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ORIGINAL ARTICLE **OPEN ACCESS**

Assessment of Antioxidant Potential of *Ocimum sanctum* Linn. Extracts from West Bengal, India

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ABSTRACT
Synthetic antioxidants are reported to have various side effects including carcinogenicity and potential risks to human health. Therefore, there is resurgence to search for natural antioxidants. We aimed to assess the various antioxidant activities Ocimum sanctum Linn extracts one of the most imperative medicinally valued herb in West Bengal region of India. The O. sanctum plants were collected from different geographical locations of West Bengal, India, and subjected to successive solvent extraction by continuous hot extraction (Soxhlet) method with different solvents viz. methanol, ethanol, acetone, chloroform, and hexane for the preparation of different polarity O. sanctum extracts. The antioxidant activities of O. sanctum extracts viz. DPPH radical scavenging assay, guaiacol peroxidase activity (GPx), catalase activity, and ascorbate peroxidase assay were evaluated using standardized assay methods. Results revealed that acetone extract of O. sanctum exhibited maximum DPPH antioxidant activity i.e., IC_{50} value of 47.50 µg/mL, GPx activity of 2.50 U/mg protein, catalase activity of 4.60 U/mg protein, and ascorbate peroxidase activity of 3.50 U/mg protein than other solvent extractions of O. sanctum. In conclusion, the acetone extract of O. sanctum could be explored for the development of natural antioxidant agents.
Keywords: *Ocimum sanctum, Antioxidant activities, Catalase, DPPH, Guaiacol peroxidase, Ascorbate peroxidase*

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INTRODUCTION

Living plants produce a vast quantity of chemicals required for their performance and improvement. Some of these chemicals are primary metabolites, which consist of proteins (amino acids), carbohydrates, fats, nucleic acids, etc. but, besides these primary chemicals, the plants further provide just so-called secondary metabolites, which are specific to some taxonomic groups (families, genera). About 80% of the world's population still depends on the traditional system of medicine for curing several health hazards [1]. Despite the vast scientific development in contemporary medicine, Ayurvedic system of medicine is widely practiced and accepted by people not only in India but also in many developed countries. According to the World Health Organization (WHO), about 80% of patients in India still, rely on the practitioners of the traditional system of medicines. The therapeutic use of herbal crude medicines in different rural and urban communities is most of the time regulated by their traditional beliefs, and thus a majority of the herbal drugs are used as "folk" medicines and well-practiced since long past. Furthermore, increasing dependency on medicinal plants in the industrialized communities have been found to the extraction and improvement of several remedies and chemotherapeutics from these plants and from traditionally established rural herbal remedies [2].

Population-based epidemiological evidence has helped to clarify the role of diet in preventing and controlling morbidity and premature mortality resulting from chronic diseases [3]. Diet and nutrition are vital aspects in the endorsement and maintenance of good health throughout the entire life course. Poor diet is a major contributor to the leading causes of chronic and fatal diseases including coronary heart disease, cancer, and strokes. Research and development in food science is helping to identify many functional foods ingredients, because they can provide health benefits by reducing risk and enhancing the

body's ability to manage certain chronic diseases [4-5]. The functional properties of plants/foods depend on the presence of specific chemical compounds, mainly secondary metabolites such as phenolics and flavonoids [6-8]. The presence of such bioactive compounds promotes the therapeutic uses of medicinal plants also [7, 9].

Reactive oxygen species (ROS) are essentially produced as the intermediate metabolites in a number of physiological processes like energy production in mitochondria, phagocytosis, cell growth regulation, intracellular signaling and detoxification of xenobiotics in the human body. Exposure to long term UV irradiations, chemical pollutants, organic solvents, tobacco smoke and pesticides are some of the environmental factors contributing to ROS over production. Stress generated due to current life style further adds to the overproduction of free radicals and causing tissue damage leading to deteriorating health conditions. High and chronic stress is related to a large number of pathological conditions like atherosclerosis, arthritis, ischemia, cancer and injuries to many tissues including central nervous system [10]. Human health is the primary concern as it influences the efficiency and indirectly affects the economic status of individual, family, society and nation. Use of natural antioxidants to combat increasing oxidative stress under normal and pathological conditions is exponentially rising. Application of natural based antioxidants finds a new dimension in food technology to improve the shelf life of eatables. Synthetic antioxidants are reported to have various side effects including carcinogenicity and potential risks to human health, hence research on natural antioxidants and their applications is the need of the hour [11].

