International Journal of Research
Available at https://journals.pen2print.org/index.php/ijr/
e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 06 Issue 04
April 2019

# Evaluation of Antioxidants and Anti-Cancer properties of selected Medicinal Plants

Hasan Falah Hasan Alwashm & Dr. A. Krishna Satya
*1 M.Sc., (Nano Biotechnology) 2 , Assistant Professor*
*1,2 Department of Bio Technology*
*Acharya Nagarjuna University, Andhra Pradesh, India*
Email: 07700087053a@gmail.com

**Abstract**

*Cancer is a disease which severely effects the human population. Cancer is a group of diseases involving abnormal cell growth with the potential to invade or spread to other parts of the body .There is a constant demand for new therapies to treat and prevent this life-threatening disease. Scientific and research interest is drawing its attention towards naturally-derived compounds as they are considered to have less toxic side effects compared to current treatments such as chemotherapy. The medical plants such as cinnamon , green tea and turmeric produce naturally effect occurring secondary metabolites which are being investigated for their anticancer and antioxidant activities leading to the development of new clinical drugs. With the success of these compounds that have been developed into staple drugs for cancer treatment new technologies are emerging to develop the area further . The aim to enhance anticancer and antioxidant activities of plant-derived drugs by controlling the release of the compound and investigating new methods for administration . Although many biological activities including antioxidant and anticancer properties have been reported . the antioxidant and anticancer effects were evaluated by using The MTT activity , DPPH radical scavenging activity, ABTS radical scavenging activity and Hydroxyl radical scavenging assay . This review discusses the demand for naturally-derived compounds from medicinal plants and their properties which make them targets for potential anticancer and antioxidant treatments.*

**Keywords: Cancer, Ayurveda, Inflamation,**

## Introduction

Cancer is a disease characterized by unregulated proliferation of cells. Natural products have been regarded as an important source that could contribute to potential chemotherapeutic agents. In particular, plant derived compounds have gained importance in anticancer therapy and some of the new chemotherapeutic agents currently available for use includes paclitaxel, vincristine, podophyllotoxin, and camptothecin (Mitra et al., 2012). Spices and herbs are well known for their antimicrobial and antioxidant properties, besides having the ability to produce multidimensional flavours in food (Bonillaet al., 2012; Hoqueet al., 2011; Tongnuanchan et al., 2012). Weerakkody et a., (2010) concluded that there was a highly positive linear relationship between the antioxidant and antibacterial activities and the total phenolic content in some spices and herbs. According to Moure et al., (2001), of the different parts of the plant, the leaves deserve especial attention, as well as the roots and seeds, due to their antioxidant activity, detected and reported in several studies (Bonilla and Sorbal, 2017).

Curcuma longa, a perennial herb and member of theZingiberaceae (ginger) family, grows to a height of three to five

feet and is cultivated extensively in Asia, India, China, and other countries with a tropical climate (Dobelis, 1986). Curcumin, a polyphenol with a diarylheptanoid structure that contains two $\alpha$, $\beta$-unsaturated ketones, is considered to be the majoractive constituent of turmeric. The chemical properties andthe historical background of Curcumin have been reviewed elsewhere (Sharma et a., 2005; Agarwal et al., 2003). This nontoxic natural compound hasbeen reported to possess several biological activities that are therapeutically beneficial to cancer treatment. Turmeric issued extensively in foods for its flavor and color, as well ashaving a long tradition of use in the Chinese and Ayurvedic systems of medicine, particularly as an anti-inflammatory, and for the treatment of flatulence, jaundice, menstrual difficulties, hematuria, hemorrhage, and colic (Ravindranatha and Chandrashekhara, 1980; Wahlstrom and Blennow, 1978). Turmericcan also be applied topically in poultices to relieve painand inflammation. The active constituents of turmeric arethe flavonoid Curcumin. Current research has focused on Curcumin antioxidant, hepatoprotective, anti-inflammatory,anticarcinogenic, and antimicrobial properties, in additionto its use in cardiovascular disease and gastrointestinaldisorders (Dikshith et al., 1995; Toda et al., 1985).

The traditional knowledge on the use of cinnamon for a variety of diseases has been scientifically proven by many researches. Cinnamomum zeylanicum has been reported to have many biological activities such as being an antioxidant (Prasad et al., 2009), antimicrobial and anticancer (Unlu et al., 2010), anti-inflammatory (Chao et al., 2008), antidiabetic (Adisakwattana et al., 2011), anti-mutagenic (Jayaprakasha et al., 2007) and anti-tyrosinase (Marongiu et al., 2007). However, none of these activities are reported from Sri Lanka and there is no evidence for whether those are from Ceylon cinnamon, including for antioxidant activity. Limited research has also been conducted worldwide onCinnamomum leaf as a natural antioxidant.

In ancient times, cinnamon (from the Greekkinamon), also known as a sweet wood, was greatly treasured by Egyptians, Israelites and Phoenicians.It was commonly used as a body perfume and medicine, and proclaimed as one of the maningredients in the love potions prepared by theGreek and Romans as well. Several varieties ofcinnamon can be distinguished, but only two typesre generally used: Cassia (Chinese cinnamon) andCanela (Ceylon cinnamon) Raghavan, 2007).Cinnamomum cassia (Lauraceace) belongs toan evergreen tree originating in southern China, andwidely cultivated in the countries of southern andeastern Asia (India, Malaysia, Thailand, Vietnam,Indonesia, and Laos) (Yan et al., 2015). Cassia is characterized bya sweet spicy aroma, more pungent bitter taste andthicker bark than Ceylon cinnamon (Li et al., 2013). The driedbarks of Cassia are not only known as a spice andflavoring agent, but also are regarded as a traditionalmedicine in the world (He et al., 2016). It is commonly used forthe treatment of amenorrhea, rheumatoid arthritis,cardiac palpitation, diarrhea, and gastrointestinalneurosis (He et al., 2016; Lin et al., 2003). Pharmacological studies have demonstratedthat Cassia cinnamon possesses antidiabetic (Kumar et al., 2014; Andrew 2013), antioxidant, antibacterial (Haung et al., 2014),antifungal (Giordani et al., 2006), antiulcer (de Assis Oliveira, 2014), antihyperlipidemic (Mhammad et al., 2015), and analgesic activity (Yan et al., 2015; Wu and Jia, 2012). Recently, anincreasing number of investigations on antioxidantactivity of spices have been reported (Brodowska et al., 2014, 2015; Stoilova et al., 2007; Spiridon et al., 2011).

Cinnamon has been extensively researched since it has many benefits for human life. The plants spread across Southeast Asia, China and Australia with different types and varieties such as true cinnamon and Cinnamomum zeylanicum from Srilanka; Cassia cinnamon from China and Vietnam; Cinnamomum tamala from India and Myanmar (Burma); and Cinnamomum burmannii from Indonesia. Indonesian cinnamon is especially found in the area of Sumatra and Java islands (Ravindran et al., 2004). Cinnamon bark is one of the most popular herbs utilized as a spice in cooking. In addition, its processed products in the form of essential oils and oleoresins have been widely used in pharmaceutical, cosmetic, food, beverage, and cigarette industries; also in traditional and modern medicine (Heyne, 1987; Sangal, 2011). Several compounds of cinnamon, include essential oil, eugenol, safrole, cinnamaldehyde, tannin, and calcium oxalate. Cinnamaldehyde is potential antioxidant compounds with the ability to scavenge free radicals (Thomas and Duethi, 2001).

Tea is produced from the leaves and buds of the Camellia sinensis (Theaceae) plant, and is one of the world's most popular beverages. Tea can be broadly classified according to the production method as green tea, oolong tea, black tea, or pu-erh tea. Green tea is mainly consumed in Japan and China, whereas black tea is primarily consumed in Western countries, India, and other parts of the world (Hayakawa et al., 2016)

Green tea (Camellia sinensis, Theaceae) is the most widely consumed beverage, followingwater (Yang et al., 2009), and may have cancer preventive effects in vivo. Polyphenols in green tea arethought to be responsible for the cancer preventive effects observed in laboratory andepidemiological studies. Green tea and green tea polyphenols have been shown to have anti-cancer activity in anumber of laboratory studies, which could be mediated through antioxidant or pro-oxidantmechanisms. Green tea polyphenols such as EGCG inhibit cell viability and induceapoptosis in a number of cancer cell lines such as osteogenic sarcoma (Ji et al., 2006), lymphoblastoidcells (Noda et al., 2007), leukemia cells (Nakazato et al., 2005), melanoma cells (Nihal et al., 2005), T lymphocytes (Li et al., 2000), and larynxcarcinoma (Lee et al., 2010). EGC can inhibit breast cancer cell viability through induction of apoptosis,yet not in normal breast cells (Vergote et al, 2000). Apoptosis by green tea polyphenols may occurindependent of caspase-3 induction, through activation of p53 (Lee et al., 2010). Evidence for cell cyclemodulation also exists. EGCG in green tea causes a reduction in cell viability through G1growth arrest in human breast cancer cells (Kavanagh et al., 2001; Lin et al., 1999), which likely occurs through suppression of cyclin D1 (Nihal et al., 2005). Green tea polyphenols can even cause differentiation of cancer cells intoslower proliferating cells (Zhou et al., 2004). Since, the literature shows that turmeric, cinnamon and green tea are good source of antioxidants , there by inducing anti-cancer activities, the objectives of the present study includes:

1.Testing the anti-cancer properties of turmeric, cinnamon and green tea on breast cancer (MCF-7) cell lines.

