

See discussions, stats, and author profiles for this publication at: <https://www.researchgate.net/publication/377200519>

Performance Analysis of Cowpea Skin, Sugar Cane Rind and Yam Bark as Additives in Water-Based Drilling Mud

Conference Paper · November 2023

DOI: 10.1109/ICMEAS58693.2023.10379415

CITATIONS

0

READS

55

6 authors, including:



Petrus Nzerem

Nile University of Nigeria

69 PUBLICATIONS 486 CITATIONS

SEE PROFILE



Oghenerume Ogolo

Nile University of Nigeria

33 PUBLICATIONS 126 CITATIONS

SEE PROFILE



Blessing O. Alade

Nile University of Nigeria

3 PUBLICATIONS 1 CITATION

SEE PROFILE



Ajiri Otedheke

Nile University of Nigeria

4 PUBLICATIONS 6 CITATIONS

SEE PROFILE

Performance Analysis of Cowpea Skin, Sugar Cane Rind and Yam Bark as Additives in Water-Based Drilling Mud

Petrus Nzerem

*Petroleum and Gas Engineering
Department*

Nile University of Nigeria

Abuja, Nigeria

petrus.nzerem@nileuniversity.edu.ng

Blessing O. Alade

*Petroleum and Gas Engineering
Department*

Nile University of Nigeria

Abuja, Nigeria

blessing.obma@gmail.com

Salihu Ayuba

*Petroleum and Gas Engineering
Department*

Nile University of Nigeria

Abuja, Nigeria

a.salihu@nileuniversity.edu.ng

Oghenerume Ogolo

*Innovation and Research Coordination
Department*

Petroleum Training Institute

Effurun, Nigeria

ogolo_o@pti.edu.ng

Ajiri Otedheke

*Petroleum and Gas Engineering
Department*

Nile University of Nigeria

Abuja, Nigeria

ajiri.otedheke@nileuniversity.edu.ng

Khaleel Jakada

*Petroleum and Gas Engineering
Department*

Nile University of Nigeria

Abuja, Nigeria

khaleel.jakada@nileuniversity.edu.ng

Abstract— Drilling operations require the use of drilling fluid with optimum characteristics. Desired drilling fluid properties is typically controlled using additives. Due to the environmental and safety impact of synthetic additives, this research investigated the use of degradable food waste namely cowpea skin powder (CSP), sugarcane rind powder (SRP) and yam bark powder (YP) as additives in water-based drilling mud. To check the potential of these biodegradable food waste as additives, their elemental composition and approximate composition were ascertained using Scanning electron microscope with energy dispersive x-ray spectroscopy (SEM-EDS) and proximate analysis. The method used included the collection, cleaning, drying and grinding each of the food waste (sugarcane rind, cowpea skin and yam bark) into powdered form of 200 microns, performance evaluation of the additives was done in the concentration of 1% (5grams), 3% (10grams), 4% (15grams) and 5% (20grams) each for each API standard laboratory batch of mud. All three powders were confirmed to have significant fiber, carbon, oxygen and hydrogen content, enough to affect fluid loss and filtration control. Significant effect was observed in pH, Plastic viscosity, Yield point, Gel strength and cake thickness. The organic additives tested had no significant effect on mud density and specific gravity.

Keywords— Cow pea skin, mud additives, sugar cane rind, drilling mud, Proximate analysis, yam bark

