PHYLLANTHUSEMBLICA – A MEANS FOR THE MANAGEMENT OF COFFEE EFFLUENT

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Abstract

Coffee industry uses large quantities of water during its processing. It has been estimated that 40–45 L of waste water is produced per kilogram of coffee. The waste water from coffee industries has high concentration of organic pollutants and is very harmful for surrounding water bodies, human health and aquatic life if discharged directly into the surface water. Having rich in organic matter it creates problem to the environment. Hence it is essential to treat and manage coffee waste. The available means of coffee waste management as on date is not ecofriendly and cheap. So the need of the hour is ecofriendly, cheap and cost effective means of treatment. An attempt was made in this study to use cheaply available bioproduct as a means for coffee waste treatment. *Phyllanthusemblica*wood was chosen to treat the coffee effluent. The coffee effluent was collected from Bodimetu, Thenithaluka, Tamil Nadu and its physicochemical characters and microbial load were analysed by standard methods. Before treatment the sample was undesirable in its physicochemical and biological properties. Coffee effluent treated with *Phyllanthusemblica*wood altered the physicochemical properties and reduced microbial load.

Keywords: Coffee waste, effluent, *Phyllanthusemblica*, Physicochemical characters.

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Introduction

Coffee is a major plantation crop grown worldwide and is one of the most popular beverages consumed throughout the world (Shanmukhappa et. al., 1998).It belongs to Rubiaceae family and has more than 70 species. Two of them are of significant economic importance and are arabica (*Coffeaarabica*) and robusta (*Coffearobasta*) (Clifford, 1999). During the processing of coffee huge quantity of waste is generated. The total world production of coffee waste was estimated to be 22 million metric ton coffee pulp, 2.4 million metric ton mucilage and 8.6 million metric ton hulls (FAO, 1997). The processing is done in 3 steps viz., primary, secondary and tertiary steps. Primary processing is by dry and wet methods (www.ico.org). Green beans are subjected to mechanical removal of the parchment layer from the bean in the secondary step. The beans are then graded according to size, shape, weight, colour and uniformity. In tertiary processing different products of coffee are prepared. Instant coffee and decaffeinated coffee are the two main products that comes out from tertiary treatment steps (Dinsdale et al., 1996, 1997; Fernandez and Forster, 1994; Kostenberg and Marchaim, 1993).

Coffee pulp is treated mainly by chemical means and it consisted of alkali treatment; a combined acid–alkali, and combined alkali-ensilage treatment (Ulloa Rajas et al., 2002). Aerobic and anaerobic digestion are also done. In anaerobic digestion, complex organic matters are degraded under the absence of oxygen. This process is time consuming as bacterial consortia responsible for the degradation process requires time to adapt to the new environment before they start to consume on organic matters to grow (Gerardi, 2003). Aerobic treatment, membrane treatment system and evaporation method are the currently available alternative methods for Palm Oil Mill Effluent (POME) treatment (Gopal and Ma, 1986). Treatments applied to Coffee pulp (CoP) consisted of alkali treatment, a combined acid–alkali and a combined alkali-ensilage treatment (Murillo, 1979). All the above said methods are costly, time consuming and has adverse effect. Hence the need of the hour is an ecofriendly methods of coffee waste treatment

The coffee industry uses large quantities of water during the various stages of the production process. Consequently, the amount of waste water produced is also high. Literature revealed that 40–45 L of waste water are produced per kilogram of coffee (Rodriguez *et al*., 2000). Coffee waste has high concentration of organic pollutants (Chapman, 1996, De Matos et.al,2001, INEP,2001,MoEF, 2003) and is very harmful for surrounding water bodies, human health and aquatic life if discharged directly into the surface waters (Deepa et.al., 2002, Enden

et.al., 2002). This effluent is being directly discharged to the nearby water bodies and thus causing many severe health problems like spinning sensation, eye, ear and skin irritation, stomach pain, nausea and breathing problem among the residents of nearby areas. So, there is a pressing need to curb this problem through innovative and ecofriendly techniques (AlemayehuHaddis, Rani Devi, 2008). Hence an attempt is made in this study to use *Phyllanthusemblica*wood as a means for coffee effluent treatment.

One of the earlier claims is that the water treated with the wood of*Phyllanthusemblica*become soft, safe for drinking and healthy living(Durairasan, 1999). Due to the high cost and solid waste produced by chemical and membrane filtration treatment technology alternate method is the need of the hour. The alternate must be ecofriendly and cheap. Therefore, this study is aimed to treat the coffee effluent using the natural product *Phyllanthusemblica*wood.

Materials and methods

Ten liters coffee effluent was collected from Bodimetu, Thenithaluka, Tamil Nadu. The effluent was collected from selected site in polythene bottles and was kept in room temperature till use. The samples were collected in the month of January, 2013. The samples were immediately brought to the laboratory to assess various physicochemical and biological characters. Temperature and pH of the effluent were recorded at the time of sample collection, by using thermometer and pocket digital pH meter respectively. While other parameters such as hardness, chlorides, alkalinity and nitrate were estimated in the laboratory by standard methods as prescribed in APHA, (1998). Biological characteristics of the collected distillery effluent were analyzed as per standard methods.

Preparation of plant material

Good quality dried *Phyllanthusemblica (*Nellikattai) wood was purchased from local traditional medicine shop (NattuMarunthuKadai), Tiruchirappalli. Wood was cleaned and dried under shade. The bark from the wood was removed and was powdered using mortar and pestle and this powder was stored in air tight container and this was used for further study.

Treatment with *Phyllanthusemblica*

Coffee effluent collected for the study purpose from Bodimetu, Thenithaluka, Tamil Nadu was treated directly with *Phyllanthusemblica*wood powder at a concentration of 50g/L and

the treatment is for a period of a month. The physicochemical and biological parameters were checked before and after treatment at 7 days interval.

Result

The results revealed that the colour of the coffee effluent was dark brown before treatment but after treatment with *Phyllanthusemblica*the colour was light greenish brown. Fruity taste and unpleasant odour was changed to bitter and pleasant after treatment with *Phyllanthusemblica*(Table 1). The temperature and pH of the coffee effluent remained same before and after treatment with *Phyllanthusemblica*(Table 1).

The chemical parameters analysed revealed that there was a reduction in alkalinity (3 fold), total hardness (4 times), total calcium (4 fold), magnesium (3 fold), and chloride (6 times lowered). This reduction is gradual. Similarly DO,BOD and COD were also reduced several fold after a monthtreatment with *Phyllanthusembilca*(Table 2).

Bacterial load was too heavy in coffee effluent before treatment and after treatment with plant material the number of bacteria got reduced. At the end of 36th day there was no bacterial at all (Table 3).

Table 1: Physical characters of coffee effluent

S.No	Parameters analysed	Physical characters before treatment	Physical characters after treatment with *Phyllanthusembilca*					
			1st day	8th day	15th day	22nd day	29th day	36th day
1	Colour	Dark brown	Light greenish brown	Light greenish brown	Light greenish brown	Light greenish brown	Light greenish brown	Light greenish brown
2	Taste	Fruity, Ripe	Bitter	Bitter	Bitter	Bitter	Bitter	Bitter
3	Odour	Unpleasant	Pleasant	Pleasant	Pleasant	Pleasant	Pleasant	Pleasant
4	Temp.	35^{o} C	35^{o} C	35^{o} C	35^{o} C	35^{o} C	35^{o} C	35^{o} C
5	pH	9	9	8.5	8	7.5	7	6.5

Table 2: Chemical Characters of Coffee effluent

S.No	Parameters analysed	Chemical characters before treatment	Chemical characters after treatment with *Phyllanthusembilca*					
			1st day	8th day	15th day	22nd day	29th day	36th day
1	Total Alkalinity	10mg/l	10mg/l	8mg/l	6mg/l	4mg/l	3mg/l	3mg/l
2	Total acidity	9 mg/l	9 mg/l	11 mg/l	13 mg/l	16 mg/l	18 mg/l	20 mg/l
3	Total Hardness	90 mg/l	80 mg/l	60 mg/l	30 mg/l	31 mg/l	20 mg/l	15 mg/l
4	Total Calcium	80 mg/l	70 mg/l	60 mg/l	45 mg/l	31 mg/l	24 mg/l	19 mg/l
5	Estimation of Magnesium	10 mg/l	10 mg/l	8 mg/l	8 mg/l	6 mg/l	5 mg/l	3 mg/l
6	Estimation of Chloride	60 mg/l	50 mg/l	39 mg/l	24 mg/l	18 mg/l	15 mg/l	10 mg/l
7	Dissolved oxygen	15 mg/l	15 mg/l	10 mg/l	8 mg/l	6 mg/l	4 mg/l	2 mg/l
8	BOD	14 mg/l	11 mg/l	9 mg/l	9 mg/l	6 mg/l	4 mg/l	2 mg/l
9	COD	14 mg/l	12 mg/l	10 mg/l	8 mg/l	6 mg/l	5 mg/l	3 mg/l
10	Total Suspended Solids	12 mg/l	10 mg/l	9 mg/l	8 mg/l	7 mg/l	6 mg/l	5 mg/l

Table 3: Biological population of coffee effluent

S.No	Sample Code	Before treatment	Duration and microbial load after treatment (No. of colony)					
			1st day	8th day	15th day	22nd day	29th day	36th day
1	CE	Innumerable	20	16	10	4	-	-

Discussion

Colour is a very important factor for aquatic life for making food from sun rays. The photosynthetic activity is found to be reduced due to dark coloration. Dark colour will affect other parameters like temperature, DO and BOD (Waqar et al., 2012). To begin with coffee effluent was dark brown in colour with unpleasant odour and teaste. The reason could be its richness in organic matter and associated microbes. This may affect the life of microbes in it.

Odour of the waste water is due to the chemical agents like hydrogen sulphide, free chlorine, ammonia, phenols, alcohols, esters, hydrocarbons and biological agents such as algae, fungi and other microorganisms present in it (Sharma, 2000). The odour of coffee effluent is unpleasant initially and later become pleasant. It may be due to the chemical reaction happened between organic matter of the coffee waste and phytochemicals of *Phyllanthusembilca* wood.

pH is an indicator of waste. It determines corrosive nature and its ingradients. Lower the pH higher is the corrosive nature. pH was positively correlated with electrical conductance and total alkalinity (Guptaa 2009).The reduced rate of photosynthetic activity, the assimilation of carbon dioxide and bicarbonates which are ultimately responsible for increase in pH, the low oxygen values. In this study the pH was alkaline 1st and after treatment it got reduced and become slightly acidic after a month.

All physiological activities and life processes of aquatic organisms are generally influenced by water temperature (Murhekar, 2011). It is an important parameter because it affects the biochemical reactions in aquatic organisms. But here the temperature remained same at 35^{o} C before and after treatment.

Alkalinity, pH and hardness affect the toxicity of many substances in the water (Patil et al., 2012). Acidity is a measure of the combination of compounds and conditions in water. It is the power of water to neutralize OH- and is expressed in terms of CaCO3. Water attains acidity from industrial effluents, municipal waste (drainage) and from humic acid (Basavaraj et al., 2014). Acidity and alkalinity indicates a samples chemical nature. Coffee waste has high alkalinity initially and reduced gradually after treatment with *Phyllanthusembilca*wood. But the acidity was increased gradually.

Hardness, of a sample is due to presence of magnesium sulphate and it can lead to the development of laxative effect on new consumers and cause scaling in pipelines. Calcium salts tend to cause incrustations on cooking utensils and water heaters. Hence it is essential to soften the portable water (Spellman, 2003). Chloride is a common constituent of all natural water and is generally not classified as harmful constituent (JayantaChutia and siba Prasad Sarma, 2009) and it is the indicator of contamination with animal and human waste. Here the hardness, magnesium, calcium and chloride content were gradually reduced several fold after treatment and the reason could be the action between the organic matter of coffee waste and phytoconstituents of *Phyllanthusembilca*.

DO is very important for all physical and biological process going in water. The DO levels in water depends on physical, chemical and biological activities of the water body. The analysis of DO is very important in water pollution control as well as waste water control (YadavAnoop and DaultaRenu, 2014). Biological oxygen demand is the measure of oxygen required by microorganisms whilst breaking down organic matter. BOD is used as the index of organic pollution of waste water that can be decomposed by bacteria under anaerobic conditions (Mane, 2013). COD determines the oxygen required for the chemical oxidation of organic matter.COD values conveyed the amount of dissolved oxidizable organic matter including non-biodegradable matter present in it (Basavaraj, 2014). In this study DO, BOD, COD also were reduced in coffee waste after treatment with *Phyllanthusembilca*which may be due to the break own of organic matter and biological activity of microbes and plant material.

*Phyllanthusemblica*wood has primary coagulant property. The wood have shown a high coagulation activity for high-turbidity water and however the coagulation activity has been found to be low for low-turbidity water (Suleyman*et al.*, 2003). Earlier researchers have reported that in India traditionally water is purified by *Phyllanthusemblica* (wood) and it is safe and healthy for drinking. Coffee waste had numerous bacteria initially and the main reason is it richness in oraganic matter. But after its action with *Phyllanthusembilca* wood there was a tremendous reduction of bacterial load. This indicates that *Phyllanthusembilca* wood has antibacterial activity.

Conclusion

Overall results of this study indicated that *Phyllanthusembilca* wood could be a means for coffee waste management. A noval antimicrobial compound may arrive from *Phyllanthusembilca* wood if further explored.

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