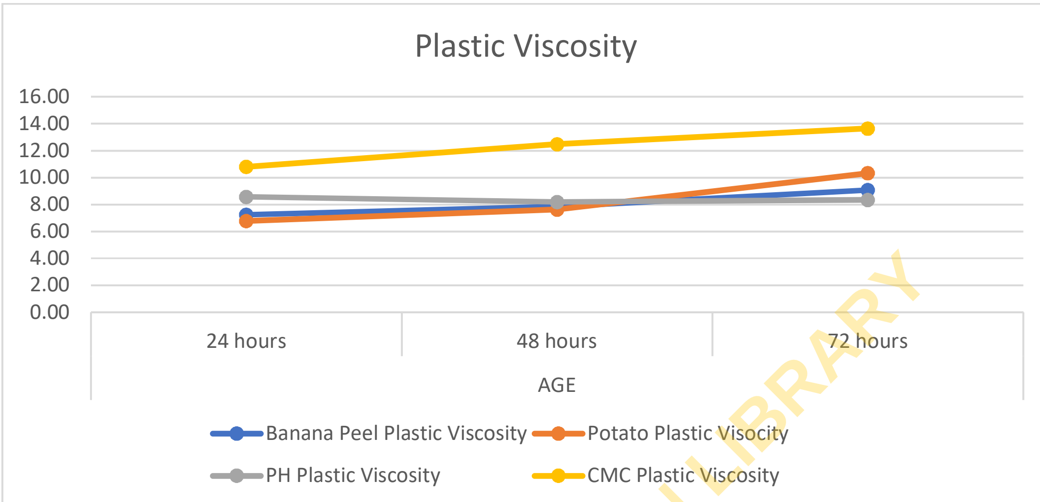

Figure 9.0: Plastic viscosity against Time (hrs)

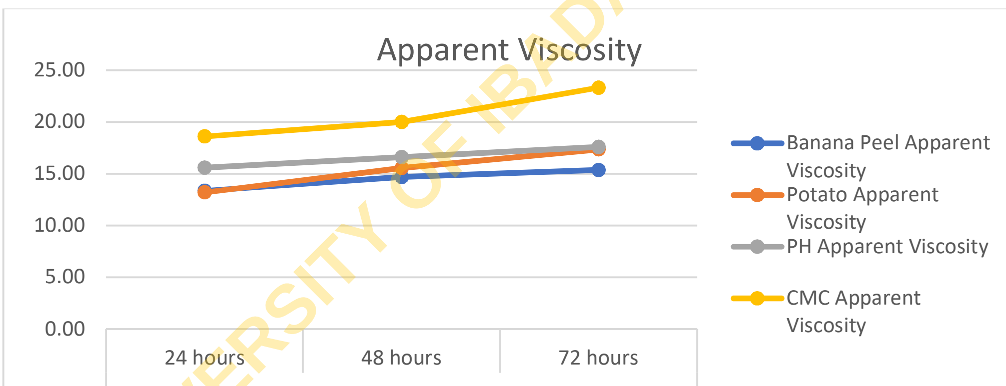

Figure 10.0: Apparent viscosity against Time (hrs)

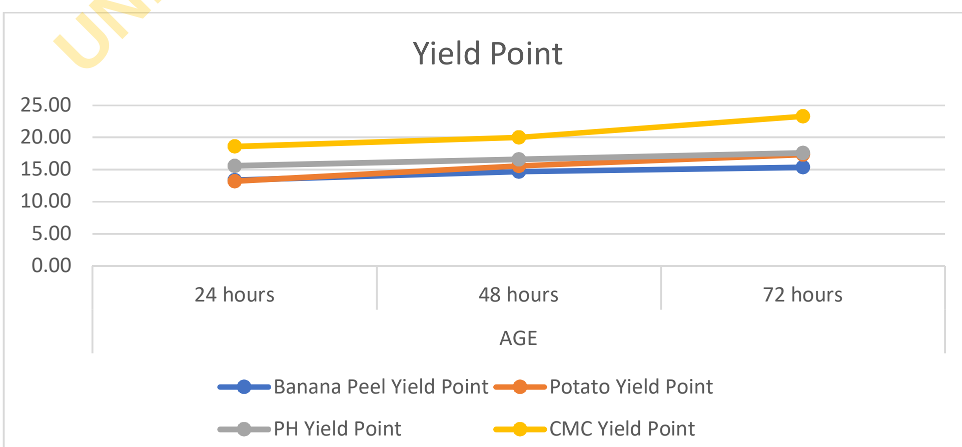

Figure 11.0: Yield point against Time (hrs)

