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Phytochemical, Antioxidant and Anti-Diabetic Activity Scrutinization in the Methanolic Fruit Extract of *Syzygium jambos*

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Abstract: Currently, even though the technologies in the sector of medicine is rapidly progressed, still the irreversible damages caused by the synthetic medications are of worrisome. Plant-based substances, in contrast are biologically compatible and eco-friendly too. In our experiment, the selected *Syzygium jambos* is an evergreen tree which presents a part of traditional healing system. The phytochemicals scrutiny (alkaloids, cardiac glycosides, flavonoids, phenols, steroids, terpenoids and proteins) disclosed through the methanolic fruit extract are chiefly attributed for the evaluated pharmacological nature. The Total phenolic content (TPC) (54.88 ± 0.56 mg of GAE/g) and Total flavonoid content (TFC) (10.28 ± 0.21 mg of QE/g) were quantified in the methanolic fruit extract of *S. jambos*. In the DPPH (2,2-diphenylpicrylhydrazyl) and ABTS [2,2'-Azino-Bis (3-ethylbenzothiazoline-6-sulphonic acid)]; antioxidant assays the methanolic fruit extract presented highest percentage inhibition on free radicals as 24.64 ± 0.40% and 64.66 ± 0.43%, respectively. The screened anti-diabetic activity of methanolic fruit extract through α-amylase and α-glucosidase was 64.66 ± 0.43% and 81.69 ± 0.60%, respectively. All the outcomes represented through our work emphasizes on the prospective pharmacological activities of the chosen methanolic extract of the fruit. This can further add bonus on researching in-depth on its therapeutic roles.

Keywords: *Syzygium jambos*, Phytochemicals, Antioxidant, Anti-diabetic, DPPH, ABTS, α-amylase, α-glucosidase

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Introduction

Humanity has long relied on natural medicines derived from plants to treat a wide range of health-related concerns. As presented by the World health Organization (WHO), maximum percentage of global mankind are dependent on plant-acquired drugs to fulfil their basic health necessities (Ullah *et al.*, 2020; Diab *et al.*, 2021). The precious information on the utility of plants as an effective healing source for maladies has been received from ancestors and transmitted from date back to emerging generations. The milder malicious impact, cost-effectiveness, ease

availability and safety aspects have prioritized the usage of medicinal plants in contrary to allopathic equivalents (Saeed *et al.*, 2012). The many secondary phyto-active metabolites encountered in the plant's sections, including tannins, alkaloids, flavonoids, phenol and glycosides, are thought to be an ample and key source of natural chemical for the development of more trustworthy and efficient lead replacement medicines. Both pure and combined versions of healing herbs are used as a substitute for pharmaceuticals (Patel *et al*., 2017). Additionally, it has been considered to present better biocompatibility than the recent chemical drugs (Devi *et al*., 2020). Certain percentage (40%) of drugs which are in current service are procured either partially or wholly from the medicinal plants and massively marked by the pharmaceutical firms (Senguttuvan *et al.*, 2014).

Unpaired form of electron bearing atom/molecules generates free radicals, which is the main contributory factor of oxidative stress. Endogenously developed reactive oxygen radicals (ROS) are the major kind of free radicals (hydroxyl radical, NO, H_2O_2, lipid peroxides (Jafri *et al.*, 2022). As a consequence of normal bioactive activities in our system free radicals are originated in milder quantity. A fluctuation in the antioxidants, a vital compound in balancing free radical concentration, causes surge in the number of free radicals in our system (Gonzalez-Palma *et al*., 2016). By aggravating the macromolecular structure damage of indispensable lipids, nucleic acid (DNA), and proteins, ROS stimulates the possibility of life-threatening degenerative diseases, cancer, chronic type of inflammation-oriented diseases, atherosclerosis, arthritis, Alzheimer's disease, diabetes mellitus and ischemic heart diseases (Pizzino *et al*., 2017). Exogenous agents also establish the creation of ROS in the human system. Medically significant plants are the marvellous candidate packed with safer antioxidant forms (Zielinska-Blizniewska *et al*., 2019).

One of the foremost significant non-communicable global public health issues is diabetes mellitus relating carbohydrate metabolic disorder (Dedvisitsakul *and* Watla-Iad, 2022). A scarcity in insulin secretion due to ineffective pancreatic or insulin inefficacy delivers imbalance in the homeostasis of glucose along with other vital biomolecules (lipids and proteins). The most prevalent threats connected to diabetes mellitus comprise retinopathy, neuropathy, nephropathy, and cardiovascular disorders (Tafesse *et al*., 2017). Prolonged hyperglycemia is the vital player of oxidative stress which together with inflammation forms the chief contributors of aforementioned complications. Rapid management of diabetes mellitus through anti-diabetic drugs such as acarbose, thiazolidinediones, voglibose and sulphonylurea can be done (Satyanarayana *et al.*, 2022). Compromised functioning, affordability and negative health impacts like diarrhoea, weight gain, intestinal bleeding, edema, vomiting and severe hypoglycemic are reported as drawbacks by the modern medicines, even though they provide strong inhibitory action on α-amylase and α-glucosidase (Sekhon-Loodu and Rupasinghe, 2019; Kifle *et al.*, 2022).

Syzygium. jambos (*S. jambos*), a tree in the Myrtaceae family, is a medium-sized tree that matures to a height of 7.5–12 meters. Alternatively, it is also mentioned as *Eugenia jambos*. It is native to India and goes by a variety of local names in different cultures, such as plum rose, water apple, and malabar plum (Ochieng *et al.*, 2022). The physical attribute and fruity aroma make this fruit to be called as rose apple. The characteristic features of this tree include densely formed crown, alternatively oriented leaves, glossy dark greenish fruits and flowers are white to slightly greenish in tint with a width of 5 cm-10 cm (Inostroza-Nieves *et al*., 2022). Every part of this evergreen tree is adopted in folk medicinal system for numerous health ailments. Fruits are diuretic and a liver and brain tonic. To mitigate fever, diarrhea and cataract, flowers and seeds are utilized. Bronchitis, asthma and other respiratory problems are managed by the bark (Mohanty and Cock, 2010). Antimicrobial (Djipa *et al.,* 2000),

anti-inflammatory, anti-cholinesterase, anti-oxidant and anti-diabetic properties (Syahfriena *et al.,* 2022) are presented by the diverse sections of this tree.

In the present study bioactive phyto-contents (phytochemicals) were qualitatively and quantitatively identified in the methanolic fruit extract of *S. jambos*. The antiradical action and anti-diabetic action of the studied fruit extract was also evaluated.

Materials and Methods

Fruit collection:

In September 2019, the fruits of *S.jambos* were procured from a local vendor of Vaniyambadi, Tamil Nadu, India. The infected, bruised and unripen fruits were removed manually. Then, to get rid of the stuck dirt, excellent, ripe fruits were rinsed in excess tap water. Additionally, distilled water was used for rinsing. The fruits were allowed to dry in the shade on a sterile plastic tray until all of the water had been removed. Once the fruits had dried for two weeks, they were processed three times in a household blender until they became a fine powder. The fruit powder that was obtained was retained in a sterile glass container.

Fruit extract preparation:

30 g of *S. jambos* fruit powder was weighed, mingled with 80% v/v methanol, and incubated in the lab at room temperature for a duration of three weeks. Then the fruit extract was filtered thrice by applying Whatman filter paper. The used methanol (solvent) was removed through evaporation by loading the fruit extract in a rotary evaporator set at 40 ℃. The residue that eventually turned darkish brown was applied for the investigations by storing at 4 ℃ in a sterile glass vial.

Phytochