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Use of Tannate derived from Tea Waste as Drilling Fluid Additive

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Abstract

Excellent drilling fluid techniques are the significant guaranteed measures to insure safety, quality, efficiency and faster completion of drilling operations. However, after the completion of drilling operations these fluids become wastes and are discarded which can have a large negative impact on the environment. Both the drilling materials and additives containing drill cuttings, oil and water are dumped onto soil, surface water, ground water and air causing severe environmental pollution. The preservation of environment has become a major concern these days. Hence, this paper focuses on the use of calcium tannate as an environment friendly drilling fluid additive that is derived from tea waste obtained from tea industries using simple procedures. In this study, basically the rheological properties of the laboratory prepared drilling mud with and without adding calcium tannate have been determined and compared.

Keywords: Calcium Tannate; Tea Waste; Drilling Fluid Additive; Environment Friendly; Cost Effective.

INTRODUCTION

Drilling fluids are any fluids which are circulated through a well in order to remove cuttings from a wellbore. The fluid is pumped down the drill string, through the nozzles of the bit, and returns back up the annulus between the drill string and the wellbore walls, carrying the cuttings produced by the bit action to the surface. The main function of the drilling fluid is to clean the hole while drilling; but also serves to cool the bit, provide power to the mud motor and measuring-while-drilling (MWD) tool, support the walls of the hole and control the well pressure, etc. An alternative method is called reverse circulation, where the flow of the fluid is reversed from the previously mentioned one. [1]

The use of drilling fluids is an essential part of a rotary drilling process. Different types of chemicals and polymers are used in designing a drilling fluid to meet functional requirements such as appropriate mud rheology, density, mud activity, fluid loss control property, etc. **[2]**

Today, the choice of drilling fluids and their additives has become complex, **[3]** considering both the technical and environmental factors. **[4]** The preservation of the environment on a global level is now important as various organizations have set up initiatives to drive the usage of toxic chemicals as drilling fluid additives. Environmental pollution has been considered a serious threat while drilling complex wells or high-temperature deep wells, which are now managed by using oil based drilling fluid systems and high-performance water-based drilling fluid systems. As environmental protection has become a consideration before any oil and gas resources exploration, people have paid more and more attention to the drilling fluid for environmental safety. **[5]**

Minimization of the environmental impact as well as safety considerations of a drilling operation directly affects the choice of drilling fluid additive systems. Due to the environmental regulatory agencies, products that have been used in the past may no longer be acceptable. As more environmental laws are enacted and new safety rules are applied, the choices of additives and fluid systems must also be re-evaluated. To meet the challenges of a changing environment, product knowledge and product testing become essential tools for selecting suitable additives and drilling fluid systems. There are many factors that are to be weighed when choosing a drilling fluid. However, the key considerations are well design, anticipated formation pressures and rock mechanics, formation chemistry, the degree of damage the drilling fluid imparts to the formation, temperature, environmental effects and regulations, logistics, and economics. To meet these key design factors, drilling fluids offer a complex array of interrelated properties. Five basic properties are usually defined by the well program and monitored during drilling. These properties are listed as viscosity, density, filter cake or filtration, solids content, and quality of water make up. Once the properties and their parameters are determined, the drilling fluid can be controlled and adjusted accordingly**. [6]**

Extensive research has been going on in search of drilling fluid systems that are less harmful to the environment, causes less damage to the reservoir and brings about minimal changes to the reservoir properties. The basic idea of this invention is to incorporate a drilling fluid system that is derived from a natural source and works as effectively as the already existing ones.

Hossain, M. E., & Wajheeuddin, M. (2016) came up with a unique idea of using powdered grass as a sustainable drilling fluid additive owing to its zero environmental impacts. Simple water based drilling fluids were formulated using bentonite, powdered grass and water to analyse the rheological and filtration characteristics and results showed that grass samples with varying particle sizes and concentrations may improve the viscosity, gel strength and filtration of bentonite drilling fluids. **[7]**

Qi, N and Zhang (2004) mentioned the application and prospect of quebracho which is a plant tannin as a drilling fluid additive. They mentioned it as a drilling fluid additive with excellent properties that makes it suitable even for ultra-deep drilling**. [8]**