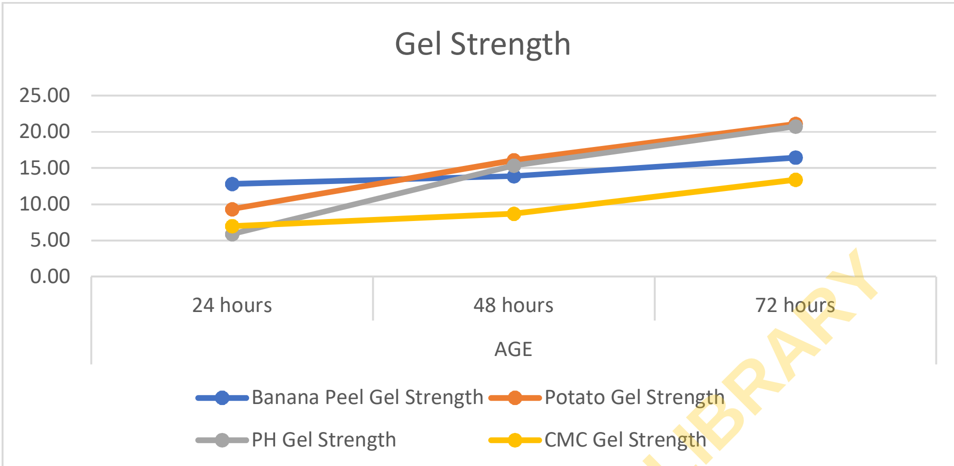

Figure 12.0: Gel Strength against Time (hrs)

3.4 Effect of Temperature on Rheological Property of The Mud Samples

The Figure 13.0 present the result of the plastic viscosity of the mud samples treated with BPP, PPP and PHP, all presented comparable behaviour while maintaining the same nearly constant trend at various specified temperatures of observation While those of CMC presented notable decline in values of plastic viscosity from 40 to 80 degrees.

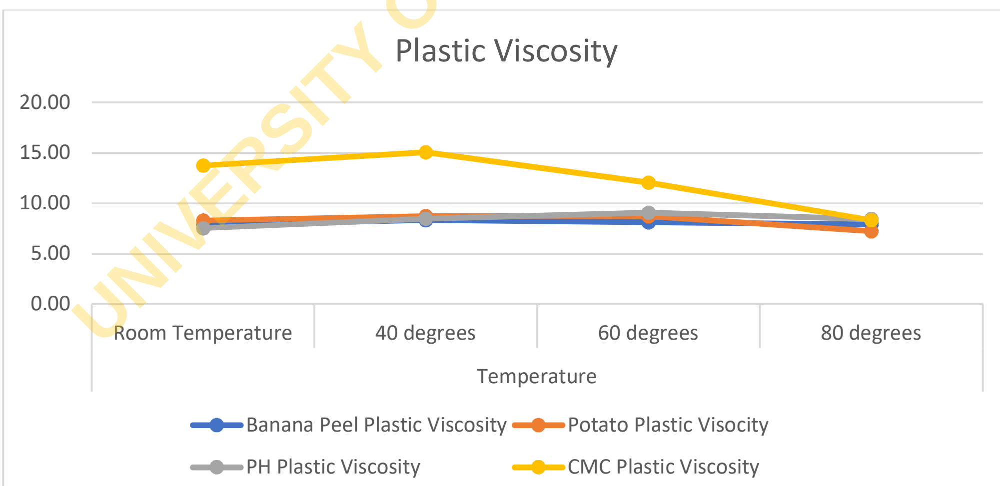

Figure 13.0: Plastic viscosity(cp) against Temperature (°C) of varying concentration of the Additives

