

The Feasibility of Using Green Olive Pits' Powder (GOPP) as a Bio-Enhancing Additive in Water-Based Drilling Fluids

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Abstract

The uses of conventional chemical additives to control drilling mud specifications predominantly have a negative impact on humans and the environment as well as a cost issue. In this work, two concentrations of green olive pits' powder (GOPP), a biodegradable and environmentally friendly additive generated from waste, were added to water-based drilling fluid. Generally, the results showed that GOPP concentration of 0.75% (4.5 gm) was more efficient than 1.5% (9 gm), and both GOPP concentrations demonstrated very little change in the mud weight (MW). The pH test showed that GOPP additive reduced alkalinity, where at 0.75%, it was decreased by 13%; while at 1.5% elucidated a decrease of 17% in alkalinity. In the same context, an alleviation in seepage loss (cc/30min) of 20% at 0.75% and 8% at 1.5% was also observed. Moreover, the mud cake decreased at 0.75% by 8%; while it increased at 1.5% by 16% as compared to the reference fluid. While for the rheological characteristics, the experimental findings illustrated that plastic viscosity (PV) insignificantly affected by both concentrations of GOPP, where PV at 0.75% was increased by 20% and at 1.5% was maximized by 40%, and this intangible increase in PV is due to the inefficient crushing of green olive pits (GOP) and irregular dispersal of particle sizes. On the other hand, both yield point (YP) and gel strength substantially boosted with GOPP additives, where YP exhibited a significant increase at 0.75% by 172% and at 1.5% was raised by 136%. Furthermore, the gel strength was significantly boosted at both concentrations. However, the results demonstrated that 0.75% concentration of GOPP was a more vigorous option to be used rather than 1.5%. To sum it all up, the findings showed that GOPP has a considerable ability to be invested as drilling fluid material other than conventional chemical additives.

Introduction

Drilling fluids have many crucial jobs in rotary drilling operations. Hence, drilling fluids are conceded as one of the most significant parts of the drilling process. Selecting the appropriate drilling fluid system will ensure the success of the drilling operations and eliminate many potential problems. Therefore, it is very important to properly design any drilling fluid system and select the appropriate mud additives suitable for the intended drilling application. Otherwise, various

undesirable consequences can occur during drilling. For example, pipe sticking, mud loss, collapse issues, etc. (Al-Hameedi et al., 2018; Alkinani et al., 2019). To prepare drilling muds with optimum properties, several chemical materials are blended together with either water-based or oil-based fluids. Because of health, safety and environmental (HSE) concerns with respect to the non-biodegradable chemicals used in drilling fluids, the oil and gas industry is constantly striving and pursuing the utilization of biodegradable and more eco-friendly additives in lieu of conventional chemical additives.

Currently, there has been a shift in the petroleum industry towards the use of water-based drilling fluids instead of oil-based fluids because water-based fluids are much safer and more eco-friendly compared to oil-based fluids. Unfortunately, there is little attention given to the potential problems of chemical additives and their negative impacts on health, safety, and environment. Some chemical additives used in drilling mud are potassium chloride, chromium-containing thinners, fluid loss additives, etc. (Amanullah, 2007).

In the last few years, the United States environmental protection agency (EPA) has enforced more stringent and rigorous instructions and rules on the disposal process and operation of drilling fluids and cuttings. The EPA regulations have motivated scientists to pursue several approaches to search and develop cheaper and safer biodegradable additives that can substitute the toxic and expensive chemical additives and can improve or optimize drilling performance. Biodegradable materials, especially those extracted from food wastes, are very attractive and considered candidates to be developed as additives to replace and substitute some of the conventional non-biodegradable and toxic materials. These waste-based additives are cost-effective, and they have a clean result on the environment.

Several research studies have been conducted with a focus on using food waste as a source of alternative additives to enhance drilling fluid properties (Amadi et al., 2018). Large quantities of food waste are generated daily which can pose alarming threats to the environment and personnel safety if not handled and managed properly. Therefore, recycling food waste materials into useful drilling mud additives a viable and optimum solution to control the side effects of these wastes (Al-Hameedi et al., 2019a).

