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Evaluation of Antioxidant and Antimicrobial Activities of Coffee Husk Extract

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Abstract:
The antioxidant and antimicrobial activity of 70% (v/v) aqueous methanolic extract of coffee husk was evaluated. Extracts of coffee husk were prepared by refluxing the dried coffee husk with aqueous methanol (70% v/v), water, methanol, ethylacetate and hexane. Maximum amount of polyphenols in coffee husk extract (CHE) were obtained from aqueous methanol (70% v/v). Total phenolic content were determined using folin ciocalteu's method. Antioxidant activity of CHE was assayed through invitro models such as antioxidant capacity by iron (111) reduction method, β-caroteine-linoleate model system and free radical scavenging activity using2,2-diphenyl-1-picrylhydrazyl (DPPH) method.Addition of 1000 ppm of CHE to refined sunflower oil and storage at room temperature (22±3oc) for 80 days showed lower peroxide value (POV) and free fatty acid (FFA) content than control samples POV and FFA. Refined sunflower oil contains 100 ppm of butylated hydroxytoulene (BHT) and 1000 ppmof grean tea polyphenols (GTP) and 1000 ppm of rosemary showed POV of 55.0,112.07 and 109.9 meq oxygen/kg and FFA content of 0.87,1.02, 1.06 mg KOH/g, respectively after 80 days of storage at room temperature. The minimum inhibitory concentration of CHE required against E.coli, S.aureus, S.typhi and S.enterica were 850, 800, 950, 1100 ppm respectively.

Key words:
Coffee Arabica, Coffee Husk Extract, Antioxidant activity, Antimicrobial activity.

1. Introduction:
India is one of the major coffee producers in the world with approximate annual production of 27.52 x 103 tones/ year. It is grown in Western hill ranges of Southern peninsular of India, Coffee husk is a major agro-industrial residue obtained after removal of pulp and seed from fruitof coffee arabica and is estimated to yield 0.36 milliontones/ year (Sanjay Mande).

Major portion of coffee husk is available at the time of coffee harvest. This makes its collection easy but creates storage problem due to its low bulk density. Until recent past, the major application of coffee husk was to convert it into fuel and chemical feedstock through a variety of thermo chemical conversion process. Scrutiny of literature revealed that one methodology based on solid state fermentation (cultivation) to produce aroma (Soares, Christen, Pandey and Soccol, 2000; Medeiros, Pandey, Christen, Freitas, Fontoura and. Soccol, 2001) citric acid (Carlos, Soccol, Luciana, Vandenberghe, Cristine Rodrigues and Ashok Pandey. 2006) and edible mushroom flamulina (Leifa, Pandey and Soccol 2001) has beenreported. Coffee husk has no fertilizer value as it contains mostly lignocellulose but it contributes to the problem of environmental pollution. It contains organic solid residues such as caffine, tannins and polyphenols (Fan, Pandey and Soccol 1999) and these have not been utilized so far. Polyphenols are important constituents of plants and theycontribute directly to the antioxidant activity due to theirexcellent hydrogen donor property or have synergetic effects when used together with phenolic antioxidants (Pathirana, Shahidi and Alasalvar. 2006).

Antioxidants are compounds, which help to inhibit many oxidation reactions caused by free radicals. Free radicals are unstable molecules that include hydrogen atom, nitric oxide and molecular oxygen. They naturally occur in the human body as a result of chemical reaction duringnormal cellular processes. Reactive oxygen species (ROS) sometimes called as active oxygen species are variousforms of activated oxygen, which include free radicals suchas superoxide (O2-) and hydroxyl radical (OH), as well as non-free radical species such as hydrogen peroxide (H2O) (Duthie, Duthie and Kyle, 2000). Spoilage of food due to bacterial and fungal infection has been a major concern for decades and it causes a considerable loss Worldwide. The demand for non-toxic, natural antibacterial Substances hasbeen in greatdemand (Davies, 1994; Enne, More, Stephens and Hall, 2001; Poole, 2001).