Figure 14.0 presents the Apparent Viscosity of Banana peel with different concentrations at different temperature. As temperature increases a sharp increase in the AV with a proportionate increase in concentrations. the Apparent Viscosity of PPP mud samples has a significant increase in the AV at all levels of concentration

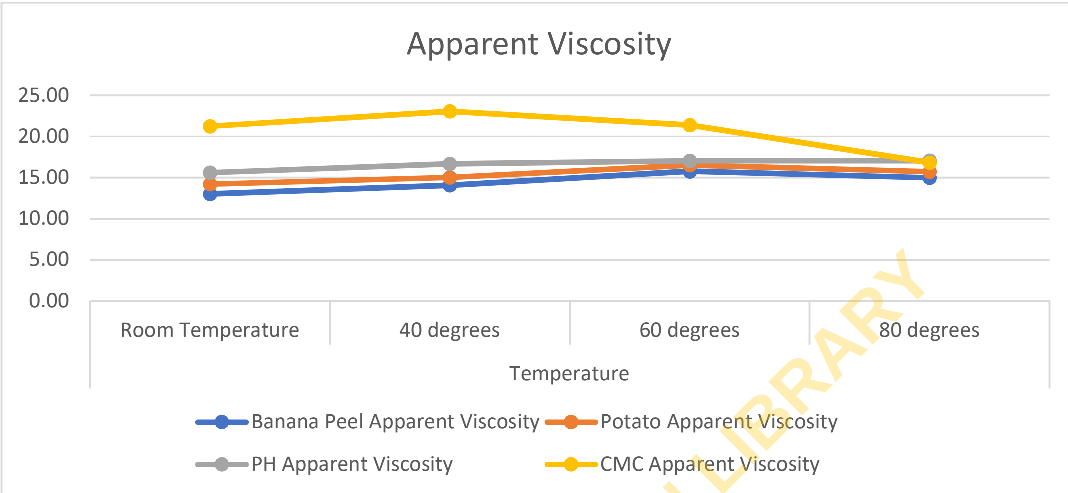

Figure 14.0: Apparent viscosity(cp) against Temperature (°C) of varying concentration of the Additives

The values of Yield point were consistently increasing for mud sample with BPP,PPP and CMC. Prior to a sudden rise in values from 60 degrees to 80 degrees, mud sample with PHP maintained a remarkably stable trend.

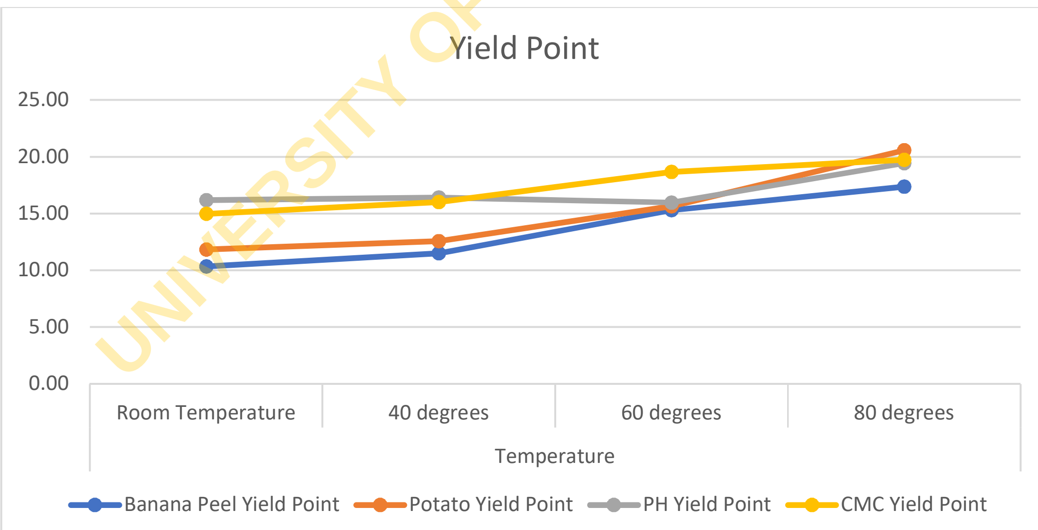

Figure 13.0: Yield point (lbf/100ft^2) against Temperature (°C) of varying concentration of the Additives

The effect on Gel Strength had the same trend as those of the effects of aging but CMC recorded the lowest values while the other mud samples a steady gradual increase over the period of observation.

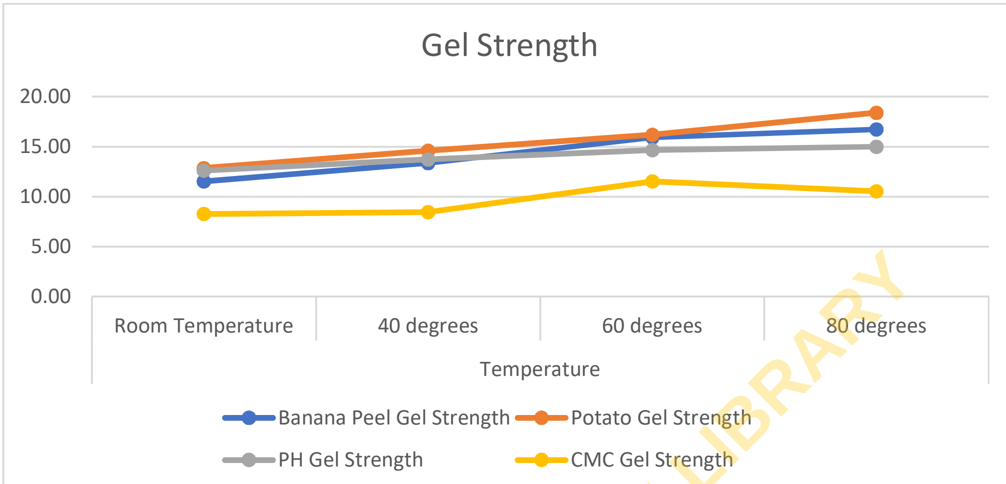

Figure 16.0: Gel Strength) against Temperature (°C) of varying concentration of the Additives

3.5 Filtrate loss of the Mud samples

The filtration loss properties of different samples of drilling fluid formulated with different locally sourced materials (Banana peel, Potato peel, Palm head), at varying concentrations (1g, 2g , 3g, 4g, 5g) was carried out and it was observed that as the concentration of BPP, SPP and PHP and added increases, less fluid was lost from the drilling fluid. Mud samples treated with PPP performed better in comparison to that BPP and PSP. At a concentration of PPP increased, 5g the filter loss was the same as the control. In figure 13.0 it is observed that there is a decrease in filtrate volume as aging increases. From the figure 14.0 it is observed that the filtrate volume is fairly constant for PHP irrespective of the time. For CMC it increases in the first 24 hours to 48 hours then decreases. While it increases throughout for PPP and BPP

