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CHARACTERISATION OF COFFEE PULP EFFLUENT FOR ITS NUTRIENT POTENTIAL AND ITS IMPACT ON SOIL ENVIRONMENT

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ABSTRACT

Coffee is being cultivated in an area of 1.9 lakh hectares in Karnataka contributing 70 percent of coffee production in the country. Coffee fruit is processed either by wet method or dry method to produce washed and unwashed coffee beans respectively. The wet method of processing coffee fruits results in superior quality beans as compared to dry methods of processing. Around 75 to 80 percent of Arabica and 10 to 15 percent of robusta is produced by wet methods as washed coffee. In recent times the production of robusta by wet method is on the increase due to growing demand in both domestic and international markets.

In wet method, during fermentation of the mucilage, only little amount of water is absorbed by raw fruits and thus the wet process discharges large quantities of the effluent. It is composed of 85 per cent water and 15 per cent solids. The consumption of water varies from 9 to 13 cubic meters and from 17 to 20 cubic meters per ton of bean coffee processed with or without recycling, respectively. This effluent is known to contain both organic and inorganic compounds and some of them are toxic in nature. The coffee pulp effluent is known to contain high Biological oxygen demand and Chemical oxygen demand load of 10 to 13 g $l^{-1}$and 18 to 23 g l^{-1}, respectively with suspended solids ranging from 7 to 10 g l^{-1} and pH varies between 4 and 4.5 in recycled pulping material (Ananda Alwar, 1998). The effluent with high BOD and COD load when discharged into water bodies can seriously affect the aquatic life and pollute ground water when stored in lagoons. The contaminated ground water and surface water will be unfit for human consumption and for agriculture.

The coffee pulper waste was collected from Hassan and Chikamagalur district of Karnataka and it was analyzed for its chemical properties and it was found that BOD, COD values were high compared to standard values. Soil samples around the pulper waste disposal sites were analyzed and it was found that nitrogen and potassium values were high.

Keywords: Coffee, BOD, COD, Nitrogen, Potassium

1. INTRODUCTION

The traditional coffee tract of India lies in Western Ghats, coffee processing units located right of this ecologically vulnerable ecosystem are causing an environmental hazard.

Coffee is being cultivated in an area of 1.9 lakh hectares in Karnataka contributing 70 percent of coffee production in the country. Coffee fruit is processed either by wet method or dry method to produce washed and unwashed coffee beans respectively. The wet method of processing coffee fruits results in superior quality beans as compared to dry methods of processing. Around 75 to 80 percent of Arabica and 10 to 15 percent of robusta is produced by wet methods as washed coffee. In recent times the production of robusta by wet method is on the increase due to growing demand in both domestic and international markets.

In wet method, during fermentation of the mucilage, only little amount of water is absorbed by raw fruits and thus the wet process discharges large quantities of the effluent. It is composed of 85 per cent water and 15 per cent solids. The consumption of water varies from 9 to 13 cubic meters and from 17 to 20 cubic meters per ton of bean coffee processed with or without recycling, respectively. This effluent is known to contain both organic and inorganic compounds and some of them are toxic in nature. The coffee pulp effluent is known to contain high Biological oxygen demand and Chemical oxygen demand load of 10 to 13 g $l^{-1}$and 18 to

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23 g l^{-1}, respectively with suspended solids ranging from 7 to 10 g l^{-1} and pH varies between 4 and 4.5 in recycled pulping material (AnandaAlwar, 1998). The effluent with high BOD and COD load when discharged into water bodies can seriously affect the aquatic life and pollute ground water when stored in lagoons. The contaminated ground water and surface water will be unfit for human consumption and for agriculture.

It has been estimated that about 75,000 to 80,000 liters of waste water is generated for curing one ton coffee beans (Damodaran, 1998) and to process 2.23 lakh tons of coffee through wet processing, 8.4 million cubic meters of waste water is generated (AnandAlwar, 1998). The issue of water pollution became very serious when the Karnataka State Pollution Control Board passed strictures to close the pulping units in Chikmagalur district during 1995 – 96. The by-products of coffee processing are mainly coffee pulp, pulp effluent, parchment husks and coffee husk. Due to contribution of these by-products to environmental pollution, effective environmentally friendly disposal methods are very essential (Mburu and Mwaura, 1996). Presently, neutralization of effluent with lime and storing in pits is being adopted for treatment of wastewater, which may not effectively protect the water environment (AnandAlwar, 1998). Hence, there is a great need to conduct studies to suggest safe ways of waste disposal for better purposes like irrigation in agriculture in the locales where the effluent is generated.

Environmental pollution because of improper waste management is an alarming challenge for developing countries to meet the millennium development goals. Several studies reported that untreated waste from traditional and modern industries is threatening surface waters worldwide, and it is severe in developing countries. Based on the type of industry, various levels and quantity of pollutants can be discharged into the environment directly or indirectly.

2 MATERIALS AND METHODOLOGY

2.1 Description of Study area :

Chikmagalur, known as the coffee country of India, is adobe of thick jungles, wildlife sanctuaries and large coffee plantations as well as hub of coffee research in India, the Central Coffee Research Institute. In Chikmagalur district coffee is grown about 81,197 hectares comprising of Arabica and Robusta varieties. Arabica occupies a total area of 57,890 hectares while Robusta 23,367 hectares. The entire Chikmagalur district coffee area is sub divided into 3 major divisions by the Coffee Board.