Grass powder was applied by Al-Hameedi et al. (2019b) as an environmentally friendly additive. Grass powder demonstrated a potential to minimize the seepage loss and strengthen the filter cake, and as such, it can substitute conventional starch materials. Potato peels powder was also applied and studied by Al-Hameedi et al. (2019c). The results of their study concluded that potato peels powder reduced fluid loss and differently influenced the rheological properties without any effect on the density. In another research study conducted by Al-Hameedi et al. (2019d), mandarin peels powder was utilized as a drilling fluid additive to enhance filtration and rheological characterizations. The results of their experimental research study showed that mandarin peels powder has reduced filtration and improved the rheology. Mandarin peels powder was also compared with polyanionic cellulose – low viscosity, conventionally used chemical, and found that MPP worked as effective as polyanionic cellulose – low viscosity. In the same vein, a fibrous food waste material was experimented by Al-Hameedi et al. (2019e). The findings of the experimental investigation demonstrated that fibrous food waste material has a potential to be used utilized as a viscosifier and filtration control agent.

The feasibility of rice husk as a filtration control agent was examined by Okon et al. (2014). It was found that rice husk has managed to enhance fluid loss properties. However, it negatively impacted PV. Iheagwara (2015) tested banana peel and concluded that it demonstrated similar impacts on drilling fluid properties when compared to NaOH.

Irawan et al. (2009) investigated the feasibility of using sugar cane and corncob as viscosity modifiers. The laboratory findings indicated that the PV was maximized, but YP and gel strength were negatively decreased. Omotioma et al. (2014) have examined and proven the applicability of mango leaves and cashew in ameliorating mud rheology.

In summary, all the previous laboratory research studies proved the feasibility of utilizing biodegradable and eco-friendly food waste products as alternatives or supportive additives to currently used conventional drilling fluid chemicals.

In this examination, the biodegradable green olive pits' powder (GOPP) was utilized to contemplate its consequences for improving the filtration attributes and other properties of water-based drilling mud. Moreover, the discoveries of acquainting GOPP with the reference fluid were compared to examine their effectiveness and performance in altering the drilling mud characteristics. GOPP is likewise analyzed for its application to substitute a portion of conventional fluid loss agents to fortify the filtration characteristics and enhancing the rheological properties, consequently diminishing the expense and enhancing the safety and minimizing harm to the environment.

Olive Background

The olive, which is classified as a fruit rather than a vegetable, is a plant that was originally cultivated in the Mediterranean region, Asia, and Africa. The cultivation of

olives goes back more than 6000 years, and it continues to flourish not only in its native countries but also in many other regions worldwide (Crop Guide, 2019). Olives first came to South America with the Spaniards in the mid-16th century, and the Spanish succeeded to plant and cultivate olives in the 1700s in California (Melford, 2016).

The olive tree is an evergreen plant, which is relatively short, thick and squat, and it has many thin branches. Olive trees can live for more than 600 years. At approximately the age of four, the tree can be mature to give olives. The color of the unripe olives is green, and the color changes as they ripen. The tree will be mature to give flowers and olives at the age of about four years. (Olive Oil News & Articles, 2015).

Over 90% of olive production consumed to make olive oils. The rest is utilized as a table olive. There are more than 2000 olive types in the world (Melford, 2016). The top five olives producing countries in the world are Spain, Italy, Greece, Turkey, and Morocco (Olive Oil News & Articles, 2015). As shown in **Table A.1 (Appendix A)**, Spain with an annual total olives production of 6,559,884 tons is considered the largest among all countries. The second-largest producer is Greece which produces 2,343,383 tons, followed by other countries; Italy produces 2,092,175 tons, Turkey produces 1,730,000 tons, and finally, Morocco produces 1,416,107 tons. A considerable olive production can also be found in California, Australia and South Africa (Olive Oil News & Articles, 2015). About 95% of American olives produced from California which has climate-friendly conditions and this constitutes less than 1% of the total world olive market (Melford, 2016). The annual global consumption of olive oil is approximately 2.25 million tons.

The extraction of olive oil from olives usually results in the production of huge amounts of byproducts, which account for 35 kg of solid waste in the form of olive oil cake (OOC) from 100 kg of treated olives. The OOC is a combination of olive pulp, skin, stones, and water. The OOC is moist, acidic, and rich with potassium, organic matters, and carbohydrates. The olive wastes contain valuable resources such as organic matter, sugars, oils, fibers, polyphenols and a wide range of nutrients that could be utilized. OOC is being utilized for feed in the swine industry, and poultry farms. Feeding byproducts of olives to livestock is an old practice for the domestication of animals. Moreover, the olive mill wastes could be utilized as a biocide to suppress plant pathogens. In addition, the olive mill represents a major environmental issue since the olive mill wastewater accounts for 45-50% of the olive volume. Such substantial amounts of byproducts may have harmful effects on the environment if not recycled or utilized. Therefore, new techniques should be developed to recycle and utilize waste material in various industries. One example is using olive wastes as environmentally friendly drilling fluid additives to minimize the cost and the side effects on the environment caused by the chemical additives of drilling fluid (Kamini et al., 2011).