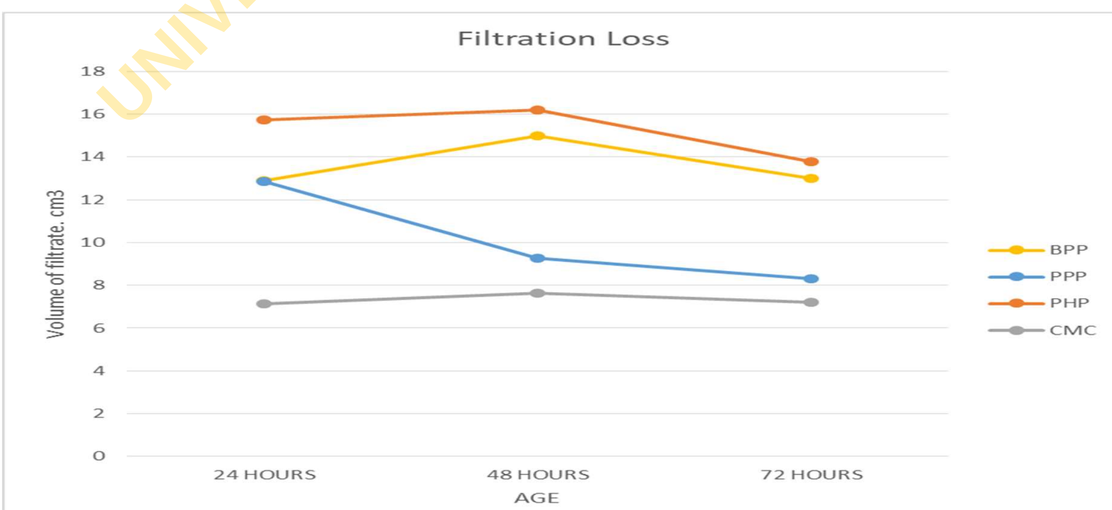

Figure 13.0: Volume of filtrate(ml) against Time (hrs)

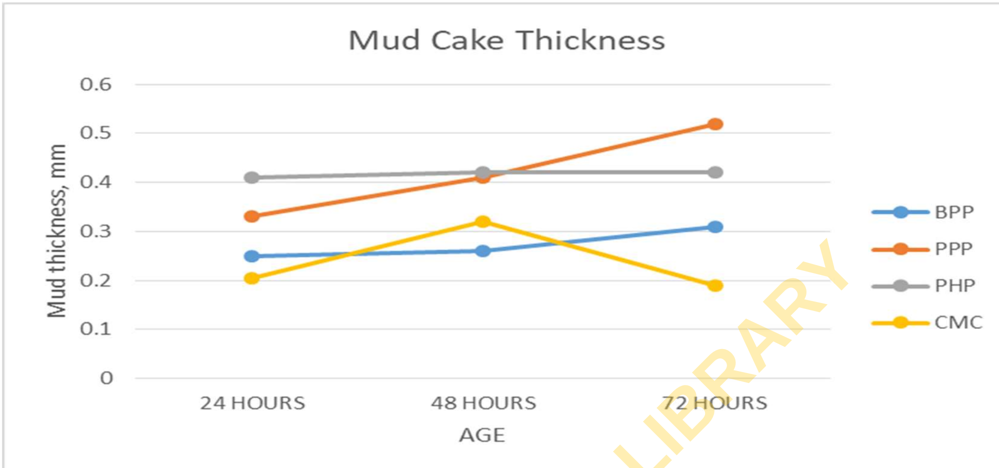

Figure 14.0: Mean of Mud thickness vs time (for all samples)

4. CONCLUSIONS

Generally, there is a significant change in the rheological properties of the alternative additives caused by corresponding change in the aging period. There is a significant positive relationship with aging and the gel strength of all additives. This indicates that an increase in the aging period causes a resultant increase in the gel strength of the additives. Temperature had a significant effect on the rheological properties of CMC and the alternative additives. Temperature had a statistically significant positive correlation with the yield point and gel strength of all additives except Palm Head ($p>0.05$).

The rheological properties of BPP and PHP had similar trends in value following a change in temperature. However, CMC and PPP displayed similar reactions in their rheological properties following a change in temperature. The rheological properties of all additives displayed different reactions to changes in the aging period. PPP and PHP had completely different changes in rheological properties' value following a change in aging period. However, CMC and BPP displayed similar reactions in their rheological properties following a change in aging period.

The filtration loss properties of different samples of drilling fluid formulated with different locally sourced materials (Banana peel, Potato peel, Palm head), at varying concentrations (1g, 2g , 3g, 4g, 5g) as a fluid loss additive were studied at room temperature (25°C) in comparison with a carboxymethyl cellulose (CMC). From the analysis of the result obtained during the course of the research, the result observed that as the concentration of BPP, PPP and PHP added increases, less fluid is lost from the drilling fluid. Mud sample treated with PPP performed better in comparison to those of BPP and PHP. At a concentration of 5g Potato peel powder had similar filtrate volume to that of CMC. Increasing the aging period slightly decreased the filtrate volume of the drilling fluid.

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