Among drilling fluid components, the rheology modifier is critically important in ensuring a proper rheological profile which performs specific functions such as suspending weighting agents, hole cleaning, suspending cuttings and transporting them up the annulus to the surface, etc. **Zhang J. et al.** (2015) suggested that development and utilization of green materials, polysaccharides and polyphenols isolated from natural sources have attracted increasing attention in oil field operation for their sustainability, biodegradability and bio safety and he himself invented S P gum (from south peach tree of China) to be a drilling fluid additive having high temperature resistance, shear stability and anti-biodegradation abilities. **[9]**

PEREZ (2015) also made an invention relating to the use of tannins as an additive and referred to it as a thinner and conditioning agent to reduce viscosity, yield point and gel strength of drilling fluid as desired. He used an unmodified tannin obtained from fruit pods of C. Coriaria that do not require any modification to produce excellent performance as deflocculants. **[7]**

From the literature surveys, the authors have come to a conclusion that Quebracho, which is a commercial catechol tannin product extracted from the bark and wood of quebracho tree found in South America, is known for its high tannin content. But the use of quebracho (tannin) as a drilling fluid additive is limited due to its scarcity and high price**.** Therefore, the extraction of tannin from tea leaf wastes which is the waste product of tea industries that has hardly any utility would prove to be beneficial. Moreover, as Assam is abundant in tea, this would also take care of the cost factor.

The scopes of this work include determining effects on the rheology of drilling mud due to increase in concentration of mud additive and to compare findings to the originally prepared mud sample. The scope of work is limited to water based mud only.

METHODOLOGY

This section outlines the methodologies used to determine the effects of drilling fluid additives on the rheological properties of the prepared drilling mud.

Material and Methods

A mud sample "A" containing only water, bentonite clay and barite as weighing agent was prepared by adding 30 gms. of bentonite and 60 gms. of barite to 1000 ml of water to obtain a bentonite-to-water ratio of 3% and a barite-to-water ratio of 6%. These ratios were maintained constant for all the mud samples used throughout this work. The rheological properties of "A" were measured and recorded. Thereafter, several other mud samples with varying additive concentrations were prepared and their rheological properties were measured and recorded. Graphs were plotted for proper analysis of the recorded data. All the rheological properties were measured at ambient conditions (around 77˚F temperature).

Preparation of the additive (Calcium Tannate)

Keep and Soak 10 gms of tea waste in 100 ml of distilled water and then bring it to a boil. Let it cool and then filter it. Take the filtrate and add 2 gms of calcium carbonate. Let it boil and allow it to cool until precipitate starts to settle. Filter the solution, the precipitate left on the filter paper is the desired product. To make sure that the precipitate obtained is our desired product the sample was sent for an IR spectroscopy, the result of which has been shown in the **Fig. 01** below. The spectra obtained was as desired as the peaks obtained fell within the right range of values for calcium tannate which served as a confirmation for the authors and to proceeded further.