The phytochemicals and secondary metabolites of plants contribute to their medicinal values. Polyphenols absorb, quench and neutralize free radicals, act as reducing agents, metal chelators and can efficiently protect biological systems from degeneration under high oxidative stress [12]. Antioxidants from plant sources, especially polyphenolic compounds effectively impede rancidity due to lipid oxidation in foods as well as development of oxidative stress related diseases [13].

India is well known as an "Emporium of medicinal plants". It possesses about 8% of the estimated biodiversity of the world with around 12,600 species and is one of the 12 mega biodiversity centers with 2 hot spots of biodiversity in the Western Ghats and North-eastern region [14]. Herbal plants or Folk medicines have been long used as a medication since classical times for the treatment of the majority of diseases. Folk plants used to enact a very significant role in world health [15, 16]. *Ocimum sanctum* (synonym *Ocimum tenuiflorum*), commonly known as holy basil, tulasi (sometimes spelled thulasi) or tulsi, is an aromatic perennial plant in the family Lamiaceae. An erect much branched softly pubescent undershrub, 30-60 cm height with red or purple sub quadrangular branches; leaves simple, opposite, elliptic, oblong, obtuse or acute, entire, serrate or dentate, pubescent on both sides, minutely gland dotted, petioles slender, hairy; flowers small, purplish, in terminal thyrsoid panicles; calyx purplish, 2-lipped, pubescent, upper lip orbicular, reflexed, lower lip 4-lobed; corolla 2-lipped; stamens 4, didynamous, filaments purple, anthers yellow; nutlets ellipsoid, smooth, mucilaginous when wetted. The leaves are acrid, thermogenic, aromatic, antibacterial, insecticidal, antiviral, appetizing, and deodorant (Figure 1).

Figure 1: Showing *Ocimum sanctum* whole plant

Literature reports revealed that the ethanolic extract of Ocimum species found to be potent in showing antimetastatic activity and in boosting antioxidant enzyme activity. Many herbs mentioned in Ayurveda for the treatment of tumors including cancer therapy and are also capable of preventing the side effects with

the complete healing power [17, 18]. Oxidative phosphorylation may cause the emergence of reactive oxygen species (ROS) that can destroy cellular DNA and other natural proteins. Higher amount of ROS may break double stranded DNA and causes the ageing of the cell, cardiac disorders, mutation with in the cells, and cancerous cell growth [19, 20]. Furthermore, synthetic drugs are not only expensive and inadequate for the treatment of diseases but also often associated with adulterations and side effects. Therefore, there is need to search for alternative drugs from plant sources [21, 22]. The primary benefits of using plants derived medicines are that they are relatively safer than synthetic alternatives offering profound therapeutic benefits and more affordable treatment [23]. Phytoconstitutens are the natural bioactive compounds found in plants. Phytochemicals have antioxidant or hormone-like effect which helps in fighting against many diseases including cancer, heart disease, diabetes, high blood pressure and preventing the formation of carcinogens on their target tissues.[24] With this scenario, the present research study was carried out to assess the various antioxidant activities O. sanctum extracts one of the most imperative medicinally valued herb in West Bengal region of India.

MATERIAL AND METHODS

Collection of plant material

The *O. sanctum* plants were collected from different locations of West Bengal, India. The plant sample was identified and authenticated by Dr. Veermani Kumar, Assistant Professor, Department of Botany, YBN University, Ranchi, Jharkhand, India. The collected *O. sanctum* plants were thoroughly washed with tap water to avoid dusts and other unwanted materials accumulated on the leaves from their natural environment. The dust free *O. sanctum* plants were shade, dried at room temperature, and then finely powered with an electric grinder.

Extraction

The finely powdered *O. sanctum* plant was subjected Soxhlet extraction with different solvents *viz.* methanol, ethanol, acetone, chloroform, and hexane for the preparation of different polarity *O. sanctum* extracts. Extracts were continuously stirred for 6 h and kept at room temperature up to 18 h. The process was repeated up to complete extraction. The extract was filtered and concentrated under vacuum in a rotatory evaporator (Buchi Rotavapor, Switzerland) at 40°C. The extract was finally freeze-dried and stored at 4°C for further use.

