RESEARCH ARTICLE

Antioxidant Potential of *Solanum Xanthocarpum* Fruit Extract

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ABSTRACT

A high concentration of biologically active chemicals that have a beneficial impact on human health is one of the distinguishing characteristics of herbs. Folk medicine has a long history of using medicinal plants as natural therapies for healing, with therapeutic benefits that include the prevention of cardiovascular illnesses, inflammatory problems, and the reduction of the risk of cancer. In addition, the pharmacological business makes use of medicinal plants since these plants contain active chemical compounds that may be used as agents in the construction of pharmaceuticals. Because of the presence of antioxidants and antibacterial elements, they are also useful as additives in the food and cosmetics industries. This is because of the preservation effects that they have. Utilizing 1,1-diphenyl-2-picrylhydrazine, the 2,2-diphenyl-1-picrylhydrantiiazyl (DPPH) free radical scavenging test was used in order to determine the antioxidant activity. For the last several decades, there has been a growing trend of conducting screening research for the antioxidant capabilities of medicinal and food plants. The goal of these studies is to discover an effective treatment for a variety of illnesses that are prevalent in today's society, as well as a way to postpone the signs of aging.

Keywords: DPPH, Antioxidant, *Solanum xanthocarpum,* Medicinal Plants

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INTRODUCTION

A significant amount of the chemicals that humans need may be found in nature. Natural sources are the primary source of the majority of the pharmacological chemicals and active compounds that are used in the treatment of a variety of ailments or in the preparation of pharmaceuticals.[1] Synthetic antioxidants, which are commonly utilized in both food and medication, are known to produce or encourage adverse effects on human health. As a result, there is a rising interest in studies looking at natural compounds that might potentially act as antioxidants.[2] Antioxidants and free radical scavengers are two functions that polyphenolic compounds may perform, making them an essential component of the human body. Medicinal plants or parts of these plants (leaves, rhizomes, roots, seeds, flowers) can be utilized in different forms such as fresh crude form and preparations as teas, decoctions, powdered plant material, or extracted forms of medicinal agents (juices, water or alcohol extracts, tinctures, essential oils, resins, balsams).[3,4] The pharmaceutical industry places a high value on medicinal plants because of the chemical contents and active chemicals that they contain. These molecules include polyphenols and flavonoids, glycosides, alkaloids, and tannins, all of which have the potential to be used as agents in the production of pharmaceuticals. In addition to their use in medicine, they may also be significant in the field of nutrition due to the fact that they contain a great deal of physiologically active compounds, such as vitamins or components of essential oils.[5] As a result of the presence of antioxidants and antibacterial elements, as well as the taste and coloring qualities of some medical plants, they are also used in the food business and the cosmetics sector. This is owing to the fact that they demonstrate a preservation effect. The use of a wide variety of medicinal herbs for culinary reasons is also extremely common in the diet of the average person, both for the goal of flavoring a variety of meals and dishes.[6] Not only are they common in the Eastern area, but they are also common in Western nations. A significant yearning for things that are natural has emerged in the industrialized world, particularly in the United States, over the course of the last several decades. Despite the fact that the natural and artificial exemplars are stated to be chemically equivalent, the majority of persons who prefer natural continue to prefer it.[7] Therefore, medicinal plants as natural sources might be of considerable economic value not only because of their use in medicine but also as food additives (for example, as antioxidants owing to their powerful antioxidant impact) taken from natural sources. This is because medicinal plants used in medicine have a high antioxidant effect. Medicinal herbs are well-known and widely used for a variety of health advantages, including the reduction of blood pressure, the prevention of cardiovascular disorders, and the reduction of the risk of cancer owing to the antioxidant activity of these plants.[8] The objective of this research is to investigate the antioxidant capabilities of the fruit extract of Solanum xanthocarpum in mice that have been selected for the experiment. In addition, there are a number of pharmaceuticals consisting of isolated chemical