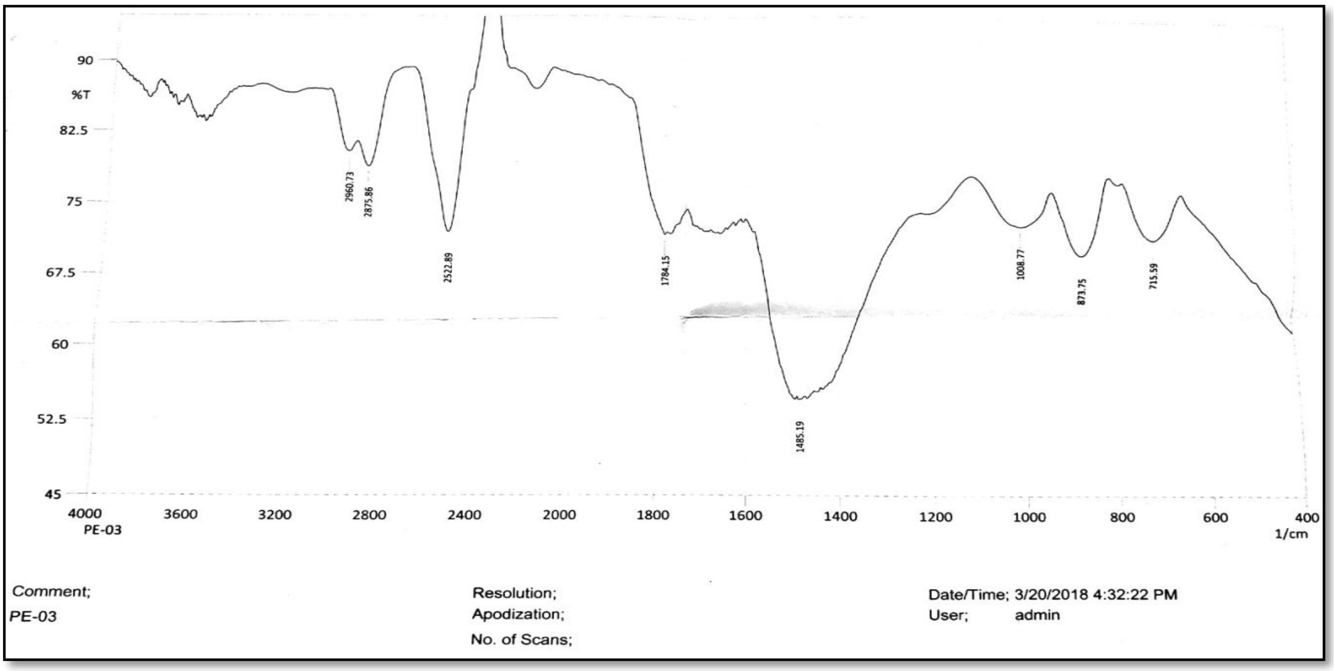

Figure 1: IR spectroscopy results of the prepared additive sample

Equipment Used

1. Mud Balance
2. M3600 Grace Rotational viscometer
3. Electronic Balance
4. M3600 DAQ software
5. Dead weight hydraulic filter press

Experimental Works

Assessment on applicability of calcium tannate as drilling fluid additive in water based mud was investigated and the results on plastic viscosity, yield point, gel strength, density and fluid loss were monitored with varying concentration of the additive and recorded as shown in the **Table 01**.

All the experiments were performed on a base mud sample whose composition was constant all throughout (mud sample "A").

Table 1: Practical Data Interpretation of the Additive Sample

Composition of Calcium Tannate, gm/100ml	Mud Properties								
	φ_{600}	φ_{300}	Apparent Viscosity, CP	Plastic Viscosity, CP	Gel Strength, b/100ft^2	Yield Point, lb/100ft^2	Density of Mud, PPG	Fluid Loss, ml	Temperature, °F
0	15.865	9.981	7.9325	5.884	2.544	4.097	8.7	12.1	73
0.5	14.873	9.198	7.4365	5.675	2.517	3.523	8.715	12.2	73
1	12.35	7.436	6.175	4.914	2.348	2.522	8.75	12.2	74
2	10.176	6.262	5.088	3.914	1.761	2.348	8.8	12.2	74
3	9.785	6.849	4.8925	2.936	1.37	2.1913	8.87	12.2	74