How to Efficiently Collect and Prepare GOPP In-House

The structural outline provided in **Figure A.1 (Appendix A)** interprets the executed process of different steps of GOPP arrangement. In the beginning, the raw green olive pits (GOP) were compiled in-house as illustrated in **Figure A.2**. After collecting the pits, they were vigorously flushed and cleaned using tap water and a mechanized manual strainer to remove all leftover olive and debris from the major pits to reinforce the output fineness of the powder. After that, GOP were adequately dried to reduce the moisture content by putting them in an oven at 82 °C (180 °F) for three hours to expedite the drying operation. Next, GOP were put under ambient laboratory conditions for 7 days. Once more, GOP were placed in an oven at the same preceding circumstances to ensure the complete drying process. Once dried, GOP was ground into a soft powder utilizing a food processor as shown in **Figure A.3** and **Figure A.4**, respectively.

Experimental Procedure and Results

To experiment with two concentrations of GOPP, a reference fluid (RF) has to be prepared with fundamental elements like water (600 cc), NaOH (0.1 gm), and bentonite (36 gm) to be as base mud, and be compared to mud samples including GOPP materials. Two additives of GOPP (0.75% (4.5 gm) and 1.5% (9 gm)) were separately introduced to the base fluid to ascertain the impact of GOPP material on the specifications of the reference fluid. Then, API testing methods have been conducted for each mud sample to assess the efficacy of the two concentrations of GOPP as clarified in **Table A.2**.

Discussion

Looking at findings in **Table A.2** and starting with 0.75% (4.5 gm) concentration, it obviously shows that 0.75% additive of GOPP was more efficient than 1.5% (9 gm) concentration of GOPP. In addition, the experimental results revealed that 0.75% of GOPP was multipurpose effective drilling mud additive for water-based fluid, where it exhibited a tangible improvement in the filtration characteristics and a considerable boost in the yield point (YP) and gel strength; while 0.75% of GOPP slightly maximized the plastic viscosity (PV). In the same context, 0.75% of GOPP had no effect on the mud weight (MW), and it clearly caused a reduction of the alkalinity when comparing it to the base mud.

For 1.5% (9 gm) concentration of GOPP, MW was negligibly reduced as compared to the reference fluid; while PV was moderately increased as compared to 0.75% (4.5 gm) concentration and the reference fluid. However, 1.5% additive of GOPP was less effective than 0.75% additive of GOPP in terms of elevating YP and the gel strength. Also, the mud experienced a minor effect during the 7.5-minute filtrate and the 30-minute filtrate. Moreover, the experimental mud with 1.5% GOPP additive slightly affected the mud cake thickness by increasing it to 3 mm as compared to the reference fluid. Similar

to 0.75% (4.5 gm) concentration, 1.5% additive of GOPP visibly minimized the alkalinity of the reference fluid.

Overall, the GOPP had a positive effect on the experimental drilling mud. Most of the mud properties either improved significantly or slightly impacted. There were no properties that were negatively affected by the GOPP. However, 0.75% (4.5 gm) concentration of GOPP elucidated a better performance and consistent efficiency as compared to 1.5% (9 gm) concentration of GOPP. Hence proposing a concentration of 0.5%-1% to be utilized of GOPP for optimum execution. **Figures A.5-A.9** illustrate the influence of introducing two concentrations of GOPP on the reference mud properties.

Conclusion

Based on previous experimental results, it can be concluded that green olive pits' powder (GOPP) additives had a negligible effect on mud density and a slight impact on plastic viscosity when adding both concentrations of GOPP. However, the yield point and gel strength were tremendously increased as compared to the reference fluid (RF) when adding 0.75% and 1.5% GOPP concentrations. In addition, 0.75% GOPP additive showed a better performance in enhancing the filtration characteristics as compared to RF and 1.5% GOPP additive, respectively. Hence, it can be concluded that GOPP additive should be utilized at a low concentration between 0.5-1% concentrations in order to achieve optimal performance for the drilling fluid properties. Lastly, the performance of the GOPP needs to be analyzed at various aging conditions and at different high pressure and high temperature along with other commonly used chemical additives to guarantee GOPP applicability when used in the field.