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During past few years, there has been increasing interest in isolating and recovering important Componentsfrom agricultural Waste toadd value addition to the residues. The emergence of Sustainable developmentby encouraging Controlledexploitation of agriculturalwaste for economic gains will help to add value addition to the coffee husk.

2. Materials and methods

2. I. Chemicals

Methanol, ethyl acetate, ethanol, ethyl ether, sulphuric acid, acetic acid, chloroform, Folin and Ciocalteu's reagent, sodium carbonate were from Ranbaxy, India; gallic acid, 2,2-diphenyl-1-picrylhydrazyl (DPPH), butylatedhydroxytoulene (BHT), potassium iodide, potassium hydroxide, 3-carotene, linolenic acid, Tween 40 were from Sigma Chemicals, USA; potassium ferric cyanide, trichloroacetic acid, sodium phosphate, ammonium molybdate were from BDH, India; nutrient agar was from HiMedia, Mumbai. Green tea polyphenols (GTP) and rosemary were from Flavors and Essence Ltd. Mysore, India. Refined sunflower oil (Sun pure) was procured fromthe local market.

2.2. Instrumentation

Visible spectra measurements were done using Specord 50 UV-Vis spectrophotometer with 1.0-cm silica quartz matched cell.

2.3. Plant material

Well ripened coffee fruit was collected from coffee plantation of Western Ghats in India. The fruits were squeezed separated into pulp, seed and peel. Only the peelwas used as husk.

2.4. Sample preparation

Coffee peel was washed with water to remove the adhering pulp and dried in hot air oven at 60oC to remove moisture and the dried husk was ground into fine powder.The material that passed through a 40-mesh sieve was usedfor further studies.

2.5. Preparation of extract

Coffee husk (50 g) was transferred to a 1000 ml round bottom flask 200 ml of 70% (v/v) methanol was added and refluxed for 45 min at 80oC on a water bath. Theextract was filtered through filter paper and the residue was reextracted under the same conditions for five times.

The filtrate was combined and evaporated in a rotary evaporator below 60oC. The procedure was repeated using different solvents like hexane, ethyl acetate, methanol and water. The extract obtained after evaporation of organic solvents was analyzed for the content of polyphenols and the resultsare reported in Table l.

Table 1: Total phenolic content in CHE

Extracts	Polyphenols (%)	Polyphenols (%)after extraction with ethyl acetate
Hexane	1.13	3.54
Methanol	6.31	10.12
Ethyl acetate	4.21	4.21
Water	3.10	6.25
Methanol(70% w/v)	7.30	13.12

The extracts collected as above were reextracted 5 times with ethyl acetate, the combined ethyl acetate portion was evaporated in rotary evaporator below 60oC, Theextract after evaporation of ethyl acetatewas used as natural antioxidant, Percentage of polyphenols enrichedafter the above process is presented in table 1.

2.6. Determination of total phenolic content

The phenolic componentswere determined according to the procedure described by Negi, Jayaprakash and Jena (2003), Twenty milligrams of extract were dissolved in 50 ml of 50 % (v/v) methanol and filteredthrough Whatman no 44 filter paper. An aliquot of 0.4 ml of sample was taken in a 25-ml standard flask and mixed with 1 ml of Folin and Ciocalteu's reagent (1:10 dilutedwith water) and allowed to react for 5 min, 1 ml of 10%sodium carbonate was added and allowed to stand for 90min at room temperature, and the absorbance of thereaction mixture was read at 725 nm. Standard graph wasprepared using gallic acid. The content of total polyphenolsin the extract was calculated from the standard graph andexpressed as percent concentration in the extract,

2.7. Quenching of 2, 2-diphenyl-1-picrylhydrazyl (DPPH) radicas by CITE

The method described by Kitts, Wijewickreme and Hu (2000) was used to assess the DPPH radical scavenging capacity of CHE.