RESULT AND DISCUSSIONS

Effect of Calcium Tannate on Viscosity

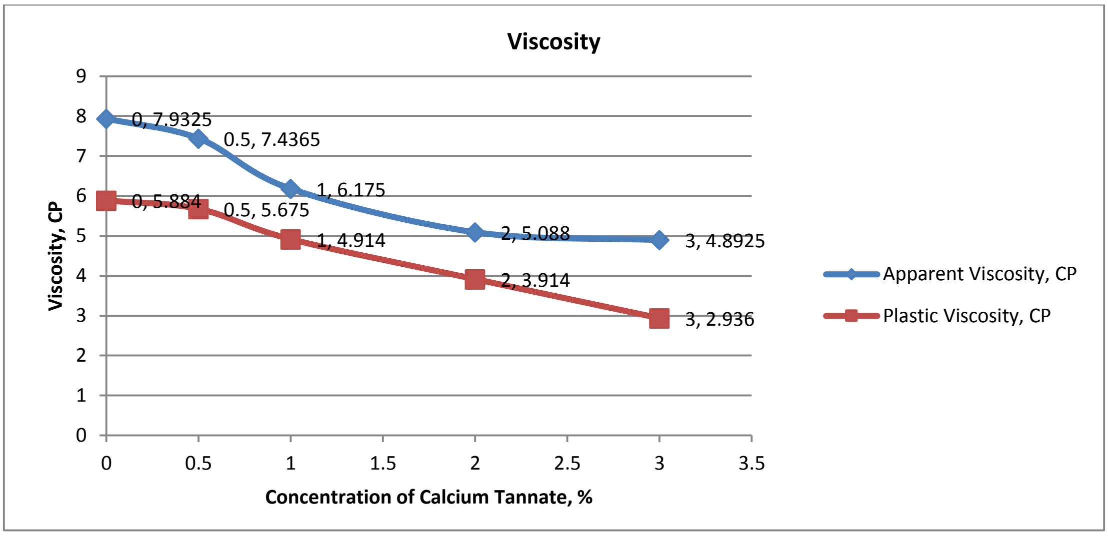

Figure 2: Plastic Viscosity vs. Concentration of Calcium Tannate

In **Fig. 02**, the trend shows that with increase in concentration of the additive (calcium tannate) there is a slight decrease in the plastic viscosity of mud. There is a gradual downward movement of the plastic viscosity curve as the concentration of the additive increases from 0.5% to 3%. From these observations, it is quite clear that the plastic viscosity in the base mud showed an overall decrease, and hence, calcium tannate can be used as a mud additive for reducing viscosity.

Effect of Calcium Tannate on Fluid Loss

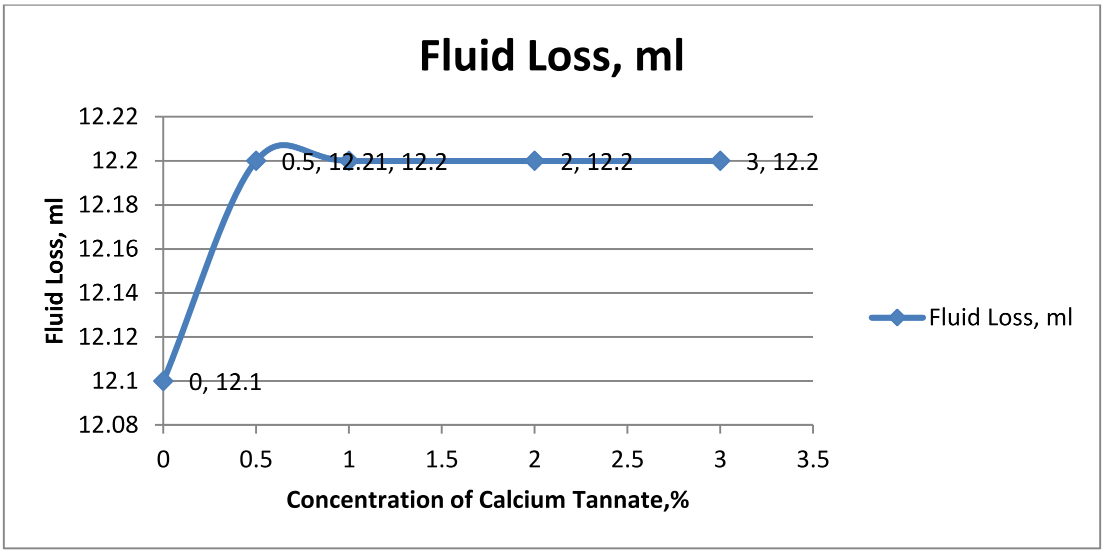

Figure 3: Fluid Loss vs. Concentration of Calcium Tannate

In **Fig. 03**, it is observed that fluid loss is slightly decreases as the additive concentration increased from 0% - 0.5%. Again, it shows a slight increase from 0.5% - 1%, and again decreased slightly as the concentration increased from 1% - 2% and so on. The fluid loss is non-uniformly fluctuating within a short range of values when calcium tannate is added in different concentrations to the base mud. So, it was clear that calcium tannate has hardly any effect in fluid loss control of the water based bentonite mud.

Effect of Calcium Tannate on Density of Mud

From the **Fig. 04**, it is clear that that the density of the base mud shows an increasing trend as concentration of the additive increases from 0% to 3%.