Determination of antioxidant activities of *O. sanctum* extracts

DPPH radical scavenging assay

The free radical scavenging activity of the *O. sanctum* extracts was tested by appraising their capacity to scavenge 2, 2′-diphenyl-1-picrylhydrazyl (DPPH) stable radicals. The DPPH assay was performed as described previous reports.[8,25] Briefly, the samples (from 0.5 to 500.0 µg/ mL) mixed with 1 mL of 90 µM DPPH solution, were made up with 95% MeOH to a final volume of 4 mL. Butylated hydroxytoluene (BHT), a synthetic antioxidant, was used as a positive control. After 1 h incubation at room temperature, the absorbance was read at 515 nm. Percent radical scavenging concentration was worked out using the following formula:

Radical scavenging (%) = 100 X ($A_{blank} - A_{sample}/A_{blank}$)

Where,

A_{blank}: Absorbance of the control (containing all reagents except the *O. sanctum* extracts)

A_{sample}: Absorbance of the test *O. sanctum* extracts

IC_{50} values: The concentration of *O. sanctum* extracts that caused 50% scavenging of DPPH radicals, and which was calculated from the curve drawn by plotting percent scavenging versus concentration

Guaiacol peroxidase activity (GPX)

The GPX activity was determined according to the modified method of Shevyakova et al., (2002).[26] The activity of GPX in the extract was determined spectrophotometrically by measuring the increase in absorbance at 470 nm. The reaction mixture contained 80 mmol/L guaiacol and 10 mmol/L H_2O_2 in 0.066 mol/L phosphate buffer, pH=7.4. The enzymatic reaction was started by adding 0.1 mL of the extract to 3 mL of reaction mixture. Enzyme activity was calculated as the increase in absorbance (ΔE) min^{-1} g^{-1} extract.

Catalase activity

Catalase activity was assayed as described by Chandlee and Scandalios (1984).[27] Briefly, 500 mg of extract was homogenized in 5 mL of ice cold 50 mM sodium phosphate buffer (pH 7.5) containing in 1mM PMSF. The extract was centrifuged at 4°C for 20 min at 12,500 rpm. The supernatant was used for the enzyme assay. The assay mixture contained 2.6 mL of 50 mL of 50 mM potassium phosphate buffer (pH 7.0) 0.4 mL, 15 mM H_2O_2 and 0.04 mL of enzyme extract. The decomposition of H_2O_2 was followed by the decline in

absorbance at 240 nm. The enzyme activity was expressed in units of 1 mM of H_2O_2 reduction per minute per mg extract.

Ascorbate peroxidase assay

Ascorbate peroxidase was extracted and estimated by the modified method of Asada and Takahashi (1987).[28] Five hundred milligrams of *O. sanctum* extract was grounded in a pestle and mortar using liquid nitrogen and 10 mL of 50 mM potassium phosphate buffer (pH 7.0) containing 1 mm EDTA, 1% PVP and 1 mM ascorbic acid. The homogenate was filtered through a double layered cheese cloth and centrifuged at 15,000 rpm for 20 min at 4°C. The supernatant was used as the source for enzymes. One mL of reaction mixture contained a 50 mM potassium phosphate buffer (pH 7.0), 0.5 mM ascorbic acid, 0.1 mM H_2O_2 and 200 µL of enzyme extract. The absorbance was read as a decrease at 290 nm against the blank, correction was done for the low, non-enzymatic oxidation of ascorbic acid by H_2O_2 (extinction coefficient 2.9 mM^{-1} cm^{-1}). The enzyme activity was expressed in units of per mg of extract.

RESULTS AND DISCUSSION

The results of DPPH radical scavenging assay of *O. sanctum* extracts was represented in Table 1 and plotted in Figure 2. Results depicted that acetone extract of *O. sanctum* exhibited maximum DPPH antioxidant activity i.e., IC_{50} value of 47.50 µg/mL followed by methanol, hexane, chloroform, and ethanol with IC_{50} values of 45.20 µg/mL, 44.30 µg/mL, 42.10 µg/mL, and 39.60 µg/mL respectively. These findings implied that the optimum extraction of secondary phytochemicals mainly polyphenols and flavonoids responsible for DPPH radical scavenging activity was observed in acetone.

Table 1: DPPH radical scavenging assay of different solvent extracts of *O. sanctum*

Solvent Extracts of *O. sanctum*	**DPPH Antioxidant Activity (IC_{50} µg/mL)**
Methanol	45.20
Ethanol	39.60
Acetone	47.50
Chloroform	42.10
Hexane	44.30

Values are expressed as mean; n=3

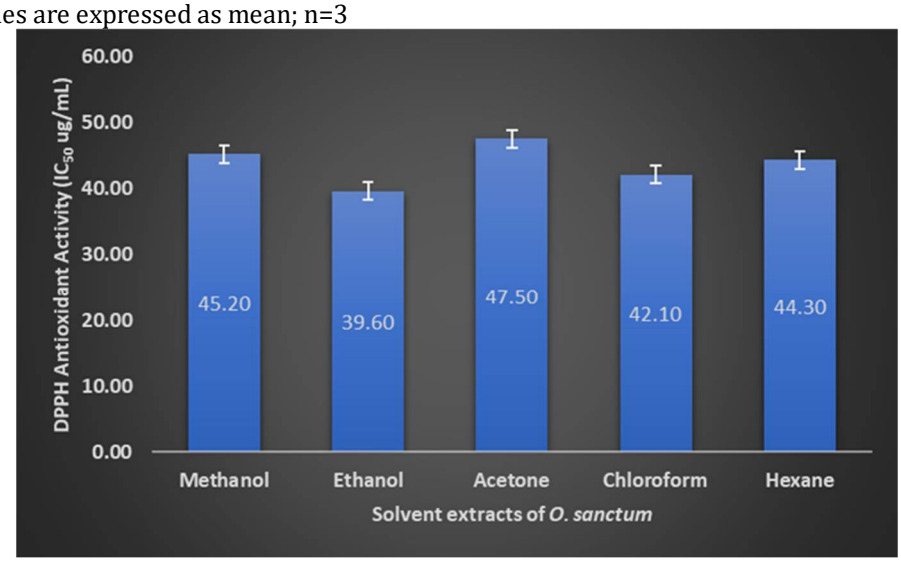

Figure 2: DPPH radical scavenging assay of different solvent extracts of *O. sanctum*

O. sanctum's antioxidant qualities confer a wide range of health advantages. A typical technique for assessing the antioxidant activity of natural substances like plant extracts is the DPPH (2, 2-diphenyl-1-picrylhydrazyl) test. In this test, antioxidants in the sample diminish DPPH radicals, which are stable free radicals, causing a purple color to turn yellow[29]. The results of DPPH radical scavenging assay of *O. sanctum* extracts were comparable with the previous findings reported by various other research investigators in the literature. Chaudhary et al., reported the strongest antioxidant activity in methanol extract of *O. sanctum* with IC_{50} value of 20.31 g/mL, Furthermore, significant antioxidant activity was also demonstrated by the ethanol and water extracts, with IC_{50} values of 26.36 and 32.74 g/mL, respectively

[30]. Accordingly, these results indicate that *O. sanctum* plant extracts have considerable DPPH radical scavenging activity, which may explain some of its health advantages.

The results of GPx activity of *O. sanctum* extracts was represented in Table 2 and plotted in Figure 3. Results revealed that acetone extract of *O. sanctum* possess maximum GPx activity i.e., 2.50 U/mg protein followed by hexane, methanol, chloroform, and ethanol extracts of *O. sanctum* with GPx activities of 2.40 U/mg protein, 2.30 U/mg protein, 2.20 U/mg protein, and 2.10 U/mg protein respectively. These findings depicted that active protein molecules responsible for GPx activity were maximally extracted in acetone.

Table 2: Guaiacol peroxidase activity (GPx) of different solvent extracts of *O. sanctum*

Solvent Extracts of *O. sanctum*	**GPx Activity (U/mg protein)**
Methanol	2.30
Ethanol	2.10
Acetone	2.50
Chloroform	2.20
Hexane	2.40

Values are expressed as mean; n=3

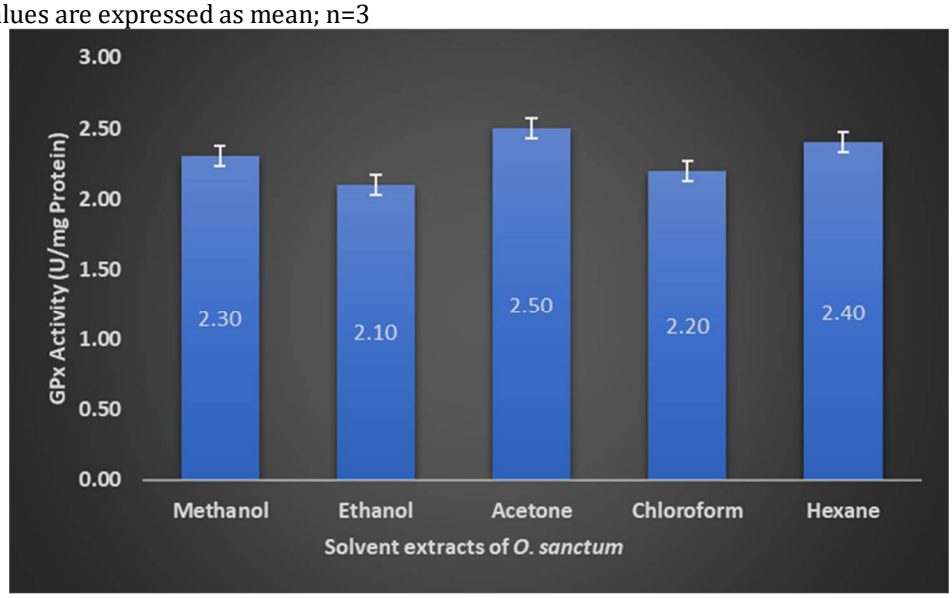

Figure 3: Guaiacol peroxidase activity (GPx) of different solvent extracts of *O. sanctum*

The results of catalase activity of *O. sanctum* extracts was represented in Table 3 and plotted in Figure 4. Results delineated that highest catalase activity of 4.80 U/mg protein was observed in acetone extract of *O. sanctum* followed by 4.60 U/mg protein, 4.50 U/mg protein, 4.30 U/mg protein, and 4.20 U/mg protein in *O. sanctum* extracts of hexane, methanol, chloroform, and ethanol respectively. These findings indicated that phytoactives ascribed to catalase activities were optimally extracted in acetone.

Table 3: Catalase activity of different solvent extracts of *O. sanctum*

Solvent Extracts of *O. sanctum*	**Catalase Activity (U/mg protein)**
Methanol	4.50
Ethanol	4.20
Acetone	4.80
Chloroform	4.30
Hexane	4.60

Values are expressed as mean; n=3

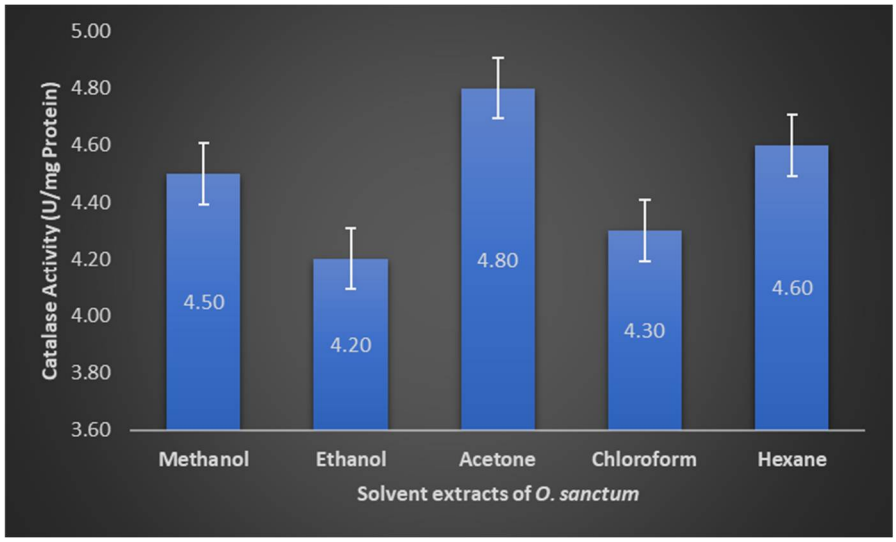

Figure 4: Catalase activity of different solvent extracts of *O. sanctum*

The results of ascorbate peroxidase activity of *O. sanctum* extracts was represented in Table 4 and plotted in Figure 5. Results revealed that acetone extract of *O. sanctum* exhibited maximum ascorbate peroxidase activity i.e., 3.50 U/mg protein followed by hexane, methanol, chloroform, and ethanol extracts of *O. sanctum* with ascorbate peroxidase activities of 3.30 U/mg protein, 3.20 U/mg protein, 3.00 U/mg protein, and 2.80 U/mg protein respectively. These findings depicted that active protein molecules responsible for ascorbate peroxidase activity were maximally dissolvable in acetone.

Table 4: Ascorbate peroxidase activity of different solvent extracts of *O. sanctum*

Solvent Extracts of *O. sanctum*	**Ascorbate Peroxidase Activity (U/mg protein)**
Methanol	3.20
Ethanol	2.80
Acetone	3.50
Chloroform	3.00
Hexane	3.30

Values are expressed as mean; n=3

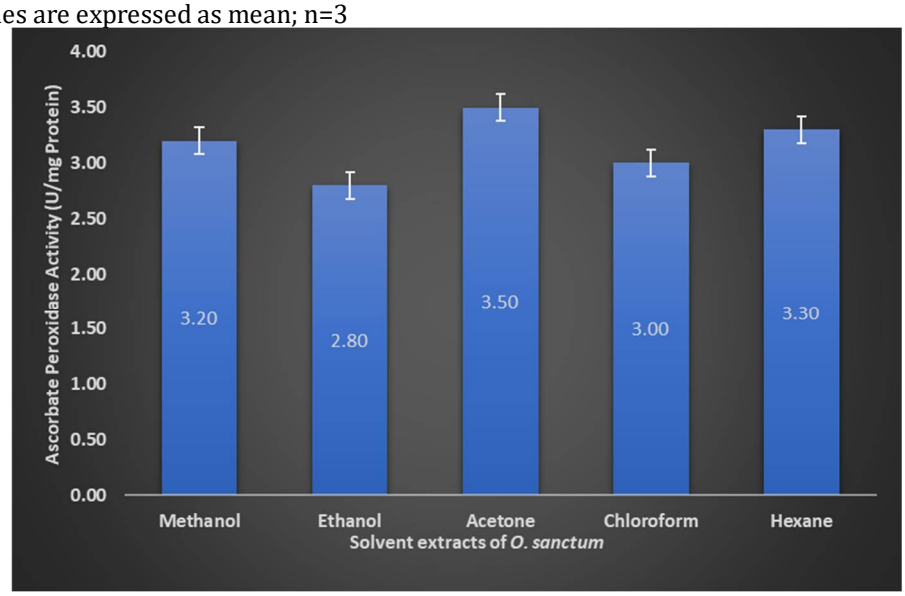

Figure 5: Ascorbate peroxidase activity of different solvent extracts of *O. sanctum*

Ascorbate is one of the most extensively studied antioxidant and has been detected in the majority of plant cell types, organelles and apoplast. Ascorbic acid is readily oxidised to monodehydro ascorbic acid as part of its antioxidant function. Ascorbic acid prevents or reduces oxidative damage as reported in uniconazole

treated tomato seedlings [31]. An increase in catalase activity was noted in barley leaves and there by effective scavenging of H_2O_2 to provide antioxidant defense mechanism [32]. The H_2O_2 scavenging system represented by ascorbate peroxidase and catalase are more important in imparting tolerance than super oxide dismutase [33, 34].

The antioxidant property of plant extracts depends on the amount of flavonoids and phenolic acids of extracts [35]. The release of secondary metabolites including phenolic acids and flavonoids from plants may vary from plant to plant and species to species. Some previous reports in the literature revealed that the variation in the antioxidant potential of different *O. sanctum* around the world [36-38]. The *O. sanctum* analyzed in the present study exhibited comparable antioxidant activity with that reported in the literature.[37] The variation in the antioxidant activity might be ascribed to the varied phenolic profiles of *O. sanctum* species native to West Bengal state of India.

CONCLUSION

The results of this study clearly demonstrated that acetone extract of *O. sanctum* possess highest antioxidant potential than other extracts of *O. sanctum* viz. methanol, ethanol, chloroform, and hexane. Hence, the acetone extract of *O. sanctum* could be explored for the development of natural antioxidant agents.

AUTHOR CONTRIBUTION STATEMENT

Siddhartha Sankar Ghosh and Kamal Kant Patra were involved in the execution of all the field collection & laboratory work and data analysis. Veermani Kumar was contributed his valuable guidance as plant identification. Keshamma E contributed her guidance on laboratory skills for research work and in preparation of the current manuscript. All authors have read and approved the final manuscript before its submission.