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A 0.1 mM DPPH solution in ethanol was mixed with 20, 40, 60, 80, 100 and 120 µg/ml of CHE and vortexed thoroughly, The mixtures were allowed to stand at ambient temperature (22±3 oC) for 30 min. The absorbance was measured at 519 mm using a spectrophotometer.The scavenging percentage was calculated according to the following equation.

$$\text{Scavenging, \%} = \frac{\{(\text{Abs Control} - \text{Abs Sample}) \text{ X } 100}{\text{Abs Control,}}$$

2,8. Antioxidantactivity assay using sunflower oil

Refined sunflower oil, free of additives, was used asthe substrate for oxidation studies. Sunflower oil samplescontaining 1000 ppm of CHE and natural antioxidants(GTP and rosemary) were separately prepared. Each 250ml prepared oil sample was placed in a 500 ml brownairtight glass bottle. Synthetic antioxidants (BFIT) weremixed with the oil for comparative study at their permittedlegal limits of 100 ppm (Duh and Yen, 1997). Controlsamples of sunflower oil without antioxidant were alsoplaced under identical conditions. All oil samples in eachtreatment were prepared in triplicate and were stored at room temperature (22 ±3oC) for 80 days. Oil samples from each treatment were withdrawn periodically to assess theantioxidant activity of CHE.

2.8.1. Antioxidant activity measurement

The rate of oxidation was followed by periodic determination of POV of stored oils. Each sample (l g) was put into 250-ml Erlenmeyer flasks and dissolved in a mixture of 25 ml of acetic acid/chloroform (3:2, w/v).Saturated solution of potassium iodide (l ml) was addedand the flask was placed in a dark chamber for 5 min, after which 75ml distilled water was added. The liberated iodine was titrated with a sodium thiosulfate solution (0.01 M) inthe presence of starch indicator (AOAC, 1990).

2.8.2. Free fatty acid content

Free fatty acid content was determined at regularintervals in stored sunflower oil. Ten grams of each sample were weighed into an Erlenmeyer flask and 50 ml of ethanol/ethyl ether (l:l v/v) mixture were added. This suspension was titrated with 0.1M potassium hydroxide (KOH), using 1 ml of phenolpthalein indicator, until faint permanent pink color persisting for 30 sec was obtained. (AOAC, 1990).

2.9. Antioxidant assay using β-caroteine-linoleatemodel system

The antioxidant activity of CHE was evaluated usingβ-caroteine-linoleatemodel system as described by jayaprakasha, Sing and Sakariah (2001), β-carotenc (0.2 mg) in 0,2 ml of chloroform, 20 mg of linolenic acid and 200 mg of Tween-40 (polyoxyethylene sorbitanmonopalmitate) were mixed. Chloroform wasremoved at40°C under vacuum and the resulting mixture was diluted with 10 ml of Water and was mixed well. To this 40 ml ofoxygenated water was added. Four milliliter aliquots of theemulsion were pipetted into different test tubes containing0.2 ml CHE (100, 200, 300, 400 µg) and BHT (100, 200, 300,400 µg) in ethanol. BHT was used for the comparative study. A control containing 0.2 ml of ethanol and 4 ml ofthe above emulsion was prepared. The tubes were placed in 50oC in water bath and the absorbance at 470 nm was takenat zero time (t = 0 min). Measurement of absorbance was continued till the color of β-caroteine disappeared in the control tubes (t=120 min) at an interval of 15 min. A mixture prepared as above without β-caroteine served asblank. All determinations were carried out in triplicates. The antioxidant activity (AA) of the extract was evaluatedbased on the extent of bleaching of the β-caroteine using the formula.

$$AA = \frac{100\ [1 - (A_o - A_t)]}{[A_0^o - A^0_t]}$$

Where, Ao and A0oare the absorbance values measured atzero time of the incubation for test sample and control, respectively. At and A0tare the absorbance measured in testsample and control after incubation for 120 min.