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Appendix A

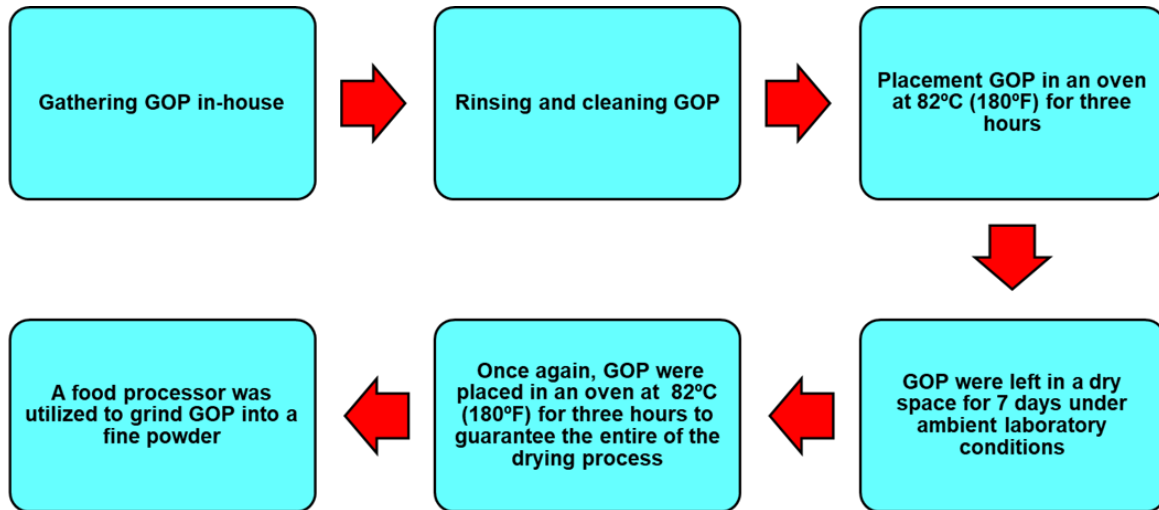


Figure A.1. The Structural Outline Symbolizing the Entire Procedure of the GOPP



Figure A.2. The Raw Material of GOP



Figure A.3. The GOPP



Figure A.4. The Food Processor

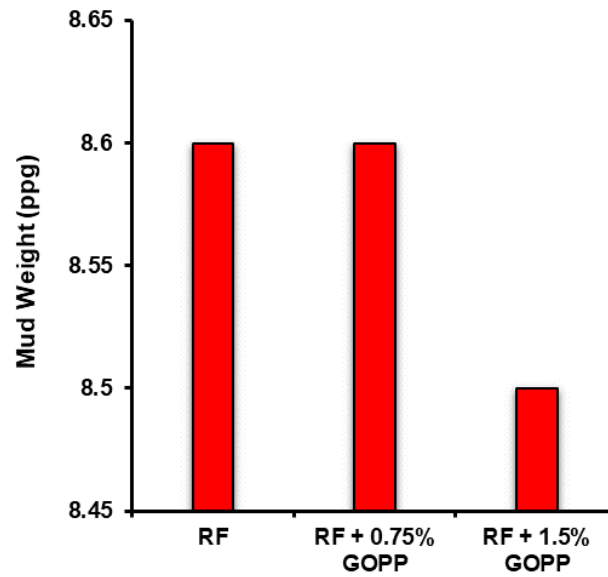


Figure A.5. The Effect of GOPP on MW

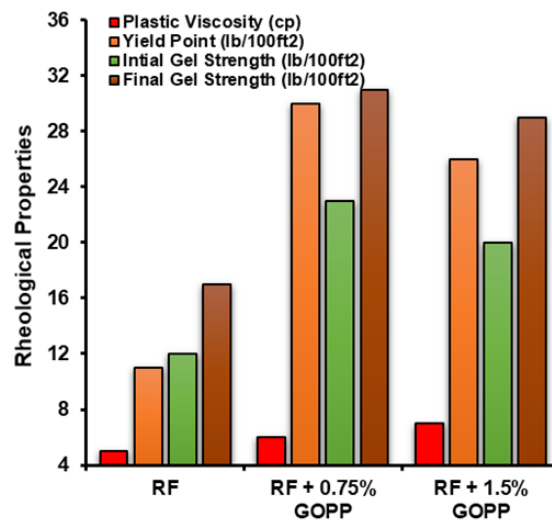


Figure A.6. The Effect of GOPP on Rheological Properties

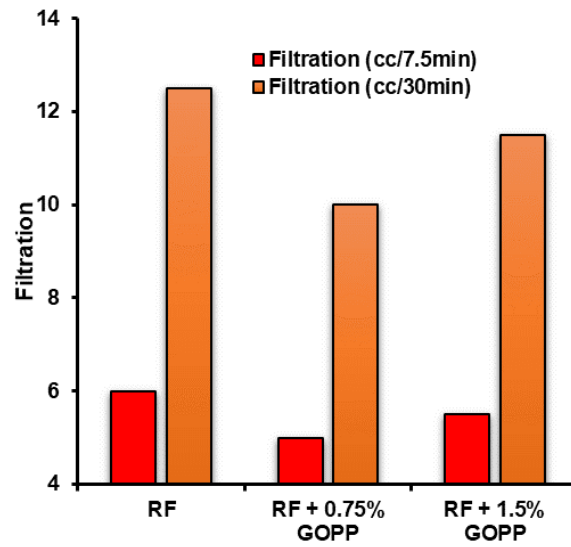


Figure A.7. The Effect of GOPP on Filtration

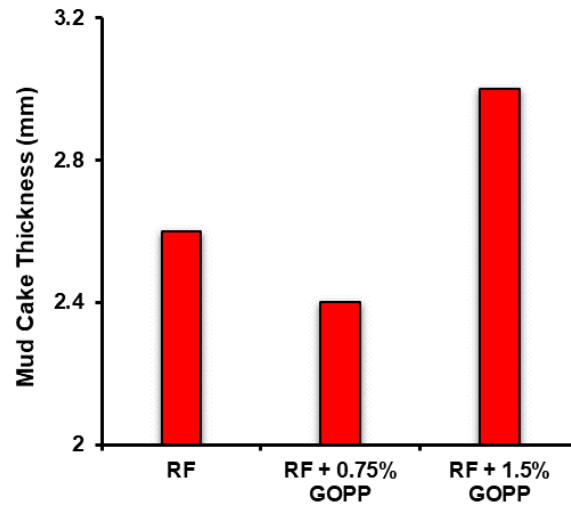


Figure A.8. The Effect of GOPP on Mud Cake Thickness

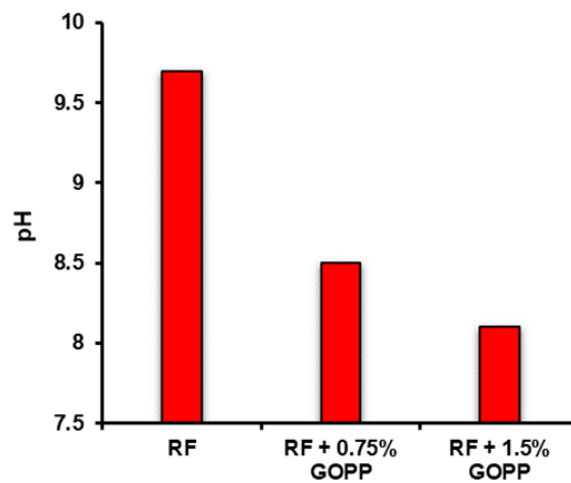


Figure A.9. The Effect of GOPP on pH

Table A.1. Olive Producing Countries (World's top Olive Producing Countries, 2018)

Rank	Country	Production (Tons)
1	Spain	6,559,884
2	Greece	2,343,383
3	Italy	2,092,175
4	Turkey	1,730,000
5	Morocco	1,416,107
6	Syria	899,435
7	Tunisia	700,000
8	Algeria	696,962
9	Egypt	694,309
10	Portugal	617,610
11	Libya	188,975
12	Argentina	175,094
13	United States of America	159,600
14	Lebanon	118,146
15	Jordan	115,813

Table A.2. Impact of GOPP on the Mud Properties

Property	RF	0.75% GOPP	1.5% GOPP
Mud Density, (ppg)	8.6	8.6	8.5
Plastic Viscosity (PV), (cp)	5	6	7
Yield Point (YP), (lb/100ft ²)	11	30	26
Initial Gel Strength, (lb/100ft ²)	12	23	20
Final Gel Strength, (lb/100ft ²)	17	31	29
pH	9.7	8.5	8.1
7.5 min Filtrate, (cc)	6	5	5.5
30 min Filtrate, (cc)	12.5	10	11.5
Filter Cake Thickness, (mm)	2.6	2.4	3