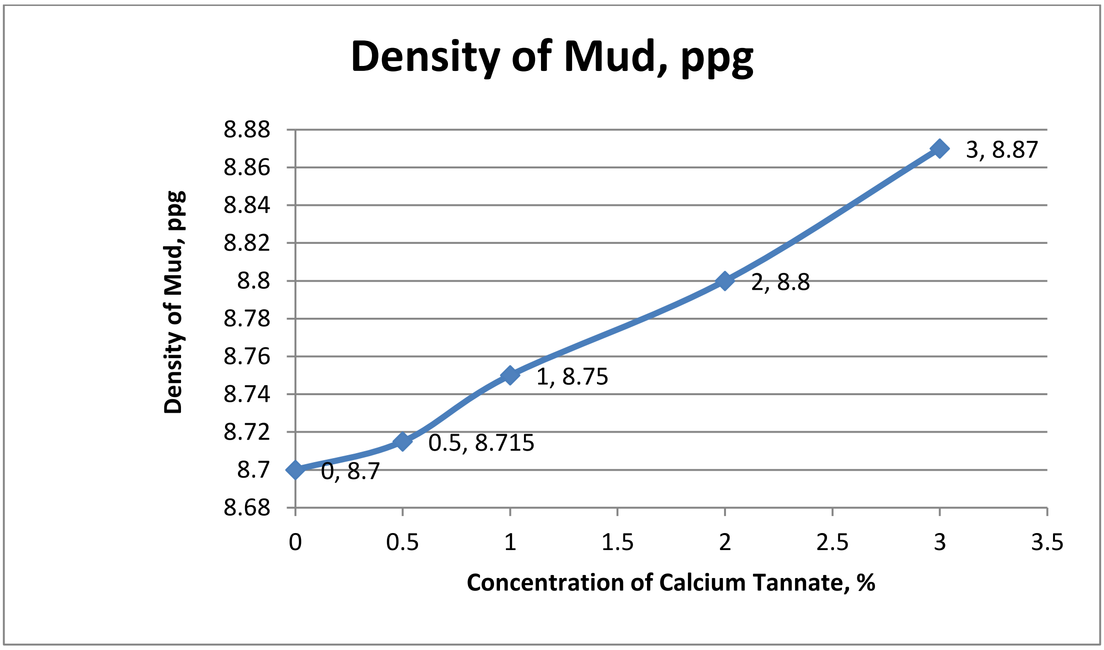

Figure 4: Density vs. Concentration of Calcium Tannate

Effect of Calcium Tannate on Gel Strength

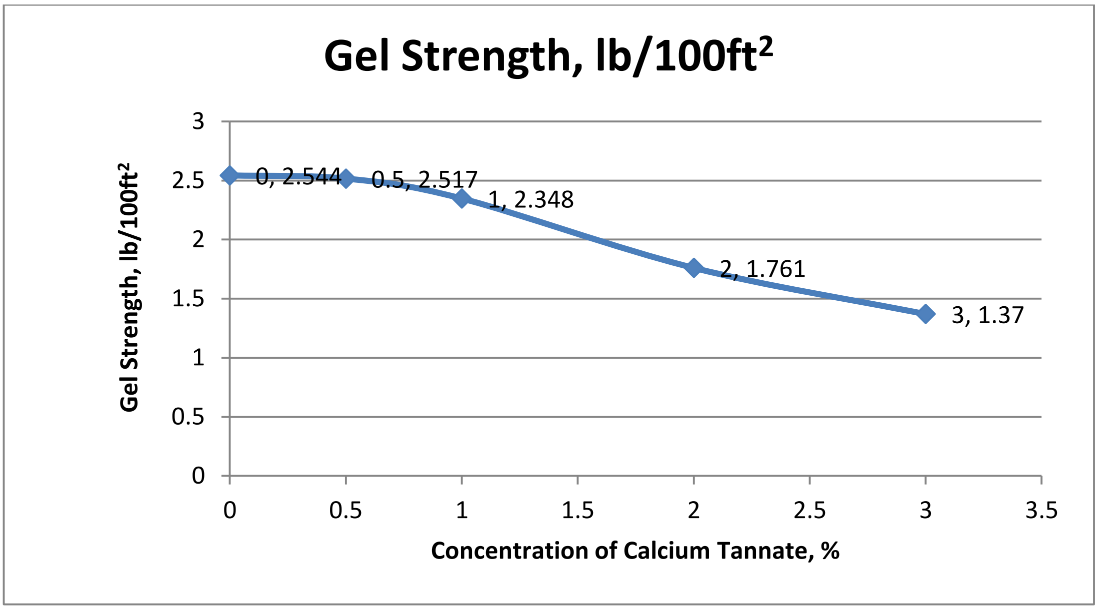

Figure 5: Gel Strength vs. Concentration of Calcium Tannate

In **Fig. 05**, it is observed that there is a gradual decrease in the gel strength as the concentration of the additive increases from 0% to 1%. Then, it shows a further rapid decreasing trend with increase in concentration of calcium tannate from 1% to 3%.