2.10. Reducing power of CHE

The reducing power of CHE was determinedaccording to the method of Oyaizu (l986). Differentamounts of extract (0.24, 0.60, l.20, 1.80, 2.40 mg/ml) in water were mixed with phosphate buffer (2.5 ml, 0.2 M, pH 6.6) and potassium ferricyanide [K3Fe(CN)6] (2.5 ml, 1%). The mixture was incubated at 50oC for 20 min. A portion (2.5 ml) of trichloroacetic acid (10%) was added to the mixture and centrifuged for 10 min. The upper layer of solution (2.5 ml) was mixed with distilled water (2.5 ml) and FeCl3 (0.5 ml, 0.1 %), and the absorbance wasmeasured at 700 nm. Absorbance of the reaction mixtureincreased with the increase in reducing power.

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2.11. Antibacterial activity

Bacterial cultures ofEscherichia coli (Gram -ve), Staphylococcus aureus (Gram +ve), Salmonella typhi (Gram -ve) and Salmonella enterica were obtained from Defense-Food Research Laboratory, Mysore, India, The cultures were grown in nutrient agar (HiMedia, Mumbai India), at 37°C. Each bacterial strain was transferred from,stored slants at 4 -5°C to 10 ml broth and cultivateovernight at 37°C. A preculture was prepared by transferring 1 ml of this culture to 9 ml broth and cultivate for 48 h, The cells were harvested by centrifugation (1200g, 5 min), Washed and suspended in saline. The CHE was tested against the bacteria by the method of Negi, Jayaprakah, Rao and Sakariah (1999). To flaks containing 20 ml melted cool agar, different concentrations of test material in Tween 40 were added.Equivalent amounts of Tween 40 were used as Controls. One hundred microliter (about 103 cfu/ml) of each bacterium to be tested Was inoculated into the flaks under aseptic conditions. Themedia were then poured into sterilized Petri plates in duplicate and incubated at 37°C for 20-24 h. The colonies, after the incubation period were counted and expressed as colony forming units per ml of culture (cfu/ml). The minimum inhibitoryconcentration (MIC) was reported as the lowest concentration of the CHE required for inhibiting the complete growth of the bacterium being tested.

3. Results and discussion

The % yields of CHE in hexane, ethyl acetate, methanol, water and aqueous methanol (70% w/v) solvents were 2.5, 4.5, 8.5, 5.6 and 17.9, respectively. The total polyphenols contents of CHE as determined by Folin-Ciocalteu method are reported as gallic acid equivalents (Table l). Amongst the solvents used aqueous 70% (v/v) methanol gave the highest yield of polyphenolic extract. The order of the efficiency of the solvents examined is aqueous methanol (70% v/v)> methanol >ethylacetate >water > hexane. The total phenolics determined are not absolute measurements but are based on their chemical reducing capacity relative to gallic acid. In the present study the responses of the CHE may arise from the variety and/ orquantity of phenolics found in extracts of coffee husk.

3.1. Free radical scavenging activity of CHE

The scavenging activity of CHE phenolics compared to gallic acid for DPPH radical is shown in Table 2. The results indicate a concentration-dependent scavenging activity of the DPPH radical.

Further it was found that the scavenging activity of CHE was found to bemaximum at 120 g/ml and it was 81.82%.

Table 2: Percent radical-scavenging activity on DPPHby CHE and gallicacid

Extract concentration ug/ml	CHE (% scavenging)	Gallic acid (% scavenging)
20	39.10±0.84	94.13±0.42
40	55.41±1.01	94.71±0.25
60	73.32±1.14	94.34±0.34
80	77.10±0.95	94.83±0.25
100	80.01±1.00	94.71±0.27
120	81.82±1.09	94.82±0.41

Mean values Standard Deviations (n=3)

3.2. Antioxidant activity of CHE in refined sunflower oil

Oxidation of lipids is undesirable as it affects theflavor, aroma, nutritional quality and even the texture of aproduct. The chemicals produced by the oxidation of lipidsare responsible for rancid flavor and aroma. BHT, GTP and rosemary are commonly used antioxidants BHT is a synthetic while GTP and rosemary are natural antioxidants. We have determined the antioxidant property of CHE and compared the values with the three reference antioxidants. The data presented in Table 3 and 4 manifest that CHE has antioxidant properties comparable to that of GTP and rosemary. However, CHE was found to be not as powerful as that of BHT in its antioxidant activity. The decrease in FFA and POV clearly indicates that auto oxidation of Sunflower oilwas greatly inhibited by the CHE. This study revealed thatthe extract can be used as natural antioxidant at little higherconcentration compared to natural antioxidants like GTPand rosemary studied.

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3.3. Antioxidant activity using β-carotene-linoleatemodel system

The data regarding the antioxidant activity using β-carotene-linoleate model system of CHE at 100, 200, 300and 400 µg concentrations are presented in Table 5. Addition of CHE and BHT prevents the bleaching ofβ-carotene to different degrees. β-caroteine depending upontheir concentration undergoes rapid discoloration in the absence of an antioxidant. This is due to the coupledoxidation of β-carotene and linolenic acid, which generatesfree radicals. The linolenic free radicals formed uponthe abstraction of a hydrogen atom from one of its diallylicmethylene groups attacks the highly unsaturated β-carotene molecules. As a result, β-carotene gets oxidizedand broken down in part, subsequently the system looses itschromophore and characteristic orange color; this can bemonitored spectrophotometrically. In the present study, the CHE was found to hinder bleaching of β-carotene byneutralizing the linoleate free radical and other free radicals formed in the system. CHE showed 91 % antioxidantactivity when used at 400 µg concentrations.

Table 3: Effect of synthetic antioxidant BHT (100 ppm), natural antioxidants GTP (1000 ppm) and rosemary (1000 ppm) and CHE (1000 ppm) on peroxide value (mmol oxygen / kg) during storage of sunflower oil.

Storage period days	Control	BHT	GTP	Rosemary	Coffee husk
1	7.60 ± 1.10	6.98 ± 1.07	7.23 ± 1.14	7.22 ± 1.07	7.23 ± 1.17
5	15.76 ± 1.35	9.77 ± 1.17	13.91 ± 1.58	9.96 ± 1.45	13.01 ± 0.98
10	30.89 ± 1.88	12.62 ± 1.82	20.21 ± 1.18	21.19 ± 1.04	20.40 ± 1.40
15	33.50 ± 2.41	13.10 ± 1.18	27.60 ± 1.78	30.88 ± 2.57	30.36 ± 1.47
20	44.12 ± 1.92	15.77 ± 1.67	36.85 ± 1.47	37.24 ± 1.48	39.06 ± 1.52
25	49.72 ± 2.15	16.85 ± 1.87	41.15 ± 2.17	46.60 ± 2.40	47.10 ± 1.91
30	62.44 ± 2.31	17.29 ± 1.92	45.57 ± 2.47	52.78 ± 1.82	51.03 ± 2.48
35	70.34 ± 2.14	18.59 ± 1.97	51.33 ± 2.38	65.95 ± 2.48	58.19 ± 2.27
40	73.79 ± 1.85	21.15 ± 1.98	53.18 ± 2.12	72.82 ± 2.17	62.61 ± 2.52
45	78.17 ± 2.41	25.71 ± 1.67	57.36 ± 2.18	77.30 ± 2.30	70.54 ± 2.54
50	88.55 ± 1.98	31.18 ± 1.18	68.88 ± 2.17	82.51 ± 1.68	85.06 ± 2.48
60	114.61 ± 1.84	41.87 ± 1.95	80.76 ± 2.08	87.76 ± 2.32	104.33 ± 1.68
70	144.12 ± 1.58	46.37 ± 1.10	92.30 ± 2.14	99.33 ± 1.97	108.15 ± 1.55
80	161.58 ± 1.68	55.00 ± 1.05	112.07 ± 2.11	109.09 ± 2.06	130.47 ± 1.53

Mean values ± Standard Deviations (n=3)

Table 4: Effect of synthetic antioxidant BHT (100 ppm), natural antioxidants GTP (1000 ppm) and rosemary (1000 ppm) and CHE (1000 ppm) on FFA (mg KOH/g sample) during storage of sunflower oil.