2.Testing the anti oxidant properties of turmeric, cinnamon and green tea.

3.Characterization of turmeric, cinnamon and green tea extracts by HPLC method.

## MATERIALS AND METHODS

Plant selection and extraction of phytocompounds

Based on the review of literature, turmeric, cinnamon and green tea leaves were

procured from local medicinal plant depot. The samplers were completely shade dried and 10g dry weight of samples were powdered and used for extraction. Extraction was carried out by conventional decoction method using analytical grade methanol for 4hrs. the samples were then filtered and evaporated to obtain the crude extracts of the samples.

Cytotoxicity Studies By MTT Assay:
For cytotoxicity studies,MCF-7 cell line was procured from ATCC, stock cells was cultured in DMEM supplemented with 10% inactivated Fetal Bovine Serum (FBS), penicillin (100 IU/ml), streptomycin (100 µg/ml) in a humidified atmosphere of 5% CO2 at 37oC until confluent. The cell was dissociated with cell dissociating solution (0.2 % trypsin, 0.02 % EDTA, 0.05 % glucose in PBS). The viability of the cells are checked and centrifuged. Further, 50,000 cells /well was seeded in a 96 well plate and incubated for 24 hrs at 37oC, 5 % CO2 incubator. 32mg/ml stocks were prepared using DMSO. Serial two fold dilutions were prepared from 3.2mg/ml to 10mg/ml using DMEM plain media for treatment. 320µg/ml, 160µg/ml, 80µg/ml, 40µg/ml, 20µg/ml, 10µg/ml were used as test concentrations. The monolayer cell culture was trypsinized and the cell count was adjusted to 5.0 x 105 cells/ml using respective media containing 10% FBS. To each well of the 96 well microtiter plate, 100 µl of the diluted cell suspension (50,000cells/well) was added. After 24 h, when a partial monolayer was formed, the supernatant was flicked off, washed the monolayer once with medium and 100 µl of different test concentrations of test drugs were added on to the partial monolayer in microtiter plates. The plates were then incubated at 37oC for 24hrs in 5% CO2 atmosphere. After incubation the test solutions in the wells were discarded and 100 µl of MTT (5 mg/10 ml of MTT in PBS) was added to each well. The plates were incubated for 4 h at 37o C in 5% CO2 atmosphere. The supernatant was removed and 100 µl of DMSO was added and the plates were gently shaken to solubilize the formed formazan. The absorbance was measured using a microplate reader at a wavelength of 590 nm. The percentage growth inhibition was calculated using the following formula and concentration of test drug needed to inhibit cell growth by 50% (IC50) values is generated from the dose-response curves for each cell line.% Inhibition calculated by using following formula:

ABTS Radical Scavenging Assay
The assay is performed as per Auddy (2003). Different concentrations of the test sample and the reference standard Quercetin(highest volume taken was 25l) are added to 225l of ABTS working solution to give a final volume of 1ml, made up by adding PBS. The absorbance is recorded immediately at 595nm. The percent inhibition is calculated at different concentrations and the IC50 values are calculated using Graph pad prism software. Percentage growth inhibitioncalculated by using following formula:

DPPH Radical Scavenging Assay:
DPPH assay was carried out as per the method of Rajakumaret al., 1994. In brief, 80l of DPPH solution; various concentration of test solution and quantity sufficient to 240 lwith HPLC grade methanol. The different concentrations tested for reference standard are 0.3125, 0.625, 1.25, 2.5, 5, 10 µg/ml. The different concentrations tested for test samples are 15.625, 31.25, 62.5, 125, 250 and µg/ml. The reaction mixture is mixed and incubated at 25°C for 15 minutes. The absorbance is measured at 510nm using semi-autoanalyzer. A control reaction is carried out without the test

International Journal of Research
Available at https://journals.pen2print.org/index.php/ijr/
e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 06 Issue 04
April 2019

sample. Percentage growth inhibition calculated by using following formula:

Determination of Catalase Activity

Catalase assay was carried using Abnova Catalase assay kit (Cat No: KA0884). 5 µl of 0.88M H2O2was diluted into 215 µl dH2O to generate 20 mM H2O2, then take 50 µl of the 20 mM H2O2 and diluted into 0.95 ml dH2O to generate 1 mM H2O2. Add 0, 2, 4, 8, 16 µl of 1 mM H2O2 solution into 96-well plate to generate 0, 2, 4, 6, 8, 16 nmol/well H2O2 standard. The final volume adjusted to 90 µl with Assay Buffer. 10 µl Stop Solution was added into each well.

78 µl samples and 12 µl fresh 1 mM H2O2 were added to each well and OD recorded immediately at 570nm absorbance (A-before). Incubated at 25°C for 30 min and OD taken at 570nm (A-after).

Hydroxyl radical scavenging assay

The deoxyribose assay is performed as described by Halliwell et al., (1987).The reaction volume of 1.0 mL was contained 5.6 mM deoxyribose, 2.8 mM H2O2 , 40 M FeCl3 , 100 M EDTA, and varying concentrations of the sample in 2.5 mM phosphate buffer, pH 7.4. Initiation of the reaction was by the addition of 0.1 mM Ascorbic acid. The mixture was incubated for 90 minutes at 37C. After incubation, 1 mL of TBA (0.7% in 0.05 N KOH) and 1 mL of 2.5% TCA was added. The mixture was heated at 100C for 8 minutes, cooled and the pink color formed is measured at 532 nm. Controls were devoid of test samples. Catechin was used as the reference standard. The percentage inhibition of hydroxyl radicals is calculated as follows:

$$\% \text{ inhibition} = \frac{\text{Absorbance (control)} - \text{Absorbance (test sample)}}{\text{Absorbance (control)}} \times 100$$

HPLC

Test samples (10mg/mL) were prepared from stock with HPLC grade Methanol, Chloroform and Hexane (based on solubility, table no: ) and used for HPLC analysis. Shimadzhu LC- Prominence 20AT with C18 column 250 mm x 4.6 mm, 5u particle used for analysis. 10ul injected per volume at the speed of 1mL/min. HPLC grade Aceto nitrile (50%) used as mobile phase A and HPLC grade Water (50%) as mobile phase B.

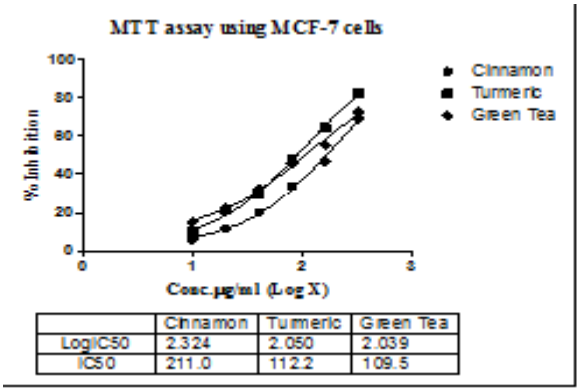
RESULT

Cytotoxicity assay:

Table No. 1: MTT assay of test samples against MCF-7 cell line

| Compound name | Conc. µg/ml | OD at 590nm | % Inhibition | IC50 µg/ml |
|---|---|---|---|---|
| Control | 0 | 0.773 | 0.00 | |
| *Cinnamon* | 10 | 0.726 | 6.08 | 211 |
| | 20 | 0.682 | 11.77 | |
| | 40 | 0.616 | 20.31 | |
| | 80 | 0.513 | 33.64 | |
| | 160 | 0.412 | 46.70 | |
| | 320 | 0.242 | 68.69 | |
| | | | | |
| *Turmeric* | 10 | 0.696 | 9.96 | 112.2 |
| | 20 | 0.608 | 21.35 | |
| | 40 | 0.543 | 29.75 | |
| | 80 | 0.404 | 47.74 | |
| | 160 | 0.278 | 64.04 | |
| | 320 | 0.139 | 82.02 | |
| | | | | |
| *Green Tea* | 10 | 0.655 | 15.27 | 109.5 |
| | 20 | 0.598 | 22.64 | |
| | 40 | 0.522 | 32.47 | |
| | 80 | 0.423 | 45.28 | |
| | 160 | 0.345 | 55.37 | |
| | 320 | 0.215 | 72.19 | |

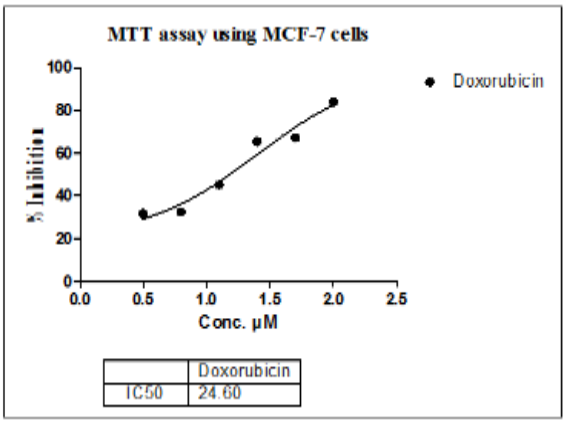
International Journal of Research
Available at https://journals.pen2print.org/index.php/ijr/
e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 06 Issue 04
April 2019




| | Cinnamon | Turmeric | Green Tea |
|---|---|---|---|
| LogIC50 | 2.324 | 2.050 | 2.039 |
| IC50 | 211.0 | 112.2 | 109.5 |

Fig.1 : Graph showing IC50 of test samples
Table No. 2: MTT assay of positive control against MCF-7 cell line

| MCF-7 | Standard | | | |
|---|---|---|---|---|
| Compound name | Conc. µM | OD at 590nm | % Inhibition | IC50 µM |
| Control | 0 | 0.768 | 0.00 | |
| *Doxorubicin* | 3.12 | 0.524 | 31.76 | 24.6 |
| | 6.25 | 0.518 | 32.55 | |
| | 12.5 | 0.421 | 45.18 | |
| | 25 | 0.265 | 65.44 | |
| | 50 | 0.251 | 67.32 | |
| | 100 | 0.124 | 83.85 | |
| | | | | |

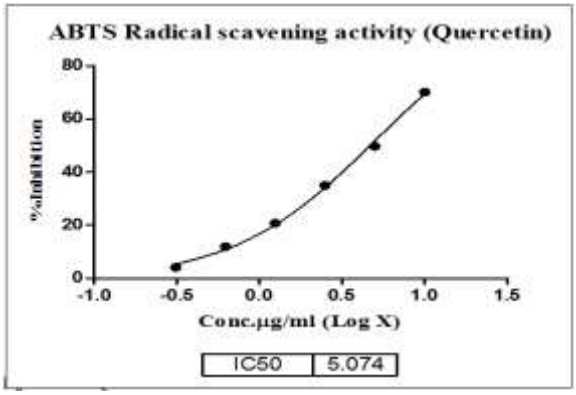



| | Doxorubicin |
|---|---|
| IC50 | 24.60 |

Fig. 2: Graph showing IC50 of Doxorubicin

Sample Cinnamon and Turmeric showed IC50 value of 210.4µg/ml and 111.7µg/ml inhibition in MCF-7 cells when compared to standard doxorubicin which is having IC50 value of 24.6µM.

| Sample | Conc (µg/ml) | OD @ 595nm | % Inhibition | IC50 (µg/ml) |
|---|---|---|---|---|
| C | 0 | 0.823 | 0 | |
| Quercetin | 0.3125 | 0.789 | 4.12 | |
| | 0.625 | 0.725 | 11.91 | |
| | 0.125 | 0.652 | 20.77 | 5.074 |
| | 2.5 | 0.535 | 34.96 | |
| | 5 | 0.414 | 49.72 | |
| | 10 | 0.246 | 70.12 | |
| | | | | |
| Turmeric | 0 | 0.774 | 0 | |
| | 6.25 | 0.656 | 15.25 | |
| | 12.5 | 0.589 | 23.92 | |
| | 25 | 0.554 | 28.41 | 94.23 |
| | 50 | 0.510 | 34.07 | |
| | 100 | 0.326 | 57.91 | |
| | | | | |
| Cinnamon | 0 | 0.774 | 0 | |
| | 6.25 | 0.703 | 9.17 | |
| | 12.5 | 0.652 | 15.75 | |
| | 25 | 0.494 | 36.14 | 39.03 |
| | 50 | 0.348 | 55.05 | |
| | 100 | 0.254 | 67.15 | |
| | | | | |
| Green tea | 0 | 0.774 | 0 | |
| | 6.25 | 0.680 | 12.17 | |
| | 12.5 | 0.590 | 23.75 | |
| | 25 | 0.425 | 45.14 | 31.74 |
| | 50 | 0.278 | 64.05 | |
| | 100 | 0.169 | 78.15 | |




| IC50 | 5.074 |
|---|---|

International Journal of Research
Available at https://journals.pen2print.org/index.php/ijr/
e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 06 Issue 04
April 2019

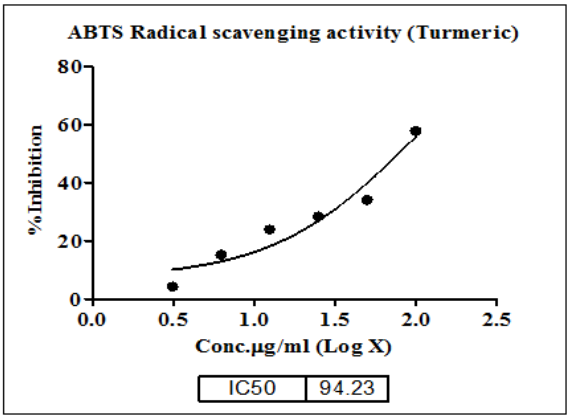



Fig. 4: IC50 of Turmeric

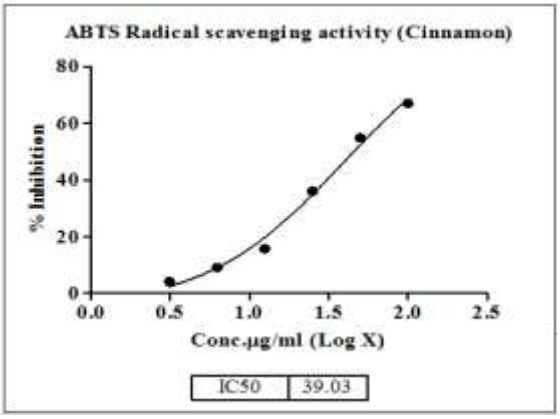



Fig.5 : IC50 of Cinnamon

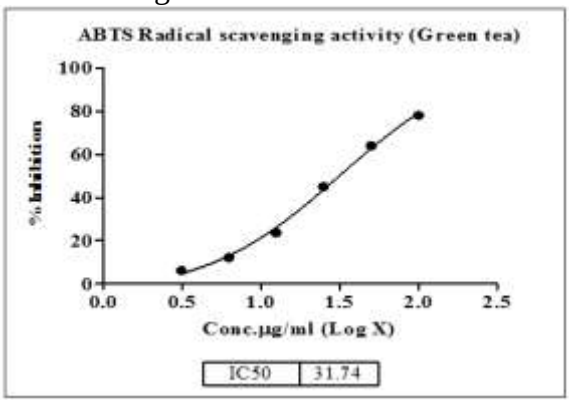



Fig. 6: IC50 of Green Tea

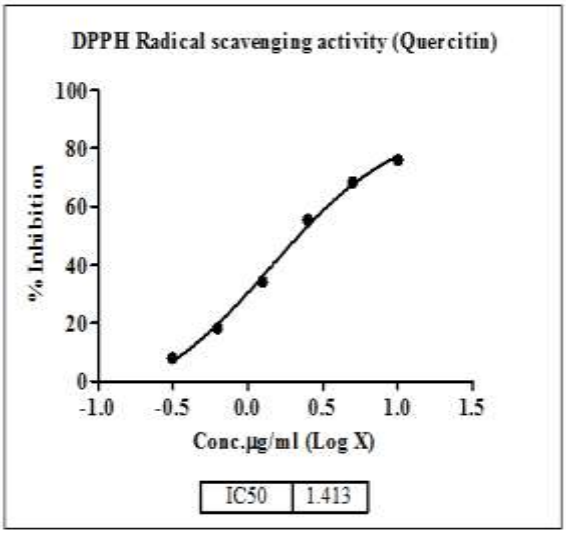
Among the samples tested above sample Green tea has showed maximum activity having an IC50 value of 31.74µg/ml while the sample Cinnamon has showed minimum activity having an IC50 value of 39.03µg/ml. Quercetin used as the standard has showed IC50 value of 5.074 µg/ml.

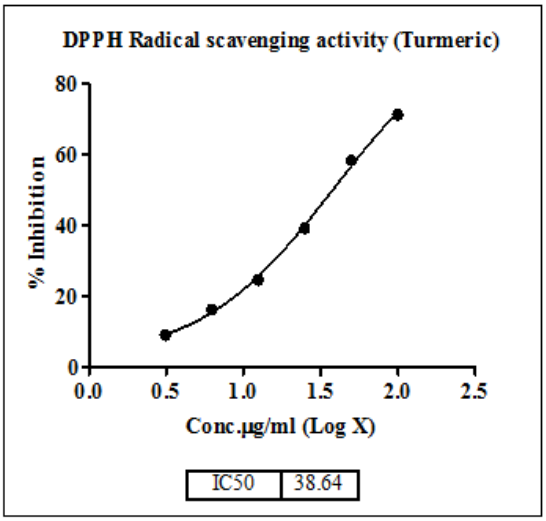
**DPPH Radical Scavenging Assay:**

**Table 4: IC50 of Standard and test samples**

| Sample | Conc (µg/ml) | OD @ 510nm | % Inhibition | IC50 (µg/ml) |
|---|---|---|---|---|
| C | 0 | 0.767 | 0 | |
| Quercetin | 0.3125 | 0.706 | 8 | |
| | 0.625 | 0.627 | 18.3 | |
| | 0.125 | 0.504 | 34.3 | 1.413 |
| | 2.5 | 0.341 | 55.5 | |
| | 5 | 0.242 | 68.4 | |
| | 10 | 0.184 | 76 | |
| | | | | |
| Turmeric | 0 | 0.711 | 0.00 | |
| | 3.125 | 0.646 | 9.12 | |
| | 6.25 | 0.595 | 16.26 | |
| | 12.5 | 0.535 | 24.68 | 38.64 |
| | 25 | 0.432 | 39.25 | |
| | 50 | 0.296 | 58.35 | |
| | 100 | 0.205 | 71.21 | |
| | | | | |
| Cinnamon | 3.125 | 0.625 | 12.12 | |
| | 6.25 | 0.560 | 21.26 | |
| | 12.5 | 0.450 | 36.68 | |
| | 25 | 0.339 | 52.25 | 20.81 |
| | 50 | 0.275 | 61.35 | |
| | 100 | 0.148 | 79.21 | |
| | | | | |
| Green tea | 3.125 | 0.631 | 11.22 | |
| | 6.25 | 0.568 | 20.17 | |
| | 12.5 | 0.507 | 28.75 | |
| | 25 | 0.404 | 43.14 | 34.07 |
| | 50 | 0.291 | 59.05 | |
| | 100 | 0.191 | 73.15 | |