Effect of Calcium Tannate on Yield Point

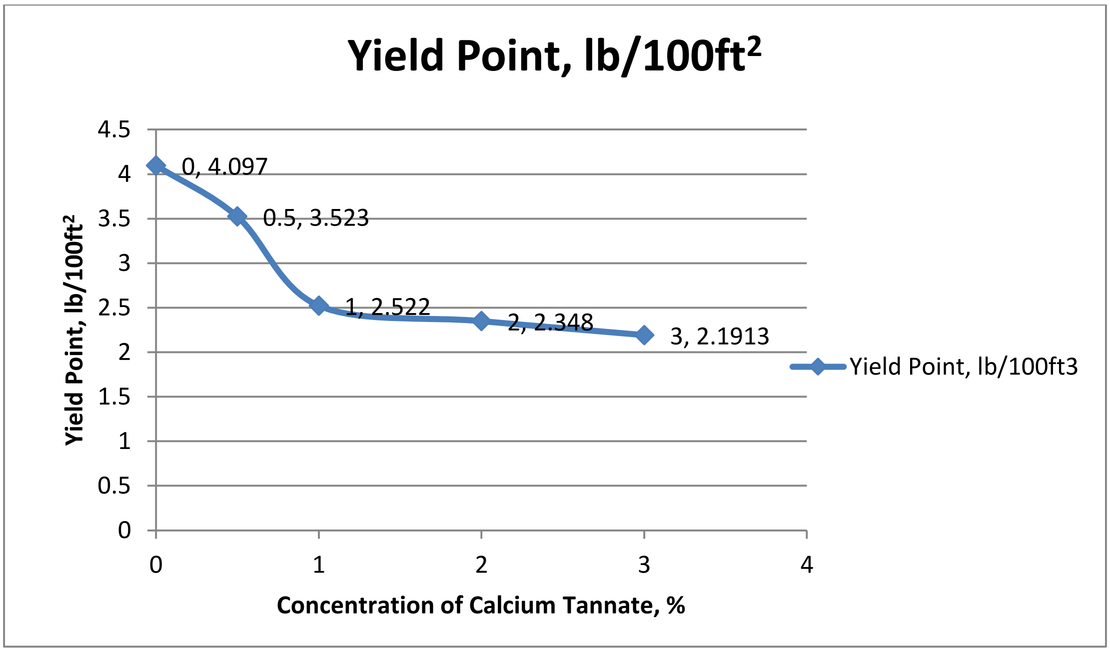

Figure 6: Yield Point vs. Concentration of Calcium Tannate

In **Fig. 06**, it is apparent that there is a prompt decrease in the yield point as the concentration of the additive increases from 0% to 1%. Then, it shows a further gradual decreasing trend with increase in concentration of calcium tannate from 1% to 3%.

CONCLUSION

Results from this study have shown the efficiency of Calcium Tannate as rheology modifier or rheology control agent in water based mud. From the above graphs and Table 01, it can be concluded that the rheological properties i.e. viscosity, gel strength and yield point decreases with increasing composition of Calcium Tannate. So, by considering the laboratory results, the optimum composition range of Calcium Tannate for successful drilling can be chosen. And, the mud density increases with increasing composition of Calcium Tannate. It has almost negligible effect on the fluid loss.

As reservoir properties happen to vary from place to place due to heterogeneity, the water based mud composition as well as the additive concentration must have to vary depending on the requirements. Nonetheless, functions of the additive would remain almost same and proper tests are to be performed in the laboratory before application to the proposed field. Thus, the calcium tannate as an environment friendly drilling fluid additive and the use of it will decrease the environment pollution since the tea waste otherwise would have disposed directly in the environment. It is cost effective since it is derived from the tea waste using simple procedures. There will be no scarcity of this material since the tea waste can be obtained from the abundant tea industries around the world.

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