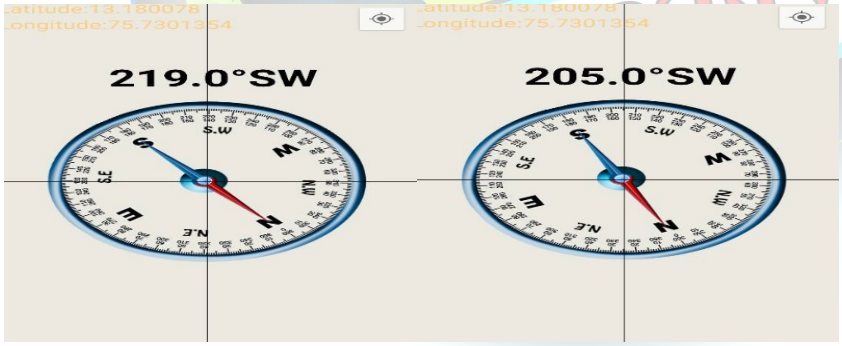

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Figure 2.1: GPS locations taken in the sites of Kesvinmane estates , Chikmagalur.

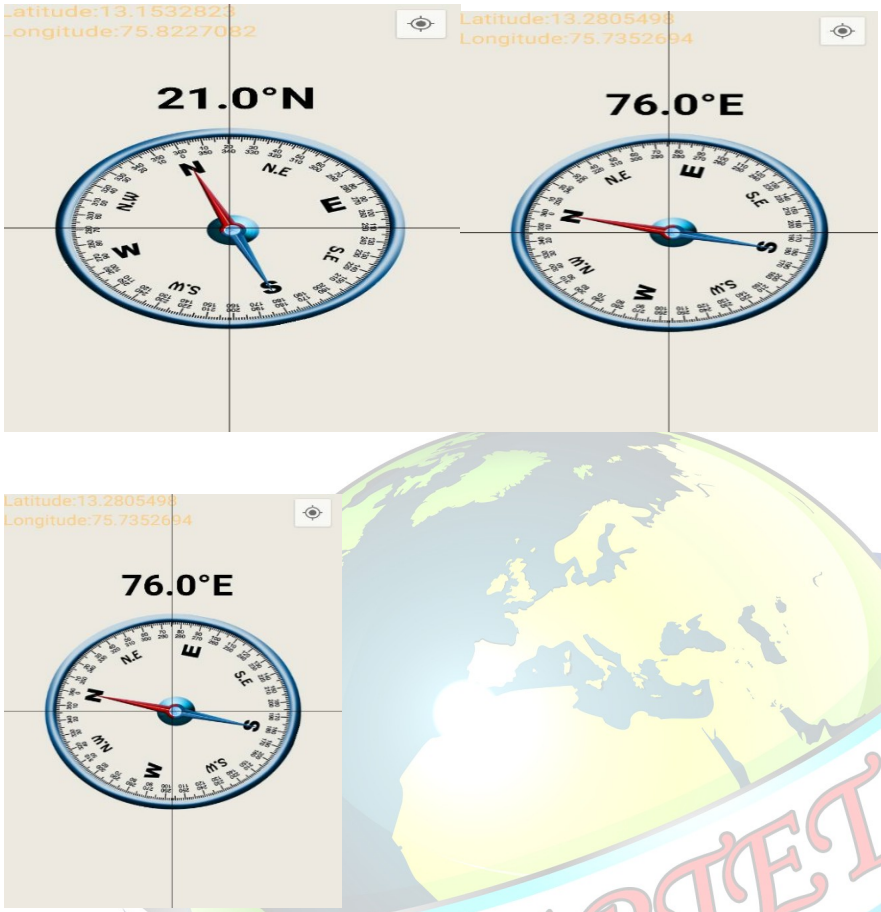

Figure 2.2: GPS locations taken in the sites of Damdally, Chikmagalur.

Hassan district is situated at southern part of the state comprising of 8 blocks. The entire district comes under 4 Agro climatic zones namely, Central dry zone, Southern dry zone, Southern transitional zone & Hilly zone. ArasikereTaluk comes under Central dry zone, ChannarayapatnaTaluk comes under Southern dry zone, Holenarsipur, Arkalgud, Alur and Belur comes under Southern transitional zone where as SakleshpurTaluk comes under Hilly zone. 8 taluks divided into 4 agro-climatic zones with geographical areas 6.62 lakh ha. The total cultivable area of the district 4.48 lakh ha.of which 79% of the area is under rain fed agriculture. The four reservoir project in Kaveri basin Hemavathi, Harangi, Vatehole&Yagachi supports irrigation to the extent of 46672 ha in Hassan District.

The soil samples were taken from Baskal, Sakaleshpurtaluk, Hassan.

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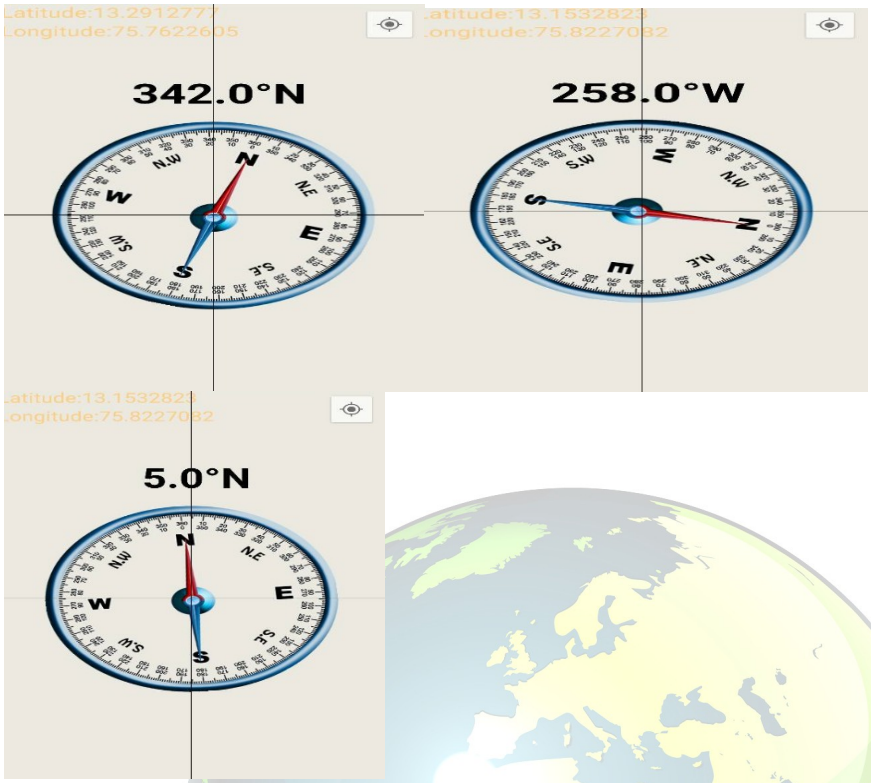

Figure 2.3: GPS locations taken in the sites of Baskal, Sakaleshpur, Hassan .

The bio-chemical nature and nutrients content of coffee pulp effluent generated in the coffee pulping units of Chikamagalurand Hassan districts of Karnataka and the impact of long term discharge on ground water quality and soil properties will be studied in and around pulping units. The effluent will be highly acidic in nature and will have high soluble salts content, BOD, COD, suspended and dissolved solids. The beneficial microbes like N-fixers and phosphate solubilizers will be in substantial number but it will be low in major nutrients and high in micronutrients contents. The study on impact of long term discharge of coffee pulp effluent on soil health and nearby surface or ground water quality indicates that available nutrients content of effluent discharged fields will be slightly higher as compared to fields not receiving any effluent and has not polluted the nearby water bodies.

Indiscriminate discharge of effluents over the years might have resulted in pollution of water and soil. The effect of the effluent discharge over the years on quality of both the surface and ground water is assessed by collecting requisite number of water samples from nearby water bodies such as ponds, open wells and bore wells at 1 - 2 km distance from the processing units. The suitability of water samples for irrigation will be assessed as per BIS standards of classification of irrigation water, which is based on electrical conductivity and sodium adsorption ratio of the water samples.

A total of twelve soil samples will be collected from Chikmagalur and Hassan district of Karnataka. Among these samples, fifteen will be collected from fields which have different history of effluent application and rest from fields which have no history of effluent application and the impact of long term discharge of coffee pulp effluent on soil properties will be studied by analyzing the samples for pH, EC and available major, secondary and micronutrients status.

3. RESULTS AND DISCUSSION

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These are the places covered in the project:

1.Kesvinmane Estates, Chikmagalur

2. DamdallyEsates ,Chikmagalur

3. Baskal Estates, Sakleshpur , Hassan

Hassan:

Location: Baskal, Sakleshpurtaluk

Pulper capacity: 35Bushals per hour

Table 3.1: Effluent characteristics of pulper

Parameters	Results
P^H	4.27 – 4.40
TDS	2051
BOD_5 mg/L	472
COD mg/L	13720

The table 3.1 indicates that the pulper has P^H ranging from 4.27 to 40.40, TDS 2051,

$BOD_5$472 mg/L, COD 13720 mg/L.

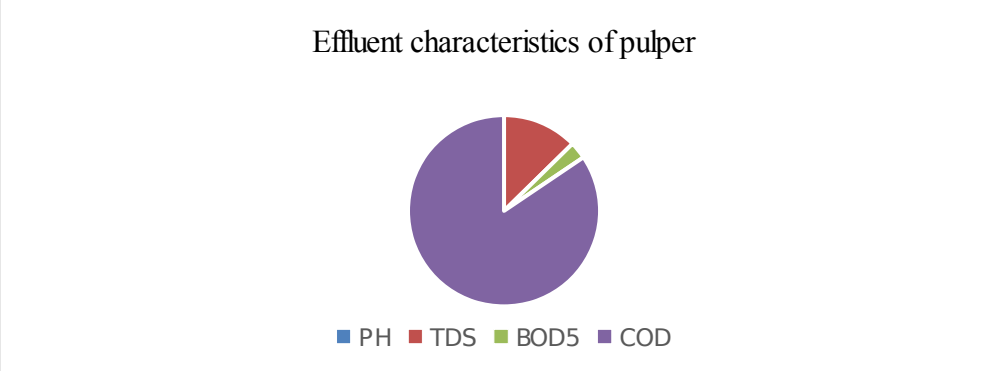

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Figure 3.1: Effluent characteristics of pulper

Table 3.2: Tests on soil sample 1

The table 3.2 indicates that the soil has Bulk density 1.98 g/cm^3, Permeability2.5*10^{-3} cm/s, Nitrogen 3780,Phosphorous 41, Potassium 170.