International Journal of Research
Available at https://journals.pen2print.org/index.php/ijr/
e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 06 Issue 04
April 2019



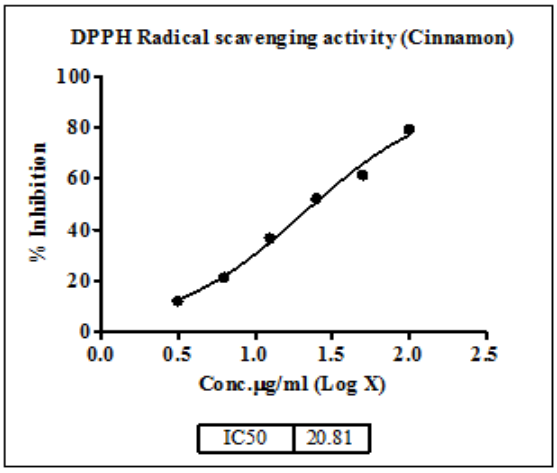




Fig. 9: IC50 of Cinnamon

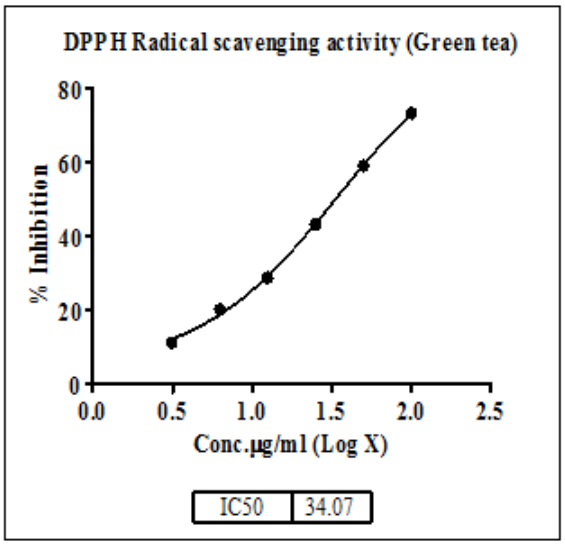



Fig. 10: IC50 of Green Tea

Among the samples tested above, Sample Cinnamon has showed maximum activity having an IC50 value of 20.81 µg/ml while the sample Turmeric has showed minimum activity having an IC50 value of 38.64 µg/ml. Standard Quercetin has showed IC50 value of 1.413 µg/ml.

**Determination of Catalase Activity**

**Table 5: Standard (H2O2) absorbance**

| Hydrogen peroxide (nM) | Abs (570) |
|---|---|
| 0.000 | 0.000 |
| 2.000 | 0.019 |
| 4.000 | 0.031 |
| 8.000 | 0.079 |
| 16.000 | 0.130 |

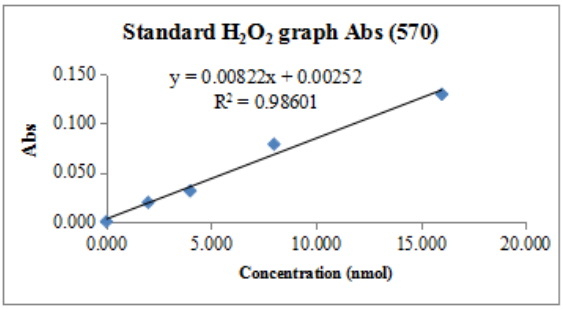



**Fig. 11: Absorbance of the H2O2 vs. their concentration**

International Journal of Research
Available at https://journals.pen2print.org/index.php/ijr/
e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 06 Issue 04
April 2019

**Table 6: Catalase activity (mU/ml) in samples**

| Sample | Conc (µg/ml) | $Abs_{before}$ | Abs after | ΔA | Conc. H2O2 nmol | Catalase activity mU/ML |
|---|---|---|---|---|---|---|
| Control | 0 | 0.0023 | 0.0029 | | | |
| Green Tea | 10 | 0.0283 | 0.0356 | 0.0320 | 3.74 | 1.87 |
| | 20 | 0.0305 | 0.0383 | 0.0344 | 4.05 | 2.03 |
| | 40 | 0.0498 | 0.0485 | 0.0492 | 5.89 | 2.95 |
| | 80 | 0.0538 | 0.0509 | 0.0524 | 6.29 | 3.15 |
| | 160 | 0.0658 | 0.0682 | 0.0670 | 8.13 | 4.06 |
| | 320 | 0.0793 | 0.0732 | 0.0763 | 9.28 | 4.64 |
| Turmeric | 10 | 0.0136 | 0.0392 | 0.0264 | 3.05 | 1.53 |
| | 20 | 0.0304 | 0.0437 | 0.0371 | 4.38 | 2.19 |
| | 40 | 0.0395 | 0.0499 | 0.0447 | 5.34 | 2.67 |
| | 80 | 0.0436 | 0.0537 | 0.0487 | 5.83 | 2.92 |
| | 160 | 0.0492 | 0.0557 | 0.0525 | 6.31 | 3.15 |
| | 320 | 0.0542 | 0.0618 | 0.0580 | 7.00 | 3.50 |
| Cinnamon | 10 | 0.0221 | 0.0387 | 0.0304 | 3.55 | 1.78 |
| | 20 | 0.0406 | 0.0489 | 0.0448 | 5.34 | 2.67 |
| | 40 | 0.0532 | 0.0598 | 0.0565 | 6.81 | 3.41 |
| | 80 | 0.0699 | 0.0756 | 0.0728 | 8.84 | 4.42 |
| | 160 | 0.0764 | 0.0814 | 0.0789 | 9.61 | 4.81 |
| | 320 | 0.0801 | 0.0855 | 0.0828 | 10.10 | 5.05 |

***Catalase activity mU/Ml= Conc. H2O2 nmol/(min*0.1)***

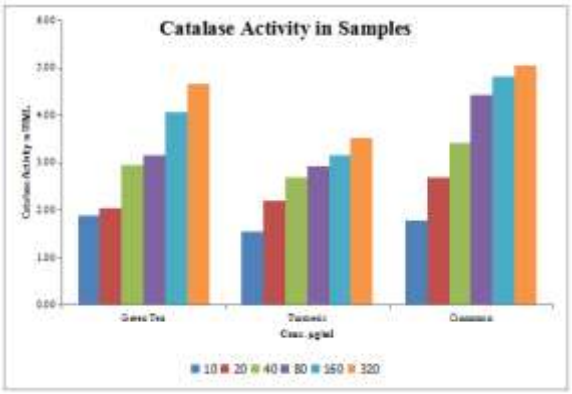
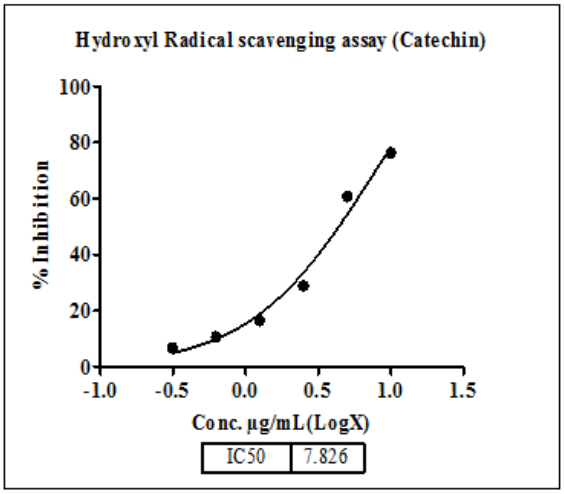



Fig. 12: Graphical representation- Conc. µg/ml plotted against Catalase activity.

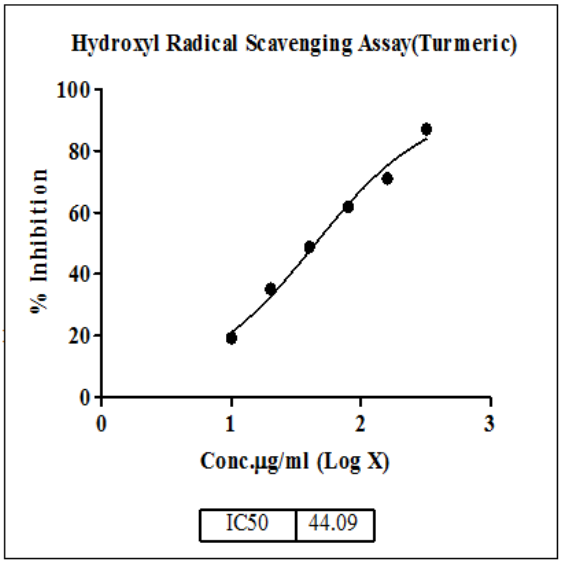
Samples Green tea, Turmeric and Cinnamontested for catalase activity has showed 4.64, 3.50 and 5.05 mU/Ml of catalase activity at the maximum concentration tested (320 µg/ml).

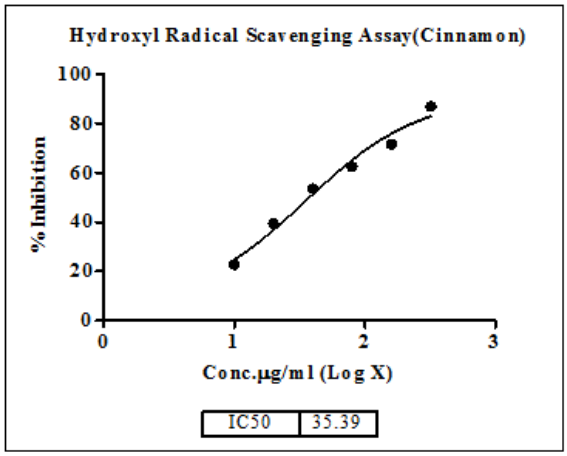
Table 7: Hydroxyl radical scavenging assay

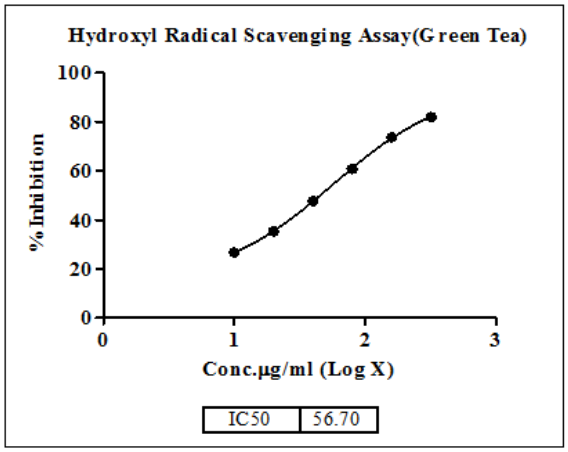
| Plants Name | Concentration (µg/ml) | Absorbance 532nm | % Inhibition | $IC_{50}$ |
|---|---|---|---|---|
| Control | 0 | 0.54 | 0.00 | |
| *Standard (Catechin)* | 0.3125 | 0.51 | 6.74 | **7.826 µg/ml** |
| | 0.625 | 0.49 | 10.61 | |
| | 1.25 | 0.45 | 16.43 | |
| | 2.5 | 0.39 | 28.89 | |
| | 5 | 0.21 | 60.72 | |
| | 10 | 0.13 | 76.27 | |
| Control | 0 | 0.59 | 0 | |
| *Turmeric* | 10 | 0.48 | 19.22 | **44.09 µg/ml** |
| | 20 | 0.38 | 35.17 | |
| | 40 | 0.30 | 48.75 | |
| | 80 | 0.22 | 61.896 | |
| | 160 | 0.17 | 71.05 | |
| | 320 | 0.08 | 87.15 | |
| *Cinnamon* | 10 | 0.46 | 22.68 | **35.39 µg/ml** |
| | 20 | 0.36 | 39.47 | |
| | 40 | 0.27 | 53.565 | |
| | 80 | 0.22 | 62.41 | |
| | 160 | 0.17 | 71.42 | |
| | 320 | 0.08 | 86.81 | |
| *Green tea* | 10 | 0.43 | 26.72 | **56.7 µg/ml** |
| | 20 | 0.38 | 35.38 | |
| | 40 | 0.31 | 47.73 | |
| | 80 | 0.23 | 60.82 | |
| | 160 | 0.15 | 73.74 | |
| | 320 | 0.11 | 81.92 | |



International Journal of Research
Available at https://journals.pen2print.org/index.php/ijr/
e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 06 Issue 04
April 2019

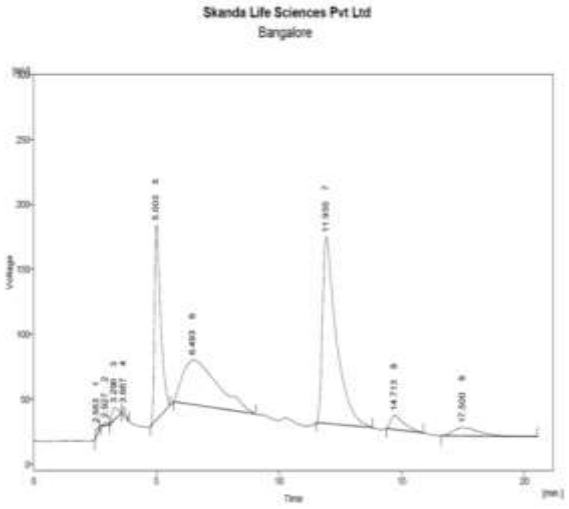



Among the samples tested above, Sample Cinnamon has showed maximum activity having an IC50 value of 35.39µg/ml while the sample Turmeric has showed minimum activity having an IC50 value of 56.70µg/ml. Standard Catechin has showed IC50 value of 7.826µg/ml.

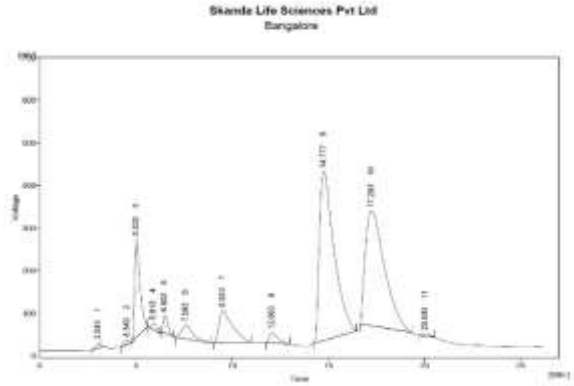
Fig.17: HPLC data of Turmeric




Result Table (Uncal - C:\SPINCHROM\WORK1\DATA\2019\APRIL\HASAN\CINNAMON)

| | Retention Time [min] | Area [mV s] | Height [mV] | Area [%] | Height [%] | W05 [min] |
|---|---|---|---|---|---|---|
| 1 | 2.563 | 35.470 | 6.092 | 0.3 | 1.7 | 0.15 |
| 2 | 2.927 | 29.045 | 2.468 | 0.2 | 0.7 | 0.16 |
| 3 | 3.290 | 148.897 | 9.371 | 1.2 | 2.6 | 0.37 |
| 4 | 3.667 | 49.681 | 6.153 | 0.4 | 1.7 | 0.12 |
| 5 | 5.003 | 2577.168 | 140.860 | 20.2 | 40.6 | 0.26 |
| 6 | 6.493 | 3434.421 | 34.412 | 26.9 | 9.3 | 1.45 |
| 7 | 11.930 | 5601.342 | 143.539 | 43.9 | 38.9 | 0.55 |
| 8 | 14.713 | 421.294 | 10.934 | 3.3 | 3.0 | 0.53 |
| 9 | 17.600 | 462.360 | 6.323 | 3.6 | 1.7 | 1.14 |
| | Total | 12759.677 | 369.160 | 100.0 | 100.0 | |

Fig.18: HPLC data of Cinnamon



International Journal of Research
Available at https://journals.pen2print.org/index.php/ijr/
e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 06 Issue 04
April 2019

Result Table (Uncal - C:\SPINCHROM\WORK\DATA\2019\APRIL\HASAN\TURMERIC)

| | Reten. Time [min] | Area [mV.s] | Height [mV] | Area [%] | Height [%] | W05 [min] |
|---|---|---|---|---|---|---|
| 1 | 3.043 | 151.290 | 11.833 | 0.3 | 1.1 | 0.18 |
| 2 | 4.643 | 188.076 | 9.960 | 0.4 | 0.9 | 0.31 |
| 3 | 5.030 | 4449.724 | 230.610 | 8.6 | 20.7 | 0.30 |
| 4 | 5.613 | 308.804 | 15.404 | 0.6 | 1.4 | 0.34 |
| 5 | 6.503 | 678.899 | 41.144 | 1.3 | 3.7 | 0.25 |
| 6 | 7.593 | 1308.179 | 32.102 | 2.5 | 2.9 | 0.57 |
| 7 | 9.523 | 3644.904 | 75.576 | 7.1 | 6.8 | 0.74 |
| 8 | 12.083 | 731.800 | 23.836 | 1.4 | 2.1 | 0.45 |
| 9 | 14.777 | 21121.185 | 396.441 | 40.9 | 35.6 | 0.83 |
| 10 | 17.263 | 18827.009 | 270.216 | 36.5 | 24.3 | 1.08 |
| 11 | 20.043 | 179.844 | 5.804 | 0.3 | 0.5 | 0.50 |
| | Total | 51589.714 | 1112.926 | 100.0 | 100.0 | |