Storage period days	Control	BHT	GTP	Rosemary	Coffee husk
1	0.24 ± 0.02	0.25 ± 0.04	0.24 ± 0.03	0.24 ± 0.05	0.25 ± 0.05
5	0.27 ± 0.03	0.28 ± 0.03	0.28 ± 0.02	0.26 ± 0.04	0.28 ± 0.01
10	0.36 ± 0.01	0.33 ± 0.03	0.31 ± 0.04	0.32 ± 0.02	0.34 ± 0.02
15	0.41 ± 0.02	0.40 ± 0.02	0.38 ± 0.03	0.40 ± 0.05	0.41 ± 0.05
20	0.47 ± 0.05	0.46 ± 0.05	0.42 ± 0.01	0.47 ± 0.04	0.48 ± 0.05
25	0.52 ± 0.01	0.49 ± 0.04	0.47 ± 0.02	0.54 ± 0.04	0.55 ± 0.07
30	0.56 ± 0.04	0.54 ± 0.06	0.50 ± 0.05	0.59 ± 0.06	0.59 ± 0.05
35	0.62 ± 0.06	0.60 ± 0.08	0.53 ± 0.07	0.64 ± 0.10	0.66 ± 0.07
40	0.71 ± 0.07	0.64 ± 0.05	0.58 ± 0.07	0.71 ± 0.07	0.73 ± 0.09
45	0.81 ± 0.06	0.68 ± 0.09	0.62 ± 0.09	0.77 ± 0.09	0.80 ± 0.08
50	1.02 ± 0.11	0.70 ± 0.08	0.69 ± 0.11	0.80 ± 0.08	0.88 ± 0.12
60	1.04 ± 0.09	0.76 ± 0.12	0.81 ± 0.10	0.88 ± 0.11	0.95 ± 0.11
70	1.23 ± 0.08	0.83 ± 0.09	0.91 ± 0.12	0.96 ± 0.12	0.99 ± 0.12
80	1.27 ± 0.11	0.87 ± 0.09	1.02 ± 0.11	1.06 ± 0.12	1.01 ± 0.09

Mean values ± Standard Deviations (n=3)

Table 5 :Antioxidant activity of extract from CHE and BHA by β -carotene-linoleate model system

Sample	Concentration (µg)	Antioxidant activity (%)
CHE	100	58.21 ± 0.84
	200	79.30 ± 0.41
	300	88.10 ± 0.41
	400	91.03 ± 0.97
BHT	100	89.61 ± 0.09
	200	95.14 ± 0.14
	300	96.13 ± 0.11
	400	96.03 ± 0.05

Mean values ± Standard Deviations (n=3)

3.4. Reducing power

Table 6 shows the reducing capacity of CHE compared to BHT. For this we investigated the Fe3+/Fe2+ transformation in the presence of CHE, using the method of Oyaizu (1986). Earlier authors (pin- Der-Dhu, 1998; Pin-Der-Duh, Pin- Chan-Du and Gow-Chin Yen 1999;Tanaka, Kuie, Nagashima and Taguchi, 1998) haveobserved a direct correlation between antioxidant activity and reducing power of certain plant extracts. The reducing properties are generally associated with the presence ofreductones (Pin-Der-Duh, 1998), which have been shownto exert antioxidant action by breaking the free radicalchain by

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donating a hydrogen atom (Gordon, 1990). Reductones also react with certain precursors of peroxide, thus preventing peroxide formation. The data (Table6) on the reducing power of CHE suggests that it is likely to contribute significantly towards the observed antioxidant effect. Like the antioxidant activity, the reducing power ofCHE increased with increasing amount of Sample.However, the reducing power of BHT wasrelatively more pronounced than that of CHE.