I. INTRODUCTION

Despite the increased global drive for alternative energy source, hydrocarbon has remained the major source of energy known to mankind. The essential reason for the global crave for an alternative energy source has remained safety. The need for a safer and cleaner environment has become essential owing to the degradation of climate. While studies and quest are ongoing for alternative sources to fossils, it has become essential to operate existing technologies and processes in the safest way possible. Meeting the world demand for energy requires the drilling of oil and gas wells. To drill these wells, drilling fluids are irreplaceable essentials. The technology and processes around drilling fluid constitute about 30% of any drilling operation [1]. This makes the optimization of drilling fluid an inevitable requirement. Several types of fluids can be used during drilling depending on the flowing phase of the

mixture, water-based fluid which has water as the continuous or flowing phase has found more application in practice due to cheaper cost and availability. The drilling fluid can easily contribute about half of the potential environmental threat resulting from a drilling operation if it is not properly managed. Typically, the drilling fluid properties are monitored and maintained to give optimized drilling results. Lack of maintenance of drilling fluid properties during drilling operation could lead to wellbore damage, loss of hole and blow out. When any of these occur, it poses a threat to rig personnel and the environment; the entire drilling operation stands the risk of a huge financial loss as well and loss of time, and in extreme cases, it could result in the abandonment of the well [2]. Additives are typically used to maintain the properties of drilling fluid as the need arises. Properties of drilling fluid include, the flow resistance offered by the fluid (viscosity), the weight of the fluid per unit volume, which is the density, Gel strength which is the measure of the capability of a drilling fluid to hold particles in suspension after flow ceases and Filtration.

Others include pH (alkalinity or acidity), content and proportion of sand as well as content of calcium present (hard water) also includes Fluid loss, Filter cake thickness amongst others [3]. Biodegradable food waste has been proposed for use as additives for enhancing various properties of drilling fluid; these options provide a safer alternative to synthetic environmentally concerning options [4] [5] [6] [7] [8].

II. METHODOLOGY

A. Materials

The equipment and tools used to for processing the additives are drying trays, food processor or grinding mill. The equipment used for sample characterization and performance analysis include SEM, EDS, phenom prox model, mixer cup, mud mixer, weighing balance, marsh funnel, baroid mud balance, digital resistivity meter, pH meter, rotational viscometer, API filter press, filter paper, Vernier caliper, air compressor, graduated cylinder, thermometer, weighing balance, spatula, centrifuge, freeze dryer, small muffle furnace, desiccator, oven, reflux condenser. Samples obtained

were Nigerian white yam bark powder (YBP), sugar cane rind powder (SRP) and black eye bean (cowpea) skin powder (CSP).

B. Method

The method used included the collection, cleaning, drying and grinding each of the food waste (sugarcane rind, cowpea skin and yam bark) into powdered form of 200 microns, then characterization of the samples to understand their elemental and approximate composition using proximate analysis and Scanning electron microscopy with energy dispersive X-ray spectroscopy (SEM-EDX). The food waste powders were mixed in drilling mud formulation of API standard quantities to obtain the performance characteristics of each powder as additives; the methodology is broadly broken down into three sections as shown in Figure 1

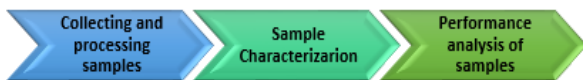


Figure 1: Sequence of the Methodology

For performance analysis, one lab barrel of water-based mud was prepared by mixing 22.5 g of bentonite clay in 350 ml of water. The filtration properties of the mud were determined using the API filter press. The filter cake thickness was also recorded with the Vernier caliper. The rheological properties were determined using a rotational viscometer. The pH of the mud was also determined using a pH meter.

Twelve more fresh lab barrel of drilling mud were prepared using standard API measures. Four batches of water-based mud containing 5, 10, 15 and 20 grams each of cowpea skin powder, sugar cane rind powder and yam bark powder and their performance results were also determined

III. RESULTS AND DISCUSSION

This section shows the results obtained during this investigation followed by the discussion about the result

A. Composition

The chemical elemental compositions indicated from the SEM-EDS; Scanning Electron Microscope Energy Dispersive X-ray spectroscopy is presented in Table 1