CONFLICT OF INTEREST

None to declare.

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REFERENCES

1. Kunwar RM, Adhikari N. (2005). Ethnomedicine of Dolpa district, Nepal: the plants, their vernacular names and uses. Lyonia. 8(1):43-9.
2. UNESCO F. (1980). 504-RAF-48 Terminal Report: Promotion of ethnobotany and the sustainable use of plant resources in Africa. Paris, France.60.
3. Shahidi F, Janitha PK, Wanasundara PD. (1992). Phenolic antioxidants. Critical reviews in food science & nutrition.;32(1):67-103.
4. Mohammad Dallak MD, Al-Khateeb M, Moh'd Abbas MD, Riyadh Elessa RE, Al-Hashem F, Nabil Bashir NB, Mohammad Khalil MK. (2009). In vivo, acute, normo-hypoglycemic, antihyperglycemic, insulinotropic actions of orally administered ethanol extract of *Citrullus colocynthis* (L.) Schrab pulp. American Journal of Biochemistry and Biotechnology.;5:119–126.
5. Uddin MN, Mitra K, Haque MZ. (2016). Comparative bio-active compounds determination and in vitro antioxidant properties of newly developed soy mixed wheat flour and traditional wheat flour. International journal of food properties.19(9):2113-26.
6. Ali S, Chatha SA, Ali Q, Hussain AI, Hussain SM, Perveen R. (2016). Oxidative stability of cooking oil blend stabilized with leaf extract of *Eucalyptus citriodora*. International Journal of Food Properties. 19(7):1556-65.
7. Lee OH, Lee BY. (2010). Antioxidant and antimicrobial activities of individual and combined phenolics in *Olea europaea* leaf extract. Bioresource technology.101(10):3751-4.
8. Hussain AI, Anwar F, Sherazi ST, Przybylski R. (2008). Chemical composition, antioxidant and antimicrobial activities of basil (*Ocimum basilicum*) essential oils depends on seasonal variations. Food chemistry. 108(3):986-95.
9. Hussain AI, Anwar F, Rasheed S, Nigam PS, Janneh O, Sarker SD. (2011). Composition, antioxidant and chemotherapeutic properties of the essential oils from two Origanum species growing in Pakistan. Revista Brasileira de Farmacognosia. 21:943-52.
10. Mazandarani M, Moghaddam Z, Zolfaghari MR, Ghaemi EA, Bayat H. (2012). Effects of solvent type on phenolics and flavonoids content and antioxidant activities in *Onosma dichroanthum* Boiss. J Med Plants Res.6(28):4481-8.