TEST CONDUCTED	TESTS RESULTS
Bulk densityg/cm^3	1.98
Permeabilitycm/s	2.5*10^{-3}
Nitrogen	3780
Phosphorous	41
Potassium	170

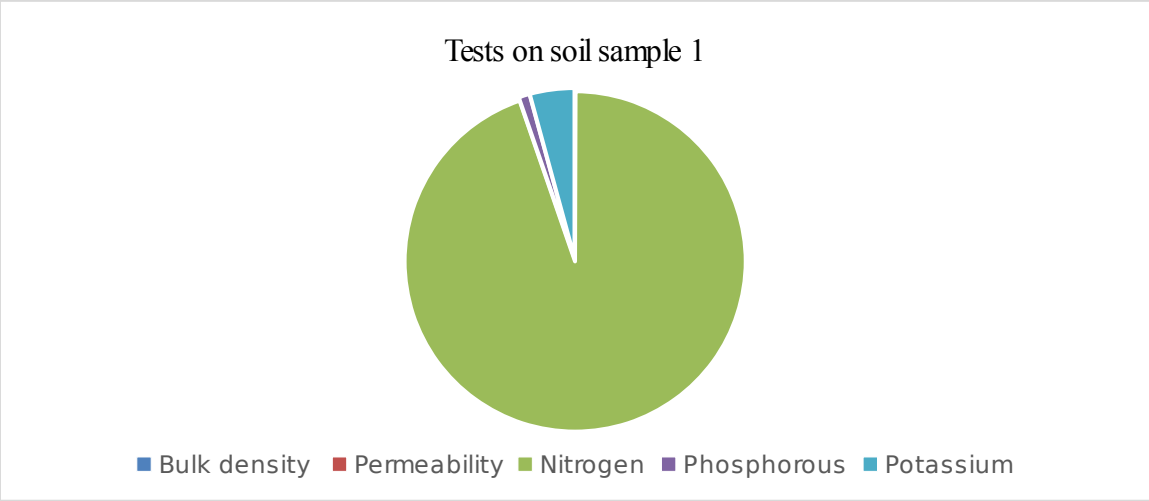

Figure 3.2: Tests on soil sample 1

Table 4.3: Tests on soil sample 2

TEST CONDUCTED	TESTS RESULTS
Bulk densityg/cm^3	2.23
Permeabilitycm/s	1.51*10^{-3}
Nitrogen	2285
Phosphorous	25
Potassium	102

The table 4.3 indicates that the soil sample has Bulk density 2.23 g/cm^3, Permeability 1.51*10^{-3}cm/s, Nitrogen 2285, Phosphorous 25, Potassium 102

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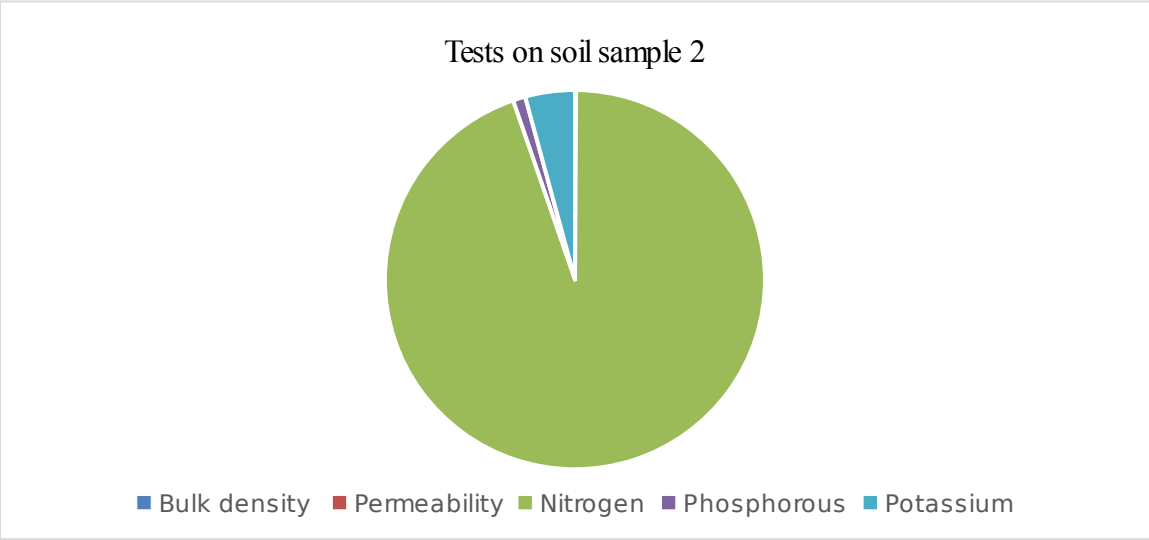

Figure4.3 : Tests on soil sample 2

Table 4.4: Tests on soil sample 3

TESTSCONDUCTED	TESTS RESULTS
Bulk densityg/cm^3	2.36
Permeabilitycm/s	1.68*10^{-3}
Nitrogen	2540
Phosphorous	28
Potassium	115

The table 3.4 indicates that the soil sample has Bulk density 2.36 g/cm^3, Permeability 1.68*10^{-3}cm/s, Nitrogen 2540, Phosphorous 28, Potassium 115