Fig.19: HPLC data of Green tea

Table 8 : HPLC summary

| sample | RT | Area% | peak |
|---|---|---|---|
| GA | 5.186 | 96 | 2 |
| Turmeric | 14.77 | 40 | 11 |
| | 17.26 | 36 | |
| Cinnamon | 11.93 | 43.9 | 9 |
| | 6.49 | 26.9 | |
| Tea | 5.193 | 69.1 | 5 |

Table 9: Comparative result of Turmeric Cinnamon to Gallic acid

| Sample | Stock | R.T | Area (mv*S) | GA ug/ml of extract | Dilution | GA mg/g | Chromatogram Reference |
|---|---|---|---|---|---|---|---|
| GA | 100ug/ml | 5.186 | 1786.55 | - | 1 | | 1 |
| Turmeric | 10mg/ml | 5.05 | 4449.60 | 249.06 | 1 | 249.061 | 2 |
| cinnamon | 10mg/ml | 5 | 2577.16 | 144.25 | 1 | 144.253 | 3 |
| Tea | 10mg/ml | 5.193 | 900.12 | 20.23 | 20 | 404.586 | 4 |

DISCUSSION

Acharya et al., (2015) showed that, Curcurmin and Berberine are of extreme antitumor agents. Ji et al., 2012 showed that curcumin is a potential anti- cancer activity. Rachana and Venugopalan (2014) showed that ethyl acetate and dichloromethane extracts have the maximum antioxidant activity. Among the extracts screened for antimicrobial activity, hexane, dichloromethane and ethyl acetate extracts showed maximum activity against all tested organisms.

The cytotoxicity of the developed conjugate against some cancerous cell lines including HeLa, Saos-2 and MCF-7 cells as well as normal fibroblast cells was studied (Razaei et al., 2018). Promising results were achieved where the conjugate could effectively kill the growing cancerous cells, while its impact on healthy cells was much less.

In the present study, sample Cinnamon, Turmeric and Green Tea tested on breast cancer cell lines (MCF-7). Samples showed IC50 value of 211µg/ml, 112.2µg/ml and 109.5µg/ml inhibition in MCF-7 cells when compared to standard doxorubicin which is having IC50 value of 24.6µM showing that all the cells are potentially inducing breast cancer.

Reactive oxygen species (ROS) and free transition metal ions cause extensive oxidative damage to cellular biomolecules such as DNA, proteins and lipids. Oxidation of these biomolecules often leads to oxidative stress, which can cause cell damage and contribute to aging and the development of many chronic and degenerative diseases such as cancers, coronary heart diseases, Alzheimer's disease and Parkinson's disease. Antioxidants are substances that counteract free radicals and prevent the damage caused by them. In recent years, antioxidants have gained a lot of importance due to their potential as prophylactic and therapeutic agents in many diseases (Abeyesekara et al., 2013). Abeysekera et al., (2013) showed that the leaf and bark extracts of Ceylon cinnamon possess marked antioxidant properties, the leaf showing the highest activity.

Bark of Ceylon cinnamon in the day-to-day life for prevention of oxidative stress-associated chronic diseases and for development of functional foods, nutraceuticals and drug discovery.

Tanvir et al., 2017 showed that the turmeric varieties from Bangladesh are promising sources of natural antioxidants, as indicated by their high contents of polyphenols, flavonoids, tannins, and ascorbic acid and by their considerable DPPH free radical-scavenging activities and FRAP values. The extraction yields investigated in both aqueous and ethanol extracts of the turmeric varieties suggest that higher antioxidant compounds could be obtained with ethanol.

Cinnamon extracts possess antioxidant activity. By these findings and purification of the activesubstance(s) present in the extracts of Cinnamon, it will be possible to discover new natural drugs serving as antioxidant agents for application in the nutritional or pharmaceutical fields, in the prevention of free radical-mediated diseases. Cinnamon barks could act as a better antioxidant agent than other parts of Cinnamon based on their radical scavenging abilities Yang et al., 2012).

The results obtained by the use of two different methods (DPPH and ABTS) proved that cinnamon bark, its methanolic extracts and essential oils can be considered as a good source of natural antioxidants. High correlation between antioxidant activity and cinnamon oil and extract may be attributed either to high concentration of the bioactive constituents or to synergy among different oil and extract constituents. Both extract and essential oil of cinnamon bark could be applied in cosmetic and pharmaceutical branches of industry (Brodowska et al., 2016).

Wijayanti et al. (2011) reported that ethanolic extract of cinnamon bark collected from different area possess antioxidant activity with various IC50 value in a range of 75.48 µg/mLand 136.88 µg/mL. In the study on beneficial of cinnamon to prevent diabetes and Alzheimer's diseases. The phytochemical analysis results indicated that polyphenols (including flavonoids, tannin) and phenolic volatile oil compounds as the major antioxidant compounds. This results suggested that the simple traditional method of preparation of infusion commonly applied by people, yielded the highest antioxidant activity Ervina et al., 2017). Recent studies have suggested that cinnamon extract exerts chemopreventive properties such as anti-proliferative and anti-oxidative effects (Schoen et al., 2005; Dhuley, 1999).

Kim et al., 2010 showed that 2'-hydroxycinnamaldehyde (HCA) shows antitumor activity in SCC-15 and HEp-2 oral carcinoma cells and inhibits cell proliferation by inducing cell cycle arrest and apoptosis.

Antioxidants are a group of substances which, when present at low concentrations, in relation to oxidizable substrates, significantly inhibit or delay oxidative processes, while often being oxidized themselves.Plants possess antioxidant principles. Various classes of phytochemicals have been shown to have antioxidant property which is due to the presence of substituted groups such as carbonyl, phenolic, phytyl side chain, electron withdrawing group, electron donating group etc.

The DPPH scavenging assay is a simple chemical experiment for the primary evaluation of any compound for its simplicity and low cost for free radical scavenging activity. In the present study, Among the samples tested above, Sample Cinnamon has showed maximum activity having an IC50 value of 20.81 µg/ml while the sample Turmeric has showed minimum activity having an IC50 value of 38.64 µg/ml. Standard Quercetin has showed IC50 value of 1.413 µg/ml.

ABTS assay is based on the scavenging of light by ABTS radicals. An antioxidant

with an ability to donate a hydrogen atom will quench the stable free radical, a process which is associated with a change in absorption which can be followed spectroscopically. The relatively stable ABTS radical has a green colour and is quantified spectrophotometrically at 734nm.

In the present study, Among the samples tested above sample Green tea has showed maximum activity having an IC50 value of 31.74µg/ml while the sample Cinnamon has showed minimum activity having an IC50 value of 39.03µg/ml. Quercetin used as the standard has showed IC50 value of 5.074 µg/ml in case of ABTS assay.

In th present study, samples Greeen tea, Turmeric and Cinnamon tested for catalase activity has showed 4.64, 3.50 and 5.05 mU/Ml of catalase activity at the maximum concentration tested (320 µg/ml) in Catalase activity assay.

Hydroxyl radical scavenging activity can be measured using the deoxyribose assay, a Fenton type reaction system which is considered one of the best known models for determining the hydroxyl radical scavenging activity.

In th present study, aAmong the samples tested above, Sample Cinnamon has showed maximum activity having an IC50 value of 35.39µg/ml while the sample Turmeric has showed minimum activity having an IC50 value of 56.70µg/ml. Standard Catechin has showed IC50 value of 7.826µg/ml in hydroxyl scavenging assay.

## REFERENCES

[1]. 1.Abeysekera W P M, Premakumara G A S and Ratnasooriya W D (2013). In vitro anti oxidant properties of leaf and bark extracts of Ceylon cinnamon (Cinnamomum zynalicum Blume). Tropical Agricultural Research, 24( 2): 128-138.

[2]. 2.Acharya B and Hemanth Kumar M (2015). Evaluation of anticancer synergetic activity of Barberine and curcumin on different models of A549, HePG2, MCF-7, Jurkat and K562 cell lines. Biomed Journal International.

[3]. 3.Adisakwattana S, Lerdsuwankij O, Poputtachai U, Minipun A and Suparpprom C (2011). Inhibitory activity of cinnamon bark species and their combination effect with acarbose against intestinal α-glucosidase and pancreatic α- amylase: Plant Foods Hum. Nutr.66, 143-148.

[4]. 4.Aggarwal B B and Harikumar K B (2009). Potential therapeutic effects of curcumin, the anti-inflammatory agent, against neurodegenerative, cardiovascular, pulmonary, metabolic, autoimmune and neoplastic diseases. Int. J. Biochem. Cell Biol.,41, 40-59.

[5]. 5.Aggarwal B B, Kumar A, and Bharti B C (2003). "Anticancer potential of curcumin: preclinical and clinical studies," Anticancer Research, vol. 23, no. 1, pp. 363–398.

[6]. 6.Andrews L (2013). Cochrane review brief: cinnamon for diabetes mellitus. Online J Issues Nurs. 18: 12.