11. Nunes PX, Silva SF, Guedes RJ, Almeida S. (2012). Biological oxidations and antioxidant activity of natural products. Phytochemicals as nutraceuticals-Global Approaches to Their Role in Nutrition and Health. 278.
12. Lobo V, Patil A, Phatak A, Chandra N. (2010). Free radicals, antioxidants and functional foods: Impact on human health. Pharmacognosy reviews. 4(8):118.
13. Sarija KS, Mohan S, Nagaraja P, Hashim KM. (2014). In vitro antioxidant studies and phytochemical screening on the seeds of *Corchorus trilocularis*. Der Pharmacia Sinica. 5(5):82-5.
14. Amuthavalluvan V. (2011). Ethnomedicinal practices and traditional healing system of Kattunayakan in Tamilnadu: An anthropological study. International Multidisciplinary Research Journal. 1(7):47-51.
15. Farnsworth NR, Morris RW. (1976). Higher plants-the sleeping giant of drug development. Am J Pharm Sci Support Public Health;148(2):46-52.
16. De Smet PA. (1997). The role of plant-derived drugs and herbal medicines in healthcare. Drugs 54(6):801-40.
17. Joseph BA, Nair VM. (2013). *Ocimum sanctum* Linn. (Holy basil): Pharmacology behind its anti-cancerous effect. Int J Pharm Bio Sci;4(2):556-75.
18. Chanda S, Nagani K. (2013). *In Vitro* and *In Vivo* methods for anticancer activity evaluation and some Indian medicinal plants possessing anticancer properties: An overview. J Pharmacogn Phytochem ;2(2):2856.
19. Symons MC, Gutteridge JM. (1998). Free Radicals and Iron: Chemistry, Biology, and Medicine. Oxford, UK: Oxford University Press.
20. Halliwell B, Aruoma OI. (1991). DNA damage by oxygen-derived species. Its mechanism and measurement in mammalian systems. FEBS Lett ;281(1-2):9-19.
21. Benkeblia N. (2004). Antimicrobial activity of essential oil extracts of various onions (*Allium cepa*) and garlic (*Allium sativum*). LWT-food science and technology. ;37(2):263-8.
22. Akerele O. (1993). WHO guidelines for the assessment of herbal medicines. Herbal Gram;1993; 22:13-28
23. Chopra RN, Nayer SL, Chopra IC, (1992). Glossary of Indian Medicinal Plants, Council of Scientific and Industrial Research.37:7–246.
24. Daniel VN, Daniang IE, Nimyel ND. (2011). Phytochemical analysis and mineral elements composition of *Ocimum basilicum* obtained in jos metropolis, plateau state, Nigeria. IJET-IJENS. 11(6):161-5.
25. Hussain AI, Rathore HA, Sattar MZ, Chatha SA, Ahmad F, Ahmad A, Johns EJ. (2013). Phenolic profile and antioxidant activity of various extracts from *Citrullus colocynthis* (L.) from the Pakistani flora. Industrial crops and products. 45:416-22.
26. Shevyakova NI, Stetsenko LA, Meshcheryakov AB, Kuznetsov VV. (2002). The activity of the peroxidase system in the course of stress-induced CAM development. Russian Journal of Plant Physiology. 49:598-604.
27. Chandlee JM, Scandalios JG. (1984). Analysis of variants affecting the catalase developmental program in maize scutellum. Theoretical and applied genetics. 69:71-7.
28. Asada K, Takahashi M. (2005). Production and scavenging of active oxygen photosynthesis. In 'Photoinhibition. Topics in photosynthesis. Vol. 9'. pp. 227–287.
29. Saeed N, Khan MR, Shabbir M. (2012). Antioxidant activity, total phenolic and total flavonoid contents of whole plant extracts Torilis leptophylla L. BMC complementary and alternative medicine. 12:1-2.
30. Chaudhary A, Sharma S, Mittal A, Gupta S, Dua A. (2020). Phytochemical and antioxidant profiling of *Ocimum sanctum*. Journal of Food Science and technology. 57(10):3852-63.
31. Senaratna T, Mackay CE, McKersie BD, Fletcher RA. (1988). Uniconazole-induced chilling tolerance in tomato and its relationship to antioxidant content. Journal of plant physiology. 133(1):56-61.
32. Vanacker H, Carver TL, Foyer CH. (1998). Pathogen-induced changes in the antioxidant status of the apoplast in barley leaves. Plant physiology. 117(3):1103-14.
33. Willekens H, Chamnongpol S, Davey M, Schraudner M, Langebartels C, Van Montagu M, Inzé D, Van Camp W. (1997). Catalase is a sink for H_2O_2 and is indispensable for stress defence in C3 plants. The EMBO journal.16(16):4806-16.
34. Sairam RK, Deshmukh PS, Saxena DC. (1998). Role of antioxidant systems in wheat genotypes tolerance to water stress. Biologia plantarum. ;41:387-94.
35. Selvam K, Rajinikanth R, Govarthanan M, Paul A, Selvankumar T, Sengottaiyan A. (2013). Antioxidant potential and secondary metabolites in *Ocimum sanctum* L. at various habitats. Journal of Medicinal Plants Research. 7(12):706-12.
36. Beatovic DV, Jelacic SC, Oparnica CD, Krstic-Milosevic DB, Glamoclija JM, Ristic MS, Siljegovic JD. (2013). Chemical composition, antioxidative and antimicrobial activity of essential oil *Ocimum sanctum* L. Hemijska industrija. 67(3):427-35.
37. Joshi RK. (2013). Chemical composition, in vitro antimicrobial and antioxidant activities of the essential oils of *Ocimum gratissimum*, *O. sanctum* and their major constituents. Indian journal of pharmaceutical sciences. 75(4):457.
38. Salles Trevisan MT, Vasconcelos Silva MG, Pfundstein B, Spiegelhalder B, Owen RW. (2006). Characterization of the volatile pattern and antioxidant capacity of essential oils from different species of the genus Ocimum. Journal of agricultural and food chemistry.54(12):4378-82.

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