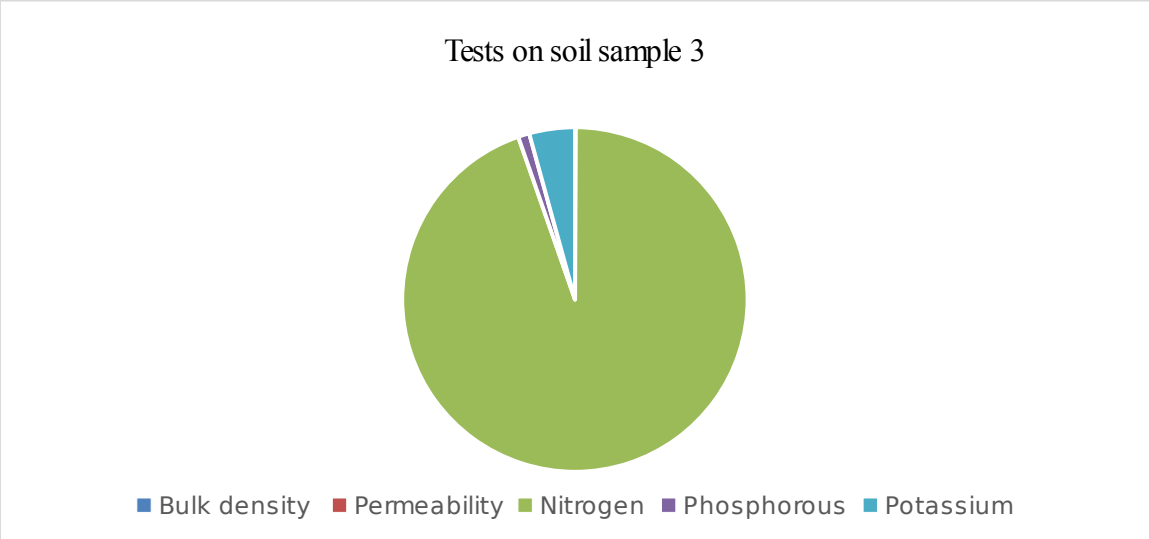

Figure 3.4: Tests on soil sample 3

CHIKAMAGALUR:
Location: Kesvinmane Estates
Pulper capacity: 30 Bushals per hour

Table 3.5: Effluent Characteristics of pulper

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Tests conducted	Test results
P^H	4.3
TDS	532
BOD_5 mg/L	587
COD mg/L	15600

The table 3.5 indicates that the pulper has P^H ranging from 4.3, TDS 532, BOD_5 587 mg/L, COD 15600 mg/L

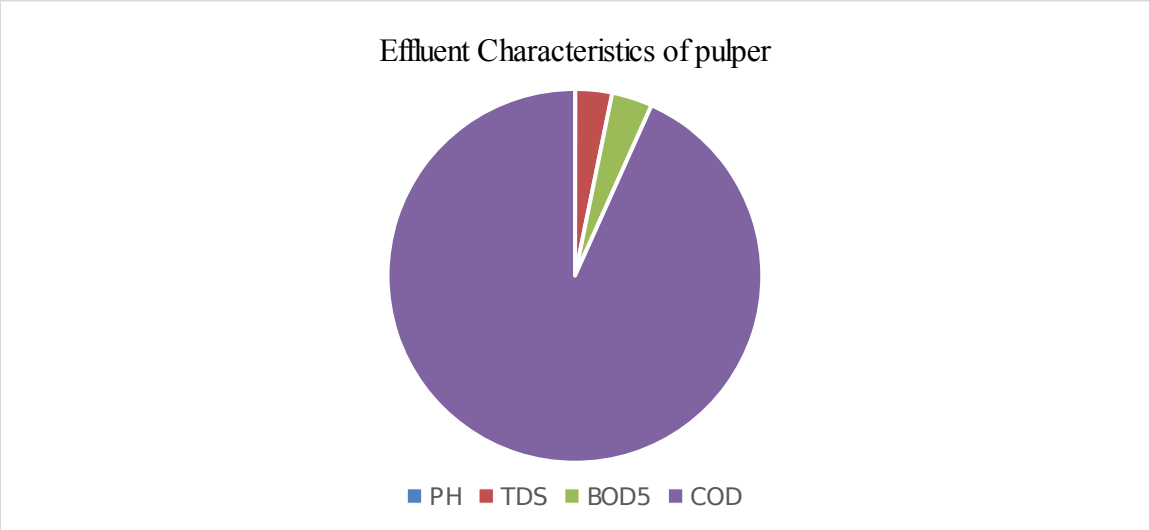

Figure 3.5: Effluent Characteristics of pulper

Tests on soil samples:

Table 3.6: Test on soil sample 1

TESTS CONDUCTED	TESTS RESULTS
Bulk density g/cm^3	2.36
Permeability cm/s	$1.54*10^{-3}$
Nitrogen	421
Phosphorous	8
Potassium	363

The table 3.6 indicates that the soil sample has Bulk density 2.36 g/cm^3, Permeability $1.54*10^{-3}$cm/s, Nitrogen 421, Phosphorous 8, Potassium 363