Table 5 : Reducing power of CHE at different concentration

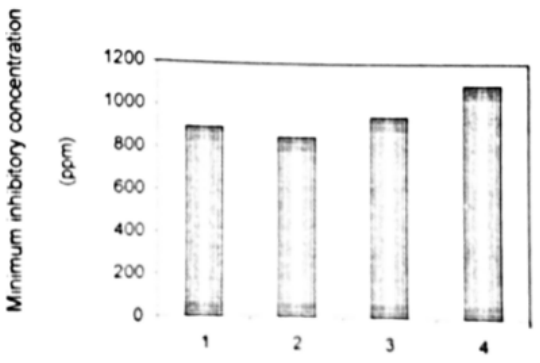
Amount of CHE (µg/ml)	Absorbance at 700nm	
	CHE	BHT
00	0.01 ± 0.01	0.01 ± 0.00
50	0.08 ± 0.01	0.18 ± 0.04
100	0.17 ± 0.03	0.38 ± 0.01
150	0.28 ± 0.00	0.58 ± 0.01
200	0.37 ± 0.04	0.62 ± 0.01
250	0.46 ± 0.02	0.73 ± 0.04
300	0.55 ± 0.01	0.85 ± 0.01

Mean values ± Standard Deviations (n=3)

3.5. Antimicrobial activity

The effect of CHE on the growth of four different bacteria is presented in Figure 1. CHE inhibited growth of bacteria to variable extent, depending on the bacterium in question. CHE was more effective against S. aureus and at 800 ppm complete inhibition of bacterial growth was observed and this was followed by E.coli, S. typhi and S.enterica which required 850, 950, 1100 ppm, respectively for complete growth inhibition.

Fig 5 : The effect of CHE on the growth ofby E.coli (1), S. aureus (2),S. typhi (3) and S.enterica (4).



4. Conclusion

First-ever studies on coffee husk have been carriedout to recover potential polyphenols which havedemonstrated antioxidant and antimicrobial properties. The study has been carried out to develop natural and costeffective material from agro-industrial residue. Theextraction procedure adopted has indicated high antioxidantand antibacterial activity. Further studies are in progress individual phenolicregarding the characterization ofunderlyingcompounds and to elucidate the mechanismbioactive properties and existence of possible synergism, ifany, among these compounds. In summary, agriculture is a predominant sector of World's economy and has reached a plateau through the use of external input-intensive technologies. These technologies helped to increase demand of feed, food and functional foods for teeming billions, but, such technologies are resource degrading and environmental polluting. In such a situation, agricultural production cannot sustain for an everlasting period. Thus, for sustainable agricultural development there is an urgent need for an effective management of agricultural waste. Reuse, regeneration and recovery are the three componentsof recycling-one of the important curative approaches inenvironmental management.

References

AOCS (1990), Official method of analysis (15thed.). Washington, DC: Association of Official Analytical Chemists.

Medeiros, A.B.P., Pandey, A., Christen, P., Freitas, R.J.S., Fontoura, P.S.G. and Soccol, C.R. (2001). Aroma compounds produced by Kluyveromyces marxianus in solid-state fermentation on packed bed column bioreactor, World Journal of Microbiology Biotechnology, 17, 767-771.

Davies, J. (1994). Inactivation of antibiotics and dissemination of resistant genes. Science, 264, 375-382.

Duh, P.D. and Yen, G.C. (1997). Antioxidant efficacy of methanolic extracts of peanut hulls in soybean and peanut oils. Journal of American Oil Chemical Society, 74,745-748.

Duthie, G.G., Duthie, S.J. and Kyle, J.A.M. (2000). Plant polyphenols in cancer and heart disease: implications as nutritional antioxidants. Nutrition research reviews, 13, 79-106.