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components that need more investigation in order to evaluate their usefulness. Additionally, understanding the major chemical constituents that are responsible for pharmacological actions would be helpful in constructing a proper yardstick for assessing quality.[9] This is because the full crude is used in therapeutic formulations that are based on indigenous medicinal systems. Solanum xanthocarpum is a perennial plant belonging to the family Solanaceae. It has a brilliant green color and a highly spiky, dispersed appearance. This plant may be found in large quantities all across India, particularly on the plains of arid areas, along roadsides, wastelands, and garbage heaps. It has been discovered that the S. xanthocarpum plant, which is a member of the dashmula family of the Ayurvedic system, has anti-asthematic, hypoglycemic, hepatoprotective, anti-inflammatory, antipyretic, and nephron-protective properties. In the course of this research, the objective was to determine whether or not the seeds obtained from the raw fruits and leaves of S. xanthocarpum display antioxidant activity in cultures.

Table 1: Physicochemical parameters of *Solanum Xanthocarpum* fruit

S. No.	Physicochemical parameter values	(% w/w)
1	Total ash	7.89
2	Water soluble ash	4.35
3	Acid insoluble ash	1.23
4	Loss on drying	12.2
5	Alcohol soluble extractive	12.07
6	Water soluble extractive	14.98
7	Foreign organic matter determination	0.8

Table 2: Solvent extractive values (%w/w) of *Solanum Xanthocarpum* fruit

S. No.	Name of extract	Extractive value (% w/w)
1	Petroleum ether	1.68
2	Chloroform extract	2.13
3	Methanol Extract	9.62
4	Water Extract	10.24

MATERIAL AND METHODS

Collection, Authentication of Plant and Preparation of Samples

The fruits of Solanum Xanthocarpum were collected from the malwa region. The plant was identified and authenticated. Fresh fruits were used for Pharmacognostical studies. The fruits were dried under shade and powdered to 60# separately and stored in airtight containers and used for phytochemical and pharmacological studies.

Pharmacognostic Evaluation

Air-dried powdered material was subjected to qualitative and quantitative physicochemical estimations.

Physicochemical Evaluation: Proximate Analysis

Physicochemical (Proximate) analysis helps to set up certain standard for dried crude drugs in order to avoid batch-to-batch variation and also to judge their quality. Their studies also give an idea regarding the nature of phytoconstituents present. Proximate analysis of Solanum Xanthocarpum fruits powders were carried out using methods prescribed in the Ayurvedic pharmacopoeia of India by subjecting them to various determinations like Total Ash, Acid insoluble ash, Water soluble ash, Alcohol soluble extractive value, Water soluble extractive value, Loss of moisture content, Swelling index.

Extraction and Isolation of the Compounds from *Solanum Xanthocarpum*

Methanol extract (200g) was partitioned between ethyl acetate and water. The ethyl acetate soluble portion was concentrated by evaporation and fractionated by silica gel column chromatography (Merck 200 mesh) with n-hexane–ethyl acetate mixtures of increasing polarity as eluent to yield three fractions. Fraction 1 elute with (n-hexane: ethyl acetate 80: 20), Fraction 2 (n-hexane: ethyl acetate 40: 60), and Fraction 3 (n-hexane: ethyl acetate 10: 90). Fraction 1was rechromatographed on a silica gel column chromatography eluting with n-hexane–EtOAc (50: 50) to yield compound 1.

Fraction 2 was rechromatographed on silica gel using n-hexane–EtOAc (1: 2) to yield two subfractions; sub-fractions 1 and 2. Subfraction 2 was showed single spot on

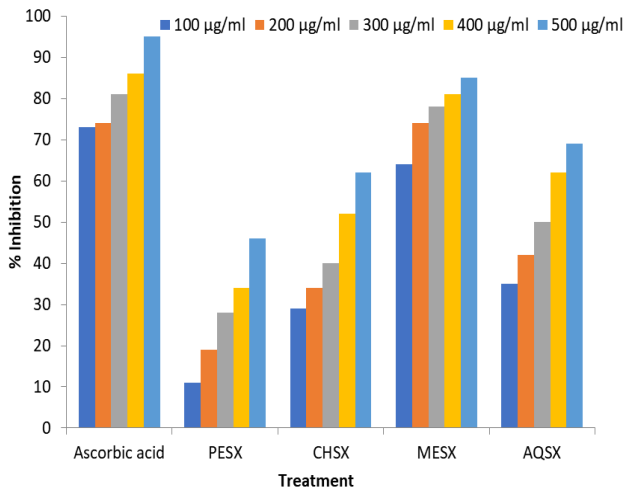

Figure 1: Graphical representation of Solanum Xanthocarpum fruits extracts on DPPH radical scavenging model

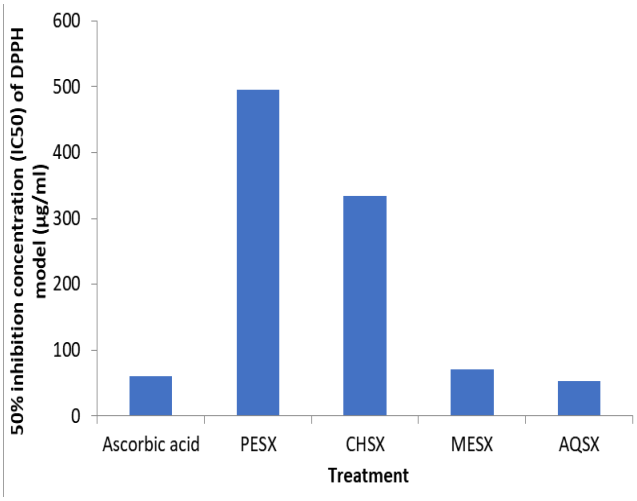

Figure 2: Graphical representation of 50% Inhibitory Concentration (IC50) Solanum Xanthocarpum fruits extracts and Ascorbic acid on DPPH radical scavenging model

Table 3: Phytochemical analysis of *Solanum Xanthocarpum* extracts

S. No.	Chemical class	Chemical test	Petroleum ether extract	Chloroform extract	Methanol extract	Water Extract
1	Alkaloids	Dragendorff's test	-	+	+	+
2	Napthoquinone	Juglone test	-	-	+	-
2	Steroids	Salkowaski test	+	+	+	-
3	Carbohydrate	Molish test	-	-	+	+
4	Triterpenes	Vanillin-sulphuric acid test	+	+	-	-
5	Tannin	Ferric chloride test	-	-	+	+
6	Glycoside	Keller-killani test	-	-	+	+
7	Proteins	Biuret test	-	-	+	+
8	Flavonoids	Shinoda Test	-	-	+	+
9	Saponins	Lead acetate test	-	-	+	+

Where, + is Present and - is Absent

TLC and yield compound 2. The structures of the isolated compounds were confirmed by 1 H NMR and mass spectra.

Anti-oxidant Activity

Antioxidants may be defined as any substance, when present at low concentration compared with those of an oxidizable substrate, significantly delays or prevents oxidation of that substrate in a chain reaction. Antioxidants have become a popular research topic because they cannot be generated by the human body and hence have to be consumed in the diet. Many fruit and vegetables have been found to be rich sources of antioxidants. Since a large portion of the human diet is based on fruit and vegetables, it is important to understand the biological and biochemical interactions between these dietary antioxidants and living systems.[9]

Chemicals and Plant Extract

1,1-diphenyl-2-picryl hydrazyl (DPPH), DMSO, Ascorbic acid Sodium nitro prusside, Griess reagent (1%w/v sulphanilamide, 2% w/v H3PO4 and N-(1-naphthyl) ethylene diamine di hydrochloride), Hydrogen peroxide (H2O2) Thiobarbituric acid Sodium phosphate buffer, 1mM ferric chloride Nitro blue tetrazolium Phenazene methosulphate, Nicotinamide adenine phosphate di nucleotide

PESX: Petroleum ether extract of Solanum Xanthocarpum fruits (100-500µg/ml)

CHSX: Chloroform extract of Solanum Xanthocarpum fruits (100-500µg/ml)

MESX: Methanol extract of Solanum Xanthocarpum (100-500µg/ml)

AQSX: Aqueous extract of Solanum Xanthocarpum (100-500µg/ml)

Antioxidant actions might be exerted by inhibiting generation of reactive oxygen species and reactive nitrogen species or by directly scavenging free radical or by raising the levels of endogenous antioxidant enzymes by up regulating expression of the genes encoding superoxide dismutase, catalase or glutathione peroxidase. For the assessment of free radical scavenging activity, the extracts of selected plants Petroleum ether, chloroform and methanol extracts of Solanum Xanthocarpum fruits were dissolved in 5% DMSO. DPPH, Nitric oxide, hydroxyl radical, superoxide radical methods were carried in the present study.

Determination of DPPH Radical Scavenging Activity of *Solanum Xanthocarpum* Fruits Extracts

The free radical scavenging activity of the Petroleum ether, chloroform and methanol extracts of Solanum Xanthocarpum fruits were evaluated using 1,1 diphenyl-2-picryl hydrazyl (DPPH), by the method described by (Brand- Williams et al, 1995). In its radical form, DPPH absorbs at 517nm, but upon reduction by an antioxidant or

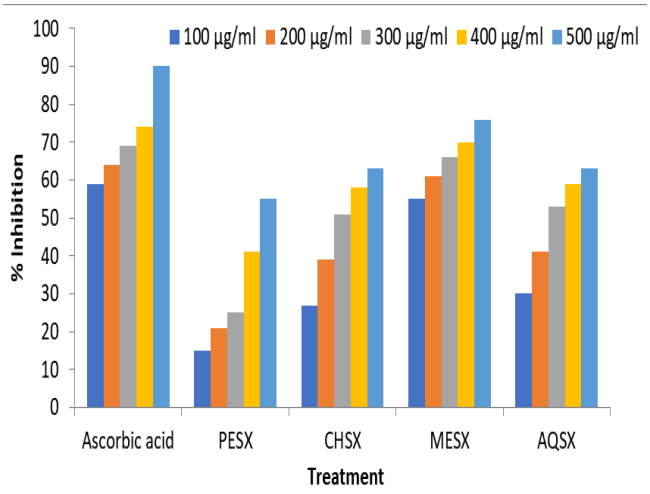

Figure 3: Graphical representation of Solanum Xanthocarpum fruits extracts on Nitric oxide radical scavenging model

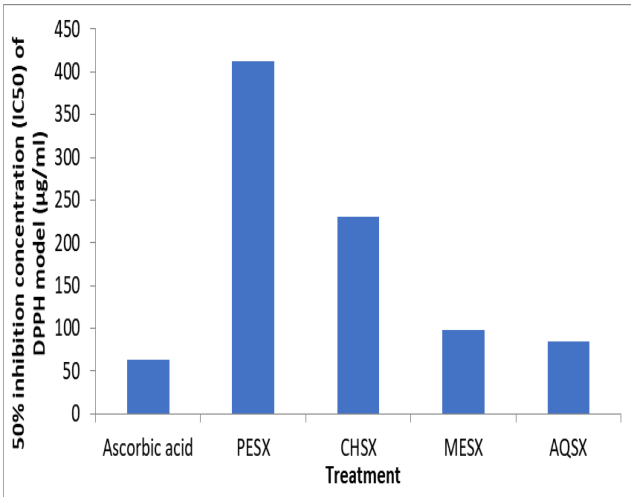

Figure 4: Graphical representation of 50% Inhibitory Concentration (IC50) Solanum Xanthocarpum fruit and Ascorbic acid on Nitric oxide radical scavenging model

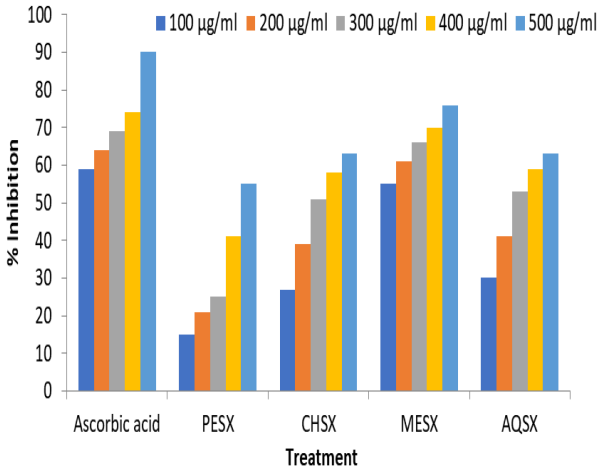

Figure 5: Graphical representation of Solanum Xanthocarpum fruit extracts on Hydroxyl radical scavenging model

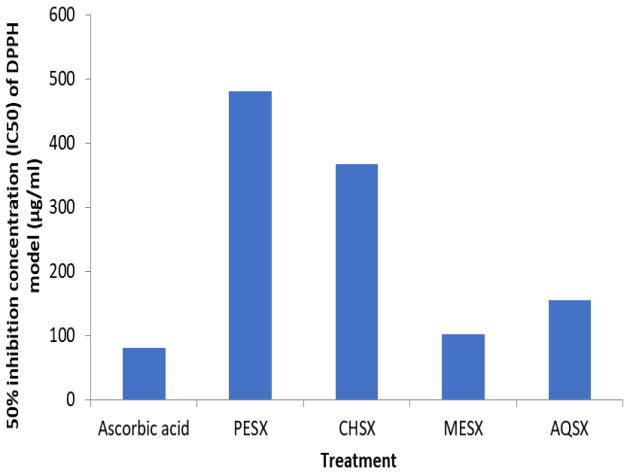

Figure 6: Graphical representation of 50%Inhibitory Concentration (IC50) Solanum Xanthocarpum fruit extracts and Ascorbic acid on Hydroxyl radical scavenging model

Table 4: Results of Solanum Xanthocarpum fruits extracts on DPPH radical scavenging model

Concentration	100µg/ml	200 µg/ml	300 µg/ml	400 µg/ml	500 µg/ml
Ascorbic acid	73.12	76.04	81.08	86.05	95.15
PESX	11.85	19.25	28.25	34.17	46.12
CHSX	29.14	34.87	40.28	52.47	62.87
MESX	64.87	74.29	78.95	81.98	85.65
AQSX	35.14	42.63	50.14	62.24	69.35

a radical species, the absorption decreases.1ml of 0.25mM solution of DPPH in DMSO was added to the different concentrations of selected plant extracts which were dissolved in DMSO (100- 500µg/ml). After 30 min, the absorbance was measured at 517nm by UV-Visible spectrophotometer (shumadzu UV-Vis1800). All the test analysis were run in triplicate and averaged. Lower absorbance of reaction mixture indicates higher free radical scavenging activity. Ascorbic was used as a positive control. Ascorbic acid was used as a standard.[10] The percentage DPPH decolonization of the sample was calculated by the equation:

$$Percentage\ of\ DPPH\ scavenging\ = \left[\frac{A0-A1}{A0}\right] X\ 100$$

A0 = Absorbance of the control, and
A1=Absorbance of the extract/ standard.

Determination of Nitric Oxide (NO) Radical Scavenging Activity of *Solanum Xanthocarpum* Fruits Extracts

Nitric oxide radical scavenging activity the method used was based on the standard methods with some modification (Sreejayan and Rao 1997). Nitric oxide (NO) was generated from sodium nitro prusside (SNP) and was measured by the griess reagent (1% w/v sulfanilamide, 2%w/v H3PO3 and 0.1% w/v N-(1-Naphthyl) ethylene diamine dihydrochloride). SNP in aqueous solution at physiological PH spontaneously generates NO, which interacts with oxygen to produce nitrite ions that can be estimated by the use of griess reagent. Scavengers of NO compete with oxygen leading to reduced production of NO. SNP (1ml of mM) was mixed with 1ml of selected plants extracts in different concentrations (100µg/ml-500µg/ml) in (Di methyl sulphoxide) DMSO. The mixture was incubated at 25ºc for 180 minutes. To 1ml of the incubated solution, 1ml

Table 5: *In vitro* 50% inhibition concentration (IC_{50}) of Solanum Xanthocarpum fruits extracts on DPPH radical scavenging model

Extract /compound	50% inhibition concentration (IC_{50}) of DPPH model (µg/ml)
Ascorbic acid	61
PESX	496
CHSX	334
MESX	70.32
AQSX	53.25

of griess reagent was added. The absorbance of the chromophores formed during the diazotization of nitrite with sulphanilamide and subsequent coupling with N-(1-naphtyl) ethylene diamine dihydrochloride was read at 546nm by UV-Visible spectrophotometer (Shimadzu UV-Vis1800). All the test analysis were run in triplicate and averaged. Lower absorbance of reaction mixture indicates higher free radical scavenging activity.[11] Ascorbic was used as a positive control. The percentage inhibition was calculated by

$$Percentage\ of\ Nitric\ oxide\ scavenged\ = [(A0-A1)/A0]X\ 100$$

Where A0 = Absorbance of the control, and
A1 =Absorbance of the extract/ standard.

Determination of Hydroxyl Radical Scavenging Activity of *Solanum Xanthocarpum* Fruits Extracts

Hydroxyl radical scavenging activity was determined by the method of (Halliwell et al 1995) based on the ability to compete with deoxyribose for hydroxyl radical. Hydroxyl radical produced by the reduction of H_2O_2 by iron in the presence of ascorbic acid degrade deoxyribose to form products, which on heating with 2-thiobarbuturic acid

Table 6: Results of Solanum Xanthocarpum fruits extracts on Nitric oxide radical scavenging model

Concentration	100µg/ml	200 µg/ml	300 µg/ml	400 µg/ml	500 µg/ml
Ascorbic acid	71.42	74.04	78.08	84.05	93.35
PESX	11.54	24.34	37.21	40.25	53.25
CHSX	51.23	54.86	56.74	64.34	70.13
MESX	61.87	68.87	72.25	75.65	81.25
AQSX	53.37	56.24	59.62	65.45	72.05

(TBA) for a pink coloured chromogen. The reaction mixture, of a final volume of 1ml, containing 0.4ml of 20mM sodium phosphate buffer (pH 7.4), 0.1ml of 100-500 µg/ml of selected plant extracts in DMSO, 0.1ml of 60mM deoxyribose, 0.1 ml of 10mM H2O2, 0.1 ml of 1mM ferric chloride, 0.1 ml of 1Mm Ethylene diamine tetra acetic acid (EDTA) and 0.1ml of 2mM 1-ascorbic acid, was incubated at 370 C for 1 h. The reaction was terminated by the addition of 1 ml of 17mM TBA and 1ml of 17Mm trichloro acetic acid (TCA). The mixture was boiled for 15 min, cooled in ice and the absorbance was measured at 532nm by UV-Visible spectrophotometer (Shimadzu UV-Vis 1800). All the test analysis were run in triplicate and averaged. L-Ascorbic acid was used as a positive control.[12] The hydroxyl radical scavenging of the extract was reported as the percentage of inhibition of the deoxyribose degradation and was calculated according to the following equation

Calculation of % Inhibition

$$\%\ Inhibition\ =\ [(A0 - AT)/A0] \times 100$$

Where A0 = Absorbance of the control, and
AT =Absorbance of the extract/ standard.

RESULTS AND DISCUSSION

Physicochemical Evaluation

Physicochemical parameter such as Ash values (Total ash, Acid insoluble ash and Water soluble ash), Extractive values, Loss on drying of selected plant drugs Solanum Xanthocarpum fruit were performed. Ash values of crude drug provide an idea about the inorganic composition or earthy matter and other impurities present in drug. The extractive values are mainly useful for the determination of adulterated or exhausted drug. All parameters of both drugs were found within the limit as per standard books. Results of physicochemical parameters of *Solanum Xanthocarpum fruit* are shown in 1.

Preliminary Phytoprofiles Screening of Leaves of *Solanum Xanthocarpum* Fruit

Extraction process of plant metabolites in the crude drugs. Extractive values are useful for the evaluation of nature of the active phytoconstituents present in the drug especially when the constituents of a drug cannot be readily estimated by any other means.

Methanol Extracts of selected plant drugs Solanum Xanthocarpum fruit was obtained by continuous soxhlet were subjected to qualitative phytochemical tests to identify the presence of secondary metabolite (viz., alkaloids, glycosides, tannins, flavonoids, sterols, fats, oils, phenols and saponins) present in them. Aqueous extract obtained by maceration method are also subjected to qualitative phytochemical tests. Phytochemical screening of Solanum Xanthocarpum showed that Methanol extract showed the presence of carbohydrates, glycosides, alkaloids, tannins, flavanoids, protein and amino acids and saponins whereas Water extract showed the presence of carbohydrates, tannins, flavanoids, protein and amino acids and saponins. Results are presented in Table 3.

Table 7: *In vitro* 50% inhibition concentration (IC_{50}) of Solanum Xanthocarpum fruits extracts on Nitric oxide radical scavenging model

Extract /compound	50% inhibition concentration (IC_{50}) NO model (µg/ml)
Ascorbic acid	65.4
PESX	412.4
CHSX	230.2
MESX	98.5
AQSX	85.6

Anti-oxidant Activity

Analysis of the free radical scavenging activities of the Solanum Xanthocarpum fruits extracts revealed a concentration dependent free radical scavenging activity resulting from reduction of DPPH, NO, Hydroxyl radical and superoxide radical radical to non-radical form. The scavenging activity of Ascorbic acid, a known antioxidant used as positive control, was however higher.

DPPH Radical Scavenging Activity of *Solanum Xanthocarpum* Fruits Extracts

DPPH radical is considered to be a model for a lipophilic radical. A chain in lipophilic radicals was intiated by the lipid autoxidation. DPPH is a stable free radical at room temperature and accepts an electron or hydrogen radical to become a stable diamagnetic molecule. The reduction capacity of DPPH was determined by the decrease in its absorbance at 517nm, which is induced by antioxidant. Positive DPPH test suggests that the samples were free radical scavengers. The scavenging effect of l-Ascorbic acid, and plant extracts increased gradually with increase in concentration.

Percentage Inhibition of in vitro anti oxidant result of various Solanum Xanthocarpum fruits extracts by DPPH Method and ascorbic acid as standard at various concentrations are given in Table 4, and Figure 1. In case of Solanum Xanthocarpum extracts the order of reduction potential was: Ascorbic acid> MESX > AQSX > CHSX > PESX.

PESX: Petroleum ether extract of Solanum Xanthocarpum fruits (100-500µg/ml)

CHSX: Chloroform extract of Solanum Xanthocarpum fruits (100-500µg/ml)

MESX: Methanol extract of Solanum Xanthocarpum (100-500µg/ml)

AQSX: Aqueous extract of Solanum Xanthocarpum (100-500µg/ml)

Table 8: Results of Solanum Xanthocarpum fruit extracts on Hydroxyl radical scavenging model

Concentration	100µg/ml	200 µg/ml	300 µg/ml	400 µg/ml	500 µg/ml
Ascorbic acid	59.25	64.47	69.28	74.15	90.36
PESX	15.78	21.54	25.63	41.28	55.24
CHSX	27.48	39.34	51.41	58.26	63.37
MESX	55.38	61.26	66.38	70.24	76.26
AQSX	30.48	41.34	53.41	59.26	63.37

Note: All the results showed hydroxyl radical scavenging activity in a dose dependent manner.

Table 9: *In vitro* 50% inhibition concentration (IC_{50}) of Solanum Xanthocarpum fruit extracts on hydroxyl radical scavening model

Extract /compound	50% inhibition concentration (IC_{50}) Hydroxyl radical model (µg/ml)
Ascorbic acid	81
PESX	482
CHSX	368
MESX	103
AQSX	156

Percentage Inhibition of in vitro anti oxidant result of various Solanum Xanthocarpum fruits extracts by DPPH Method and ascorbic acid as standard at various concentrations are given in Table 5, and Figure 2. In case of Solanum Xanthocarpum extracts the order of reduction potential was: Ascorbic acid> MESX > AQSX > CHSX > PESX.

Nitric Oxide (NO) Radical Scavenging Activity of *Solanum Xanthocarpum* Fruits Extracts

Nitric oxide plays an important role in various types of inflammatory processes in the body. In the present study the fruit extracts of selected Solanum Xanthocarpum checked for its inhibitory effect on Nitric oxide production. Nitric oxide radical generated for sodium nitroprusside at physiological pH was found to be inhibited by the extracts. The methanol extract of Solanum Xanthocarpum at varied concentrations showed remarkable inhibitory effect of nitric oxide radical scavenging activity compared to other extract. Results (Table 6, Figure 3) revealed that all the tested extracts showed the percentage of inhibition in a dose dependent manner.

The inhibitory effect of Solanum Xanthocarpum fruits extracts on Nitric oxide radical scavenging model were shown in Table 6.7 and Figure 6.14. The methanol extract of Solanum Xanthocarpum at varied concentrations showed remarkable inhibitory effect of nitric oxide radical scavenging activity compared to other extract. The methanol extract of Solanum Xanthocarpum at varied concentrations showed remarkable inhibitory effect of nitric oxide radical scavenging activity compared to other extract.

Hydroxyl Radical Scavenging Activity of *Solanum Xanthocarpum* Fruits Extracts

The hydroxyl radical is an extremely reactive free radical formed in biological systems and has been implicated as a highly damaging species in free radical pathology, capable of damaging almost every molecule found in living cells. This radical has the capacity to join nucleotides in DNA and cause strand breakage, which contributes to carcinogenesis, mutagenesis and cytotoxicity. Hydroxyl radical scavenging capacity of an extract is directly related to its antioxidant activity. The highly reactive hydroxyl radicals can cause oxidative damage to DNA, lipids and proteins. The effect of the selected plant extracts were assessed by means of the iron (II)- dependent DNA damage assay. The fentone reaction generated hydroxyl radicals (OH) which degrade DNA deoxy ribose, using Fe 2+ salts as an important catalytic component. Oxygen radicals may attack DNA either at the sugar or the base, giving rise to a large number of products. All the results showed hydroxyl radical scavenging activity in a dose dependent manner.

The methanol extract of Solanum Xanthocarpum at varied concentrations showed remarkable inhibitory effect of Hydroxyl radical scavenging activity compared to petroleum ether, chloroform and methanol extract.

The methanol extract of Solanum Xanthocarpum fruit at varied concentrations showed remarkable inhibitory effect of Hydroxyl radical scavenging activity compared to petroleum ether and ethyl acetate extract.

SUMMARY AND CONCLUSION

Since the introduction of the modern system of plant classification in India, the botanical identity of the bulk of the problems stated in the pharmacopoeia of diverse traditional systems of medicine has been established. In certain circumstances, only extensive chemical and pharmacological analyses can reveal the true source of the crude medication. There are also a number of medications whose isolated chemical ingredients require more analysis to determine their utility. Solanum species have been known to exhibit various bioactivity in leaf, root and ripened fruits. Our preliminary esults suggest that raw fruits and in particular seeds of S. xanthocarpum exhibit strong anti-inflammatory and anti-oxidation potentiality. Our experimental data suggest that either phenolic compounds or alkaloids are likely to be the active pharmaceutical ingredient (API). Experiments are underway to dissect more on biochemical characterization of an API from the SE and acetone seed extracts. Oxidizing agents may damage a number of biological molecules such as nucleic acids, membrane lipids, enzymes, or synovial fluid polysaccharides. Secondary metabolites from medicinal plants function as small molecular weight antioxidants, but their particular mechanisms of action are variable, and depend both on a structure and environment.

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