[7]. 7.Ammon H P and Wahl M A. Pharmacology of curcuma longa (1991). Planta Medica,57, 1-7.

[8]. 8.Bonilla J, Atares L, Vargas M and Chiralt A (2012). Effect of essential oils and homogenization conditions on properties of chitosan-based films. Food Hydrocolloids, Oxford, v. 26, n. 1, p. 9-16.

[9]. 9.Bonilla J and Sorbal P J A (2017) Antioxidant and antimicrobial properties of ethanolic extracts of Gauarana, boldo, rosemary and cinnamon. Brazilian Journal of Food Technology, 20.

[10]. 10.Chao L K, Hua K F, Hsu H Y, Cheng S-S, Lin I F, Chen C-J, Chen S-T and Chang S-T (2008). Cinnamaldehyde inhibits pro-inflammatory cytokines secretion from monocytes/macrophages

through suppression of intracellular signaling: FCT.46, 220-231.
[11]. 11.Chen C C, Sureshbabul M, Chen H W, Lin Y S, Lee J Y, Hong Q S, Yang Y C and Yu S L (2013). Curcumin Suppresses Metastasis via Sp-1, FAK Inhibition, and E-Cadherin Upregulation in Colorectal Cancer. Evidence-Based Complementary Altern. Med. 1−17.
[12]. 12.De Assis Oliveira F, Andrade LN, de Sousa EB V and de Sousa DP (2014). Anti-ulcer activity of essential oil constituents. Molecules. 19: 5717-5747.
[13]. 13.Dikshit M, Rastogi L, Shukla R and Srimal R C (1995). "Prevention of ischaemia-induced biochemical changes by curcumin and quinidine in the cat heart," Indian Journal of Medical Research, vol. 101:31–35.
[14]. 14.Dobelis N Ed.,(1986). Magic and Medicine of Plants, Reader's Digest Association, Pleasantville, NY, USA.
[15]. 15.Gafner S, Lee S K, Cuendet M, Barthelemy S, Vergnes L, Labidalle S, Mehta R G, Boone C W and Pezzuto J M (2004). Biologic evaluation of curcumin and structural derivatives in cancer chemoprevention model systems. Phytochemistry, 65, 2849-2859.
[16]. 16.Giordani R, Regli P, Kaloustian J and Portugal H (2006). Potentiation of antifungal activity of amphotericin B by essential oil from Cinnamomum cassia. PhytotherbRes. 20: 58-61. 11.
[17]. 17.He S, Zeng K W, Jiang Y and Tu P F (2016). Nitric oxide inhibitory constituents from barks of Cinnamomum cassia. Fitoterapia. 112: 153-160.

[18]. 18.Hong J, Bose M, Ju J, Ryu J H, Chen X, Sang S, Lee M J and Yang C S (2004). Modulation of arachidonic acid metabolism by curcumin and related beta-diketone derivatives: effects on cytosolic phospholipase A(2), cyclooxygenases and 5-lipoxygenase. Carcinogenesis,25, 1671-1679.
[19]. 19.Hoque M S, Benjakul S and Prodpran T. Properties of film from cuttlefish (Sepia pharaonis) skin gelatin incorporated with cinnamon, clove and star anise extracts. Food Hydrocolloids, Oxford, v. 25, n. 5, p. 1085-1097.
[20]. 20.Huang D F, Xu J G, Liu J X, Zhang H and Hu QP (2014). Chemical constituents, antibacterial activity and mechanism of action of the essential oil from Cinnamomum cassia bark against four food-related bacteria. Microbiology. 83(4): 357-365.
[21]. 21.Jayaprakasha G K, Negi P S, Jena B S and Jagan Mohan Rao L (2007). Antioxidant and antimutagenic activities of Cinnamomum zeylanicum fruit extracts: JFCA, 20, 330-336.
[22]. 22.Ji J L, Haung X F and Zhu H L (2012). Curcumin and its formulations: Potential anti-cancer agents. Anti-cancer agents in Medicinal Chemistry, 12:2310-218.
[23]. 23.Kumar KI M, Isaac A, Ninan E, Kuttan R and Maliakel B (2014). Enhanced anti-diabetic activity of polyphenolrich de-coumarinated extracts of Cinnamomum cassia. J Funct Foods. 10: 54-64.
[24]. 24.Lin C C, Wu S J, Chang C H and Ng L T (2003). Antioxidant activity of Cinnamomum cassia. Phytother Res.17: 726-730.

[25]. 25.Li XW, Li J, Van der Werff H, eds (2013). Cinnamomum cassia in flora of China. Missouri Botanical Garden, St. Louis MO & Harvard University Herbaria, Cambridge, MA.

[26]. 26.Maheshwari R K, Singh A K, Gaddipati J and Srimal R C (2006). Multiple Biological Activities of Curcumin: A Short Review. Life Sci.,78, 2081−2087.
[27]. 27.Marongiu B, Piras A, Porcedda S, Tuveri E, Sanjust E, Meli M, Sollai F, Zucca P and Rescigno A (2007). Supercritical CO2 extract of Cinnamomum

zeylanicum: chemicalcharacterization and antityrosinase activity: J. Agric. Food Chem., 5(24), 10022-7.
[28]. 28.Palmal S, Maity A R, Singh B K, Basu S and Jana N R (2014). Inhibition of Amyloid Fibril Growth and Dissolution of Amyloid Fibrils by Curcumin-Gold Nanoparticles. Chem.Eur. J. 20, 6184−6191.
[29]. 29.Panchatcharam M, Miriyala S, Gayathri V S and Suguna L (2006). Curcumin Improves Wound Healing by Modulating Collagen and Decreasing Reactive Oxygen Species. Mol. Cell. Biochem. 290, 87−96.
[30]. 30.Prasad K N, Yang B, Dong X, Jiang G, Zhang H, Xie H and Jiang Y (2009). Flavonoid contents and antioxidant activities from Cinnamomum species: IFSET.10, 627-632.
[31]. 31.Rachana S and Venugopalan P (2014). Antioxidant and antibacterial activity of wild turmeric extracts. Journal of Pharmacology and Phytochemisty, 2(6): 89-94.
[32]. 32.Raghavan S, eds (2007). Spices, seasonings, and flavorings. 2nd edn. Boca Raton, (FL): CRC Press, Taylor and Francis Group.

[33]. 33.Ravindranath V and Chandrasekhara N (1980). "Absorption and tissue distribution of curcumin in rats," Toxicology, vol. 16, (3): 259–26.

[34]. 34.Razaei S, Mohammed M, Najafpour G D, Moghadamnia A, Khazemi S and Nikzad M (2016). Separation of curcumin from Curcuma longa L. and its Conjugation with silica nanoparticles of anti-cancer activities. IJE Transactions B: Applications 31(11): 1803-1809.
[35]. 35.Roussel A, Hininger I, Benaraba R, Ziegenfuss T N and Anderson RA (2009). Antioxidant effects of a cinnamon extract in people with impaired fasting glucose that are overweight or obese. J Am Coll Nutr. 28: 16-21.
[36]. 36.Sharma R A, Gescher A J, and Steward W P (2005). "Curcumin: the story so far," European Journal of Cancer, vol. 41,no. 13,pp. 1955– 1968.
[37]. 37.Shishodia S, Sethi G, Aggarwal B B (2005). Curcumin: getting back to the roots. Ann. N. Y. Acad. Sci.,1056, 206-217.
[38]. 38.Singh D K, Jagannathan R, Khandelwal P, Abraham P M and Poddar P (2013). In Situ Synthesis and Surface Functionalization of Gold Nanoparticles with Curcumin and Their Antioxidant Properties: An Experimental and Density Functional Theory Investigation. Nanoscale, 5, 1882−1893.
[39]. 39.Tanvir E M, Hossen S M, Hossain F M, Afroz R, Gan S H, Khalil I M and Karim N (2017). Antioxidant properties o0f popular turmeric (Curcuma longa) varieties from Bangladesh. Journal of Food quality
[40]. 40.Toda S, Miyase T, Arichi H, Tanizawa H and Takino Y (1985). "Natural antioxidants. III. Antioxidative components isolated from rhizome of Curcuma longa L," Chemical and Pharmaceutical Bulletin, vol. 33 (4): 1725–1728.
[41]. 41.Tongnuanchan P, Benjakul S and Prodpran T (2012). Properties and antioxidant activity of fish skin gelatin film incorporated with citrus essential oils. Food Chemistry, London, v. 134, n. 3, p. 1571-1579.

[42]. 42.Unlu M, Ergene E, Unlu G V, Zeytinoglu H S and Vural N (2010). Composition, antimicrobial activity and in vitro cytotoxicity of essential oil from Cinnamomum zeylanicumBlume (Lauraceae): FCT.48, 3274-3280.

[43]. 43.Verderio P, Bonetti P, Colombo M, Pandolfi L and Prosperi D (2013). Intracellular Drug Release from Curcumin-Loaded PLGA Nanoparticles Induces G2/M Block in Breast Cancer Cells. Biomacromolecules, 14, 672−682.

[44]. 44.Wahlstromand B and Blennow G (1978). "A study on the fate of curcumin in the rat,"Acta Pharmacologica et Toxicologica, vol. 43,no. 2: 86–92.
[45]. 45.Weerakkodi N S, Caffin N, Turner M S and Dykes G A. In vitro antimicrobial activity of less-utilized spice and herb extracts against selected food-borne bacteria. Food Control, London, v. 21, n. 10, p. 1408-1414.
[46]. 46.Wright J S(2002). Predicting the Antioxidant Activity of Curcumin and Curcuminoids. J. Mol. Struct.: THEOCHEM, 591, 207−217.

[47]. 47.Yallapu M M, Khan S, Maher D M, Ebeling M C, Sundram V, Chauhan N, Ganju A, Balakrishna S, Gupta B K, Zafar N, Jaggi M and Chauhan S C (2014). Anti-Cancer Activity of Curcumin Loaded Nanoparticles in Prostate Cancer. Biomaterials, 35, 8635−8648.

[48]. 48.Yang C H, Li R X and Chuang L Y (2012). Antioxidant activity of various parts of Cinnamomum cassia extracted with different extraction methods. Molecules, 17:7294-7304.
[49]. 49.Yang X X, Li C M and Huang C Z (2016). Curcumin Modified Silver Nanoparticles for Highly Efficient Inhibition of Respiratory Syncytial Virus Infection. Nanoscale 8, 3040−3048.
[50]. 50.Yan Y M, Fang P, Yang M T, Li N, Lu Q and Cheng YX (2015). Anti-diabetic nephropathy compounds from Cinnamomum cassia. J Ethnopharmacol. 165: 141-147.
[51]. 51.Zhou H, Beevers1 C S and Huang S. The targets of curcumin. Curr. Drug Targets, 2011, 12, 332-347.
[52]. 52.Mahmmad HA, Jubrail AM S and Najeeb MK (2015). Impact of cinnamon extract on hyperlipidemic and diabetic rats. Int J Chem Biomol Sci. 1(3): 96-106.
[53]. 53.Wu F and Jia RH (2012). Research advances on pharmaceutical function of extracts of Cinnamomum cassia. Herald Med. 31: 882-885.
[54]. 54. Brodowska AJ, Śmigielski K, Nowak A, Brodowska K, Catthoor R and Czyżowska A (2014). The impact of ozone treatment on changes in biologically active substances of cardamom seeds. J Food Sci. 79(9): 1649-1655.
[55]. 55.Brodowska AJ, Śmigielski K, Nowak A, Czyżowska and Otlewska A (2015). The impact of ozone treatment in dynamic bed parameters on changes in biologically active substances of juniper berries. PLoS ONE. 10(12): e0144855.
[56]. 56.Stoilova I, Krastanov A, Stoyanova A, Denev P and Gargova S (2007). Antioxidant activity of a ginger extract (Zingiber officinale). Food Chem. 102: 764- 770.
[57]. 57.Spiridon I, Colceru S, Anghel N, Teaca CA, Bodirlau R and Armatu A (2011). Antioxidant capacity andtotal phenolic contents of oregano (Origanum vulgare), lavender (Lavandula angustifolia) and lemon balm (Melissa officinalis) from Romania. Nat Prod Res. 25: 1657-1661.
[58]. 58.Brodowska K M, Brodowska A J, Smigielski A and Lodyga-Chruscinska E (2016). Antioxidant profiles of essential oils and extracts of cinnamon bark (Cinnamomum cassia). Europian Journal of Biological Research, 6(4): 310-316
[59]. 59.Ravindran P N, Babu K N and Shylaja M(2004). Cinnamon and Cassia: The Genus Cinnamomum. CRC Press, Boca Raton.
[60]. 60.Heyne K (1987). Tumbuhan Berguna Indonesia. Jilid 3. Departemen Kehutanan. Jakarta.
[61]. 61.Sangal A(2011). Role of cinnamon as beneficial antidiabetic food adjunct: a review. Advances in Applied Science Research 2(4):440-450.
[62]. 62.Thomas J and Duethi P P(2001). Cinnamon. In: Peter, K.V., editor.Handbook of Herbs and Spices. Woodhead,Cambridge, United Kingdom.

[63]. 63.Wijayanti W A, Zetra Y and Burhan P(2011). Minyak Atsiri Dari Batang Cinnamomum (Kayu Manis) Dari Famili Lauraceae Sebagai Insektisida Alami, Antibakteri Dan Antioksidan. Skripsi. Fakultas Matematika dan Ilmu Pengetahuan Alam Institut Teknologi Sepuluh Nopember. Surabaya.
[64]. 64.Ervina M, Nawu Y E and esar S Y (2017). Comparison of in vitro antioxidant activity of infusion , extractions and fractions of Indonesia Cinnamon (Cinnamomum bermannii) bark. International Food Research Journal, 23(3): 1346-1350.
[65]. 65.Schoene NW, Kelly MA, Polansky MM and Anderson R A (2005) Water-soluble polymeric polyphenols from cinnamon inhibit proliferation and alter cell cycle distribution patterns of hematologic tumor cell lines. Cancer Lett 230: 134-140.
[66]. 66.Dhuley J N (1999) Anti-oxidant effects of cinnamon (Cinnamomum verum) bark and greater cardamom (Amomum subulatum) seeds in rats fed high fat diet. Indian J Exp Biol 37: 238-242.
[67]. 67.Kim S, Sung Y, Kwon B, Yoon J, Lee H, Ahn H and Hong S ( 2010). 2'-Hydroxycinnamaldehyde Shows Antitumor Activity against ral Cancer In Vitro and In Vivo in a Rat Tumor Model. Anti-cancer Research, 30: 489-494
[68]. 68.Yang CS, Wang X, Lu G, Picinich SC (2009). Cancer prevention by tea: animal studies, molecular mechanisms and human relevance. Nat Rev Cancer. 9:429–439.
[69]. 69.Ji SJ, Han DH, Kim JH (2006). Inhibition of proliferation and induction of apoptosis by EGCG in human osteogenic sarcoma (HOS) cells. Arch Pharm Res. 29:363–368.
[70]. 70.Noda C, He J, Takano T, Tanaka C, Kondo T, Tohyama K, Yamamura H and Tohyama Y (2007). Induction of apoptosis by epigallocatechin-3-gallate in human lymphoblastoid B cells. Biochem Biophys Res Commun. 362:951–957.
[71]. 71.Nakazato T, Ito K, Miyakawa Y, Kinjo K, Hozumi N, Ikeda Y and Kizaki M (2005). Catechin, a green tea component, rapidly induces apoptosis of myeloid leukemic cells via modulation of reactive oxygen species production in vitro and inhibits tumor growth in vivo. Haematologica. 90:317–325.
[72]. 72.Nihal M, Ahmad N, Mukhtar H and Wood GS (2005). Anti-proliferative and proapoptotic effects of (–)-epigallocatechin-3-gallate on human melanoma: Possible implications for the chemoprevention of melanoma. Int J Cancer. 114:513–521.
[73]. 73.Li HC, Yashiki S, Sonoda J, Lou H, Ghosh SK, Byrnes JJ, Lema C, Fujiyoshi T, Karasuyama M and Sonoda S (2000). Green tea polyphenols induce apoptosis in vitro in peripheral blood T lymphocytes of adult T-cell leukemia patients. Jpn J Cancer Res. 91:34–40.
[74]. 74.Lee JH, Jeong YJ, Lee SW, Kim D, Oh SJ, Lim HS, Oh HK, Kim SH, Kim W J and Jung JY (2010). EGCG induces apoptosis in human laryngeal epidermoid carcinoma Hep2 cells via mitochondria with the release of apoptosis-inducing factor and endonuclease G. Cancer Lett290:68–75
[75]. 75.Vergote D, Cren-Olive C, Chopin V, Toillon R A, Rolando C, Hondermarck H and Le Bourhis XF (2002). (–)-epigallocatechin (EGC) of green tea induces apoptosis of human breast cancer cells but not of their normal counterparts. Breast Cancer Res Treat. 76:195–201.
[76]. 76.Kavanagh KT, Hafer LJ, Kim DW, Mann KK, Sherr DH, Rogers A E and Sonenshein GE (2001). Green tea extracts decrease carcinogen-induced mammary tumor burden in rats and rate of breast cancer cell proliferation in culture. J Cell Biochem. 82:387–398.
[77]. 77.Lin JK, Liang Y C and Lin-Shiau Y (1999). Cancer chemoprevention by tea

polyphenols through mitotic signal transduction blockade. Biochem Pharmacol. 58:911–915.
[78]. 78.Zhou B, Pan J, Dai F, Zhao CY, Zhang LP, Wei Q Y, Yang L, Zheng R L and Liu ZL (2004). Redifferentiation of human hepatoma cells induced by green tea polyphenols. Res Chem Intermed. 30:627–636
[79]. 79.Hayakawa S, Saito K, Miyoshi N, Ohishi T, Oishi Y, Miyoshi M and Nakamura Y (2016). Anti-Cancer Effects of Green Tea by Either Anti- or Pro-Oxidative Mechanisms. Asian Pacific Journal of Cancer Prevention, 17: 1649-1654.
[80]. 80.Mitra S K, Prakash N Sand Sundaram R(2012). Shatavarins (containing Shatavarin IV) with anticancer activity from the roots of Asparagus racemosus.Indian J Pharmacol. Nov-Dec; 44(6):732-6.