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

Enne, V. I., More, D.M. L., Stephens, P. and Hall, L. M. C. (2001). Persistance of sulphonamide resistance in Escherichia coli in the U.K. despite national prescribing restriction. Lancet, 28,325-1328.

Fan, L., Pandey, A. and Soccol, C. R. (1999), Cultivation of Pleurotus species on coffee residues Proc. 3rd International conference on Mushroom Biology and Mushroom Products and AMGA's 26thNational Mushroom Industry Conference October 12-16, Sidney,301-310.

Gordon, M. H. (1990). The mechanism of antioxidant action in vitro. In B. J. F. Hudson (Ed.), Food antioxidants (pp. 1-18). London: Elsevier Applied Science.

Jayaprakasha. G.K., Singh, R.P. and Sakiariah, K.K. (2001). Antioxidant activity of grape seed (Vitis vinifera). Food Chemistry, 73, 285-290.

Kitts, D.D., Wijewickreme, A.N. and Hu, C. (2000). Antioxidant properties of a North American Ginseng extract. Molecular and Cellular Biochemistry, 203, 1-10.

Leifa, F., Pandey, A. and Soccol, C.R. (2001). Production of Flammulina velutipes on Coffee Husk and Coffee Spent-ground, Brazilian Archives of Biology and Technology, 44, 205-212.

Medeiros, A.B.P., Pandey, A., Christem, P., Freitas, R.J.S., Fontoura, P.S.G., and Soccol, C.R. (2001). Aroma compounds produced by Kluyveromycesmarxianus in solid-state fermentation on packed bedcolumn bioreactor, World Journal of Microbiology Biotechnology, 17, 767-771.

Negi, P.S. Jayaprakasha, G.K., Rao, L.J.M. and Sakariah, K.K. (1999). Antibacterial activity ofturmeric oil-a by-product from Curcumin manufacture. Journal of Agricultural and Food Chemistry, 47, 4297-4300.

Negi, P.S., Jayaprakasha, G.K. and Jena, B.S. (2003). Antioxidant and antimutagenic activities of pomegranate peel extracts. Food Chemistry, 80,393-397.

Oyaizu, M. (1986). Studies on product of browning reaction prepared from glucose amine, Japanese Journal of Nutrition, 44, 307-315.

Pathirana, C.M.L., Shahidi, F. and Alasalvar, C. (2006). Antioxidant activity of cherry laurel fruit (Laurocerasus officinalis Roem) and its concentrated juice. Food Chemistry, 99, 121-128.

Pin- Der-Dhu, X. (1998). Antioxidant activity of burdock (Arctium lappa Linne): its scavenging effect on free-radical and active oxygen. Journal of American Oil Chemists Society. 75,455-461.

Pin-Der-Duh X., Pin-Chan-Du. X. and Gow-Chin Yen. X. (1999) Action of methanolic extract ofmung hulls as inhibitors of lipid peroxidation and non-lipid oxidative damage. Food and Chemical. Toxicology, 37, 1055-106l.

Soares, M., Christen, P., Pandey, A. and Soccol, C.R. (2000). Fruity flavour production by ratocystis fimbriata grown on coffee husk in solid-state fermentation, Process Biochemistry, 35, 857-86.

Soccol, C.R., Luciana, P.S., Vandenberghe, Rodrigues, C. and Pandey, A. (2006). New Perspectives for citric acid production and application.Food Technology and Biotechnology. 44 (2), 141-149.

Tanaka, M., Kuie, C.W, Nagashima, V. and Taguchi, T. (1988). Applications of antioxidative Maillard reaction products from histidine and glucose to sardine products. Nippon Suisan Gakknishi. 54, 1409-1414.

Sanjay Mande, Biomass gasifier-based power plants: potential, problems, and research needs for decentralized rural electrification. The energy and resource institute New Delhi.