Table 1: SEM-EDS Composition Analysis results on samples

Element Number	Element Symbol	Element Name	SRP		CSP		YP	
			Atomic Conc.	Weight Conc.	Atomic Conc.	Weight Conc.	Atomic Conc.	Weight Conc.
6	C	Carbon	58.37	58.96	55.02	57.96	52.67	56.38
7	N	Nitrogen	2.77	1.36	0.8	0.35	1.25	0.56
8	O	Oxygen	12.02	6.75	4.61	2.32	4.65	2.38
11	Na	Sodium	0.79	0.64	5	4.43	6.93	5.09
12	Mg	Magnesium	2.12	1.81	2.61	1.99	1.65	1.28
14	Si	Silicon	1.59	1.57	2.69	2.37	2.7	2.42
15	P	Phosphorus	7.72	8.4	0.92	0.89	1.27	1.25
16	S	Sulphur	0.14	0.04	0.52	0.55	3.5	3.58
17	Cl	Chlorine	5.57	6.94	3.43	3.82	2.24	2.54
19	K	Potassium	4.76	4.26	3.29	4.04	2.91	3.64
20	Ca	Calcium	5.1	5.62	9.01	10.33	3.8	4.86
26	Fe	Iron	NOT DETECTED	NOT DETECTED	0.69	0.96	2.03	3.62
30	Zn	Zinc	NOT DETECTED	NOT DETECTED	9.85	9.22	15.79	12.97
41	Nb	Niobium	NOT DETECTED	NOT DETECTED	NOT DETECTED	NOT DETECTED	1.54	4.56

This result obtained from the SEM-EDS analysis shows a high carbon concentration in all three food waste powders and a significant oxygen concentration as well, with the

sugarcane rind powder having more of carbon, oxygen, phosphorus, potassium and calcium. This result is of interest considering that polyanionic cellulose (PAC) and Sodium Carboxymethyl Cellulose (CMC) which are the two mostly used fluid loss additives in use; both contain sodium, carbon, hydrogen and oxygen. Hydrogen does not have characteristic X-Ray and cannot be detected using SED-EDX. Iron, zinc and niobium were not detected in sugarcane rind powder. Elemental compositions in cowpea skin powder and yam bark powder were similar and this outcome will be further observed in other outcomes.

The results obtained from the proximate analysis carried out on sugarcane rind powder (SRP), cowpea skin powder (CSP) and yam bark powder (YP) is given in Table 2.

Table 2: Proximate Analysis results on samples

S/N	PARAMETER	UNIT	SRP POWDER	CSP POWDER	YB POWDER
1	Moisture	%	6.89	8.87	9.54
2	Ash content	%	1.32	3.01	5.81
3	Nitrogen	%	0.18	2.62	0.43
4	Protein	%	1.1	16.37	2.66
5	Fixed Carbon	%	23.31	8.78	18.35
6	Volatile matter	%	68.48	79.34	66.3
7	Bulk density	g/l	1.063	1.137	1.129
8	Specific gravity	-	1.087	1.163	1.154
9	pH	-	7.2	7.4	7.3

Figure 2 depicts a chart illustration of the proximate analysis outcome represented in Table 3.

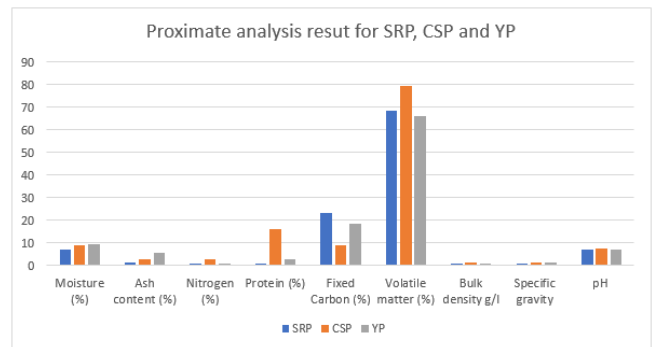


Figure 2. Proximate analysis result of SRP, CSP AND YP

The result obtained from the proximate analysis confirms high carbon content in sugarcane rind powder, and significant amount in CSP and YP; also indicative is the high volatile matters; these are unstable materials that tend to rapidly transition into other forms, examples could be hydrogen which cannot be detected by SEM-EDS. Bulk density (fiber weight), specific gravity, moisture content, ash content and pH of SRP, CSP and YP were closely related.

B. Performance Evaluation

The impact of Sugar-cane Rind powder, Cowpea Skin powder and Yam bark powder when used as additives in managing the filtration properties of water-base mud was investigated at atmospheric pressure and 26.5 °C (LTLP-Low temperature low pressure).

Result obtained from performance evaluation of Reference Fluid (RF) which is the API standard batch of drilling mud without additives and those of four batches of CSP with weight of 5g, 10g, 15g and 20g (1%, 3%, 4% and 5%) is given in Table 3.

Table 3: Performance Evaluation of Reference fluid and CSP additive

Time (mins)	Filtrate (Fluid) loss (ml) for Cow-Pea Skin Powder				
	No Additive	CSP 5g	CSP 10g	CSP 15g	CPS 20g
5	7.4	8	7.5	4.6	4.4
10	10	11.5	11	6.8	6.4
15	12	13.8	12.4	7.9	7.4
20	14.5	15.5	14.5	9.0	8.4
25	15.75	17.5	16.5	9.8	9.3
30	16.5	18.8	18	11	10.6

When cowpea skin powder (CSP) was used as additives, the result illustrated in Figure 3 Showed that Plastic viscosity, Yield point and 10secs gel strength were significantly increased by the CSP additives particularly at 15g (4%) and 20g (5%). As CSP weight increased, cake thickness increased progressively until the cake's permeability approached zero also noticeable that the fluid loss was reduced.

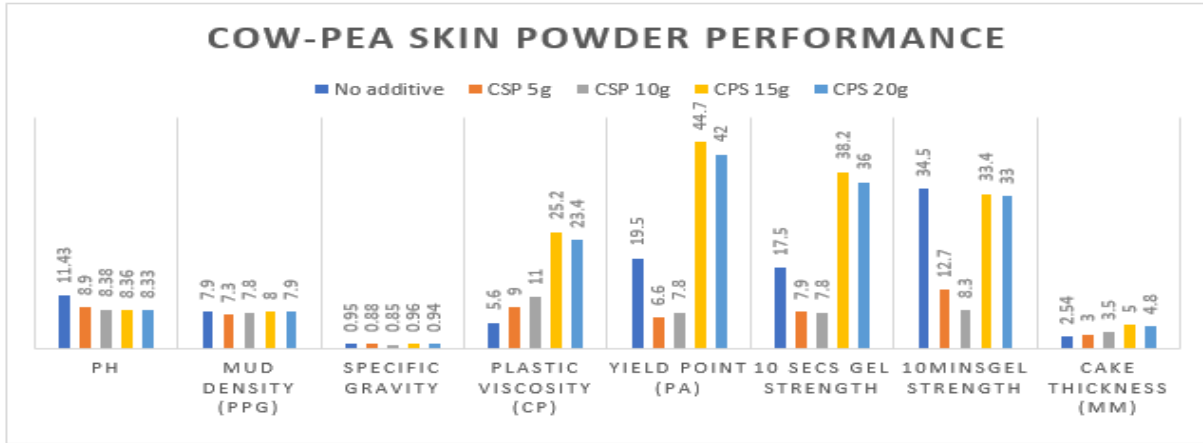


Figure 3: Performance Evaluation chart for Reference fluid and Cowpea Skin Powder additive

For the following weight percentages of sugarcane rind powder (SRP); 5g, 10g, 15g and 20g (1%, 3%, 4% and 5%), the results obtained is depicted in Figure 4.

The performance evaluation chart for reference fluid and yam bark powder additives are displayed in figure 5

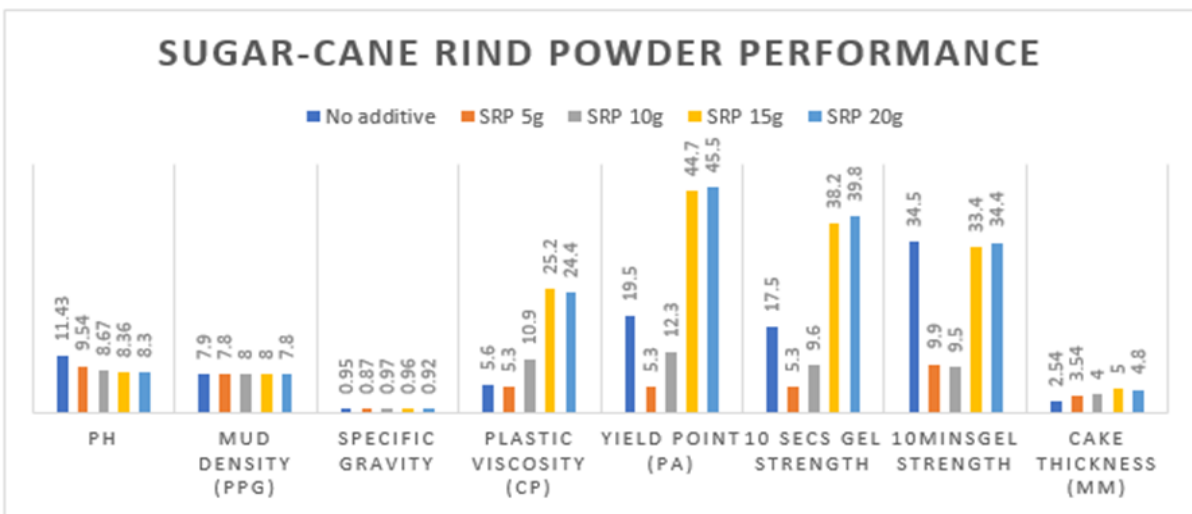


Figure 4. Performance Evaluation of Sugarcane Rind Powder as additive.

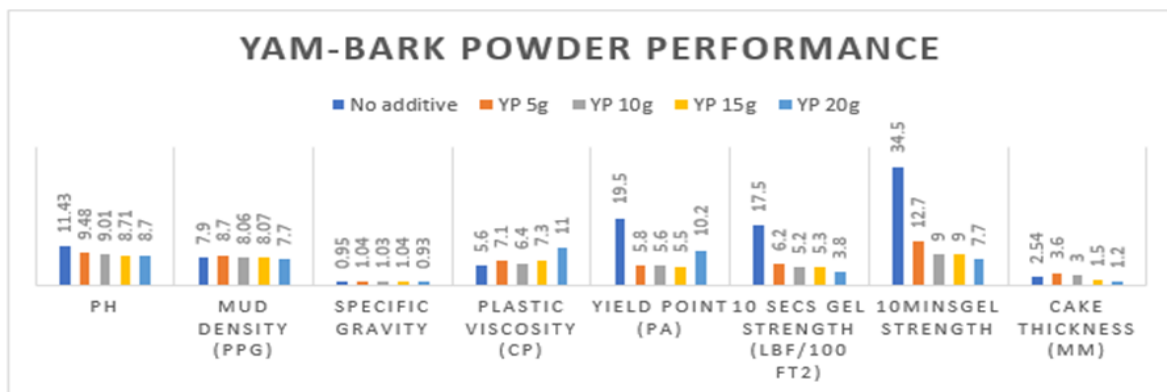


Figure 5: Performance evaluation chart for reference fluid and yam-bark powder additive

The performance of SRP as additives in four different batches of mud showed similar effect on rheology as CSP. However, a decrease in mud weight at 20gram weight and reduction in pH with increased additive weight was observed. Presence of oxygen and carbon might have resulted in anhydrite acid gases particularly carbonate, sulphates and bicarbonate that caused the reduction in the pH as observed.

Results obtained from performance evaluation of four batches of yam bark powder with weights of 5g, 10g, 15g and 20g (1%, 3%, 4% and 5%) are shown in Figure 5.

The effect of YP as additives on rheology was noticeably different from the first two powders analyzed. The different outcome of the effect of Yam bark powder might be due to Niobium that was only detected in YP and not in CSP and SRP and the higher Iron and Zinc composition (metal ions) that was only detected in this additive. From proximate analysis moisture content was highest in YP relative to SRP and CSP, this might have resulted in the reduced filter cake observed.

IV. CONCLUSION

This study confirms the potential food waste as valuable materials that can be analyzed for use as additives in drilling fluid. Experimental analysis confirms the presence of fibre in Sugar cane rind powder, cowpea skin powder and yam bark. Niobium was present in Yam bark but not in the other two; also the iron and zinc content in yam bark was higher than in others in performance Yam bark with higher moisture content and lower volatile showed a different dynamic on rheology when compared to the other two. The effect was more linear with increase in weigh while SRP and CSP gave similar effect and non-linearity of change with increase in weight. YP, CSP and SRP affect pH in much similar ways causing a reduction in hydrogen ion concentration.

RECOMMENDATION

The authors wish to thank the management of Nile University Abuja for providing the laboratory and equipment to carry out this investigation. NNPC (Nigerian National Petroleum Corporation) Ltd is also acknowledged for its support.

At the conclusion of this research, the following recommendations are suggested

- Further studies on the effect of SRP and CSP and YP on lost circulation in drilling mud. This study should delineate the effect of each of these samples.
- The drilling conditions of temperature and pressure should be simulated in confirming the impact of SRP, CSP and YP on pH.
- The economic and cost analysis of organic waste as alternative additives should be carried out.

ACKNOWLEDGMENTS

The authors wish to thank the management of Nile University Abuja for providing the laboratory and equipment

to carry out this investigation. NNPC (Nigerian National Petroleum Corporation) Ltd is also acknowledged for its support.

REFERENCES

- [1] A.T.T. Al-Hameedi, H.H. Alkinani, S. Dunn-Norman, N.A. Alashwak, A.F. Alshammari, M.M. Alkhamis, R.A. Mutar, A. Ashammarey. "Evaluation of environmentally friendly drilling fluid additives in water-based drilling mud" In SPE Europec Featured at 81st EAGE Conference and Exhibition 2019a; OnePetro: Kuala Lumpur, Malaysia
- [2] A.S. Mohammed. "Effect of temperature on the rheological properties with shear stress limit of iron oxide nanoparticle modified bentonite drilling muds" in Egyptian Journal of Petroleum 2017, 26(3), 791-802.
- [3] D. Gunnar and M.W. Sarah. "Applied Well Cementing Engineering" in Petroleum Science 2021, 13(2), 23-34
- [4] M. Amanullah, "Screening and Evaluation of Some Environment-Friendly Mud Additives To Use in Water-Based Drilling Muds." in SPE E&P Environmental and safety conference, Galveston, Texas, USA March 5-7, 2007.
- [5] T.A. Abo, A. Husam, D.N. Shari, M. Alkhamis, M.A Al-Alwani, R.A Mutar and S. Ebrahim. "Proposing a new biodegradable thinner and fluid loss control agent for water-based drilling fluid applications" in International journal of Environmental Science and Technology 2020,17(2), 120-122
- [6] O.E. Agwu and J.U. Akpabio. "Using agro-waste materials as possible filter loss control agents in drilling muds" in a review Journal of Petroleum Science and Engineering 2018, 163, 185-198
- [7] A. N. Okon, F. D. Udoh and P. G. Bassey "Evaluation of Rice Husk as Fluid Loss Control Additive in Water-Based Drilling Mud" in Society of Petroleum Engineers August 5, 2014, doi:10.2118/172379-MS
- [8] A. Ozkan, S.E. Turan and B.M. Kaplan. "Investigation of Fly Ash Effect on Rheological and Filtration Properties of Drilling Muds" in Fresenius environmental bulletin 2018, 27(12 A), 9189-9194