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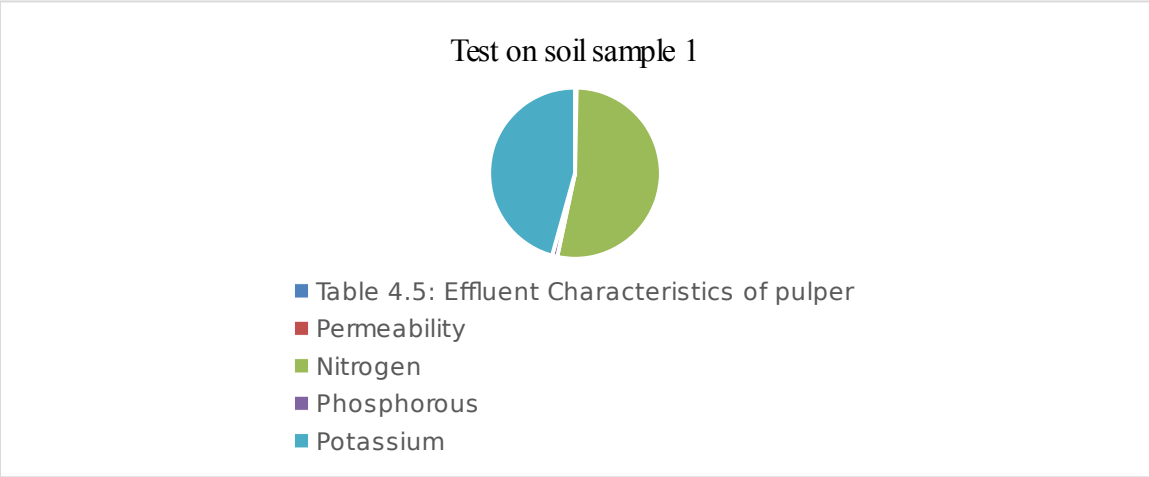

Figure 3.6: Test on soil sample 1

Table 3.7: Test on soil sample 2

TESTS CONDUCTED	TESTS RESULTS
Bulk density/cm^3	2.31
Permeabilitycm/s	1.48*10^{-3}
Nitrogen	405
Phosphorous	7
Potassium	348

The table 3.7 indicates that the soil sample has Bulk density 2.31 g/cm^3, Permeability 1.48*10^{-3}cm/s, Nitrogen 405, Phosphorous 7, Potassium 348

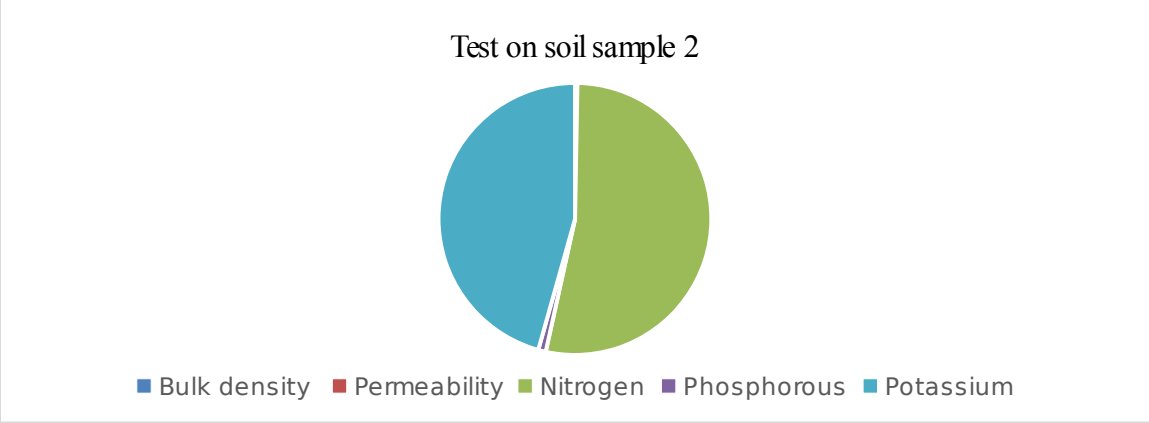

Figure 3.7: Test on soil sample 2

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Table 3.8: Test on soil sample 3

TESTS CONDUCTED	TESTS RESULTS
Bulk density g/cm^3	2.4
Permeability cm/s	1.53*10^{-3}
Nitrogen	418
Phosphorous	8
Potassium	360

The table 3.8 indicates that the soil sample has Bulk density 2.4g/cm^3, Permeability 1.53*10^{-3}cm/s, Nitrogen 418, Phosphorous 8, Potassium 360

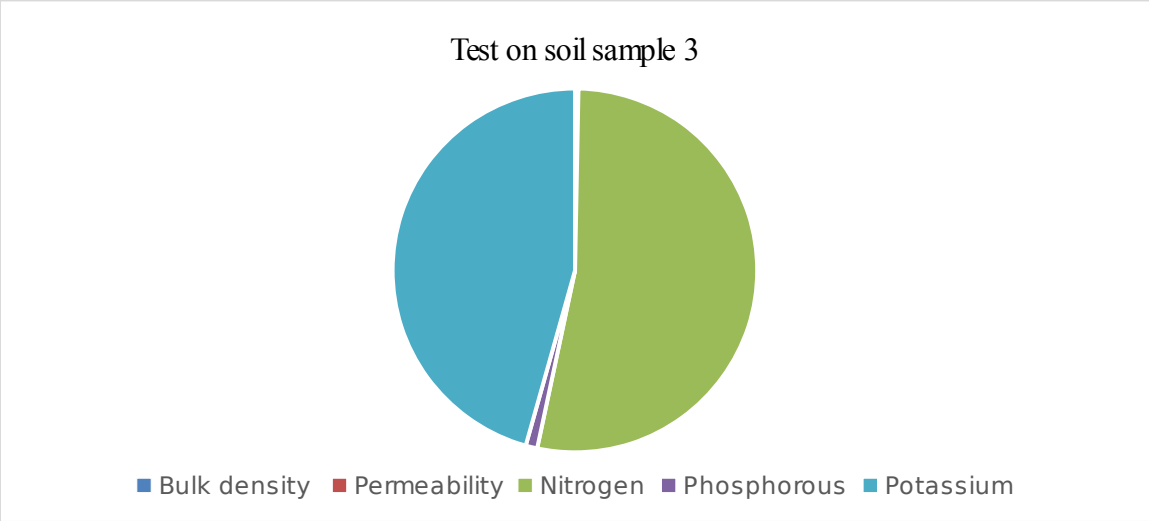

Figure 3.8: Test on soil sample 3

CHIKAMAGALUR:
Location: Damdally estates

Pulper capacity: 27 Bushals per hour

Table 3.9: Effluent characteristic of pulper

Tests conducted	**Test results**
P^H	4.35
TDS	447
BOD_5 mg/L	551
COD mg/L	13750

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The table 3.9 indicates that the pulper has P^Hranging from 4.35, TDS 447,

BOD_5 551 mg/L, COD 13750 mg/L

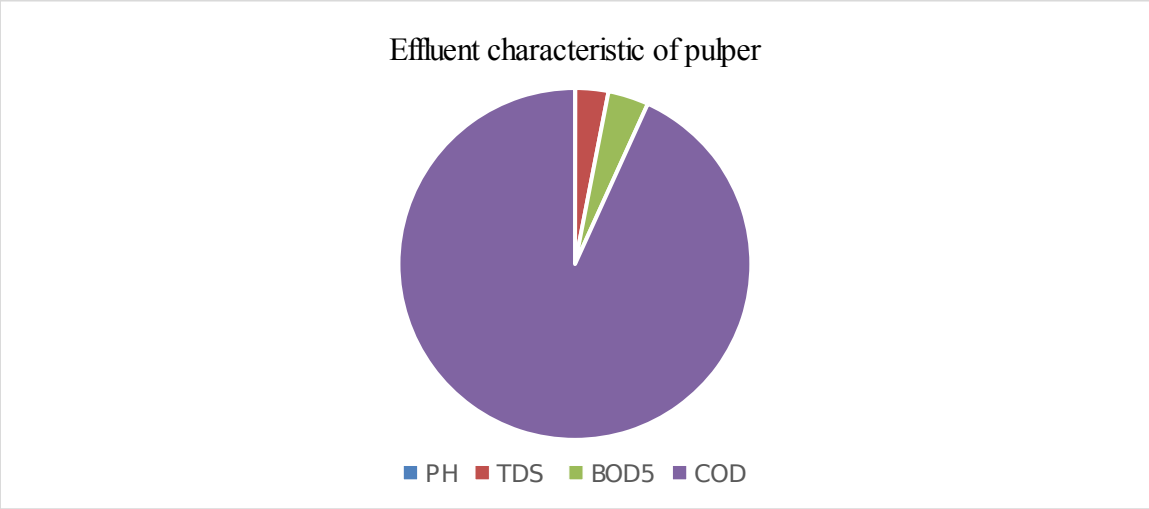

Figure 3.9: Effluent characteristic of pulper

Table 3.10: Test on soil sample 1

TESTS CONDUCTED	TESTS RESULTS
Bulk densityg/cm^3	2.12
Permeabilitycm/s	$1.34*10^{-3}$
Nitrogen	366
Phosphorous	7
Potassium	316

The table 3.10 indicates that the soil sample has Bulk density 2.12 g/cm^3, Permeability $1.34*10^{-3}$cm/s, Nitrogen 366, Phosphorous 7, Potassium 316

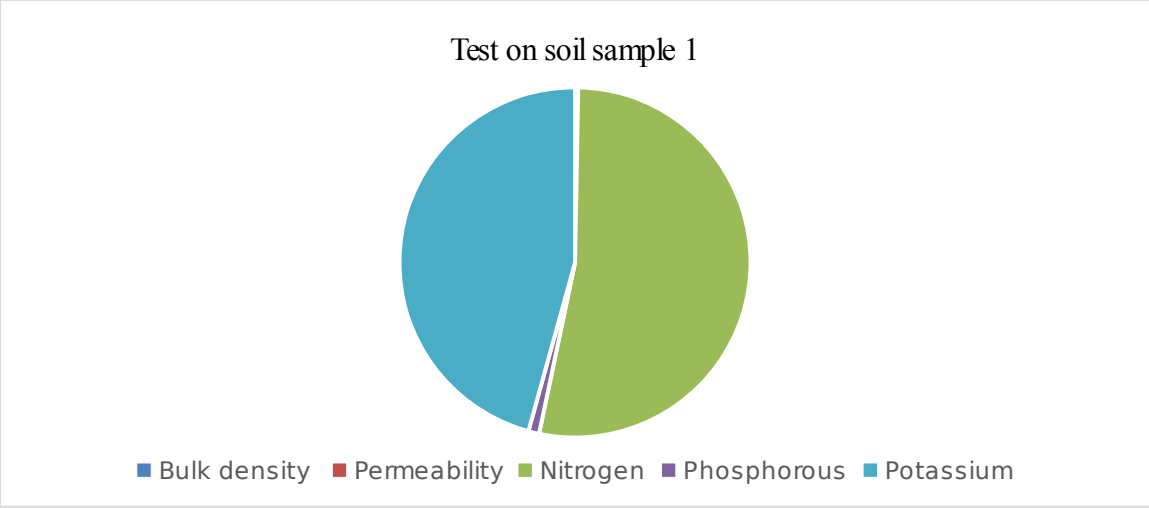

Figure 3.10: Test on soil sample 1

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Table 3.11: Test on soil sample 2

TESTS CONDUCTED	TESTS RESULTS
Bulk densityg/cm^3	2.24
Permeabilitycm/s	1.28*10^{-3}
Nitrogen	350
Phosphorous	7
Potassium	302

The table 3.11 indicates that the soil sample has Bulk density 2.24 g/cm^3, Permeability 1.28*10^{-3}cm/s, Nitrogen 350, Phosphorous 7, Potassium 302

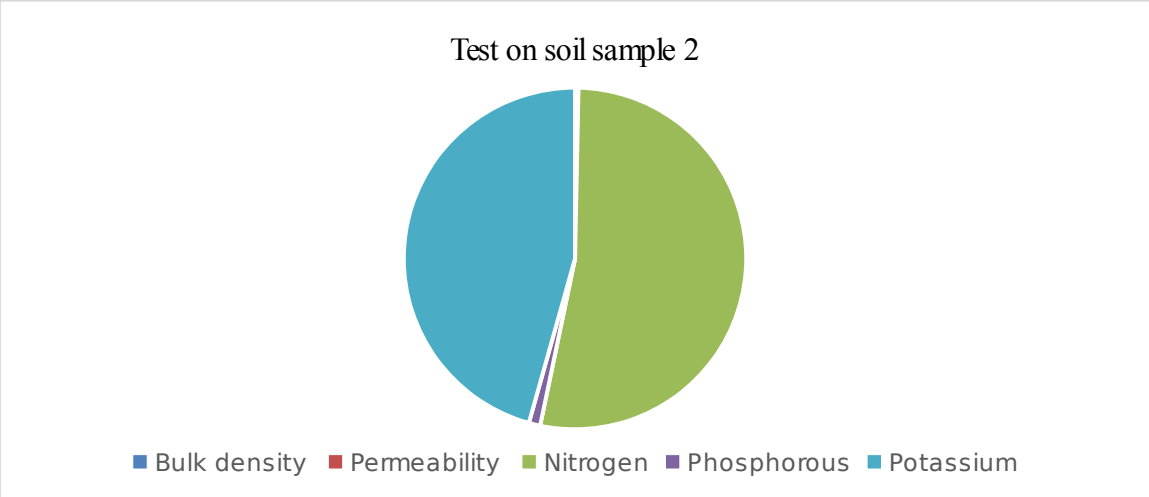

Figure 3.11: Test on soil sample 2

Table 3.12: Test on soil sample 3

TESTS CONDUCTED	TESTS RESULTS
Bulk density/cm^3	2.32
Permeabilitycm/s	1.31*10^{-3}
Nitrogen	358
Phosphorous	7
Potassium	309

The table 3.12 indicates that the soil sample has Bulk density 2.32 g/cm^3, Permeability 1.31*10^{-3}cm/s, Nitrogen 358, Phosphorous 7, Potassium 309

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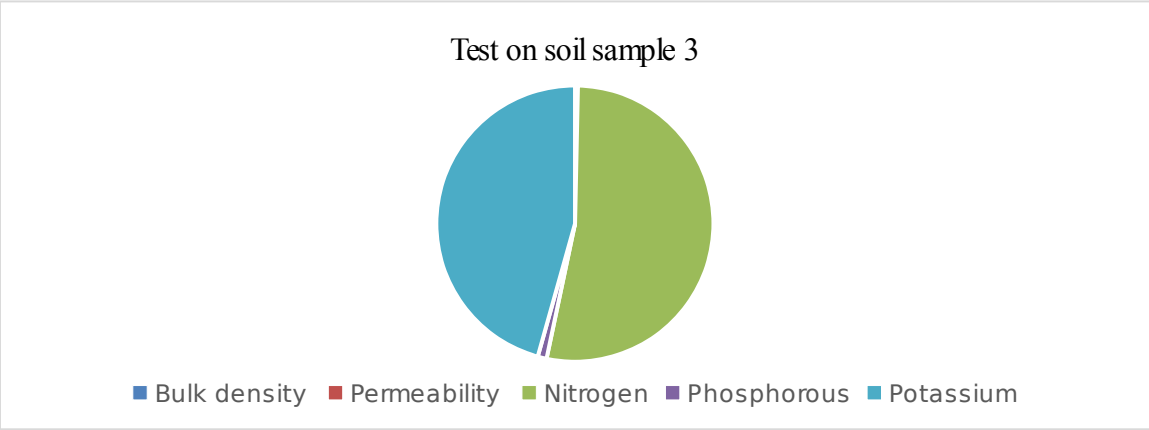

Figure 3.12: Test on soil sample 3

CONCLUSION

- The study reveals that coffee pulper effluent in site 1 contains high Total Dissolved solids and COD vales compared site 2 and 3
- The study results conclude that Nutrient contents are very high in effluent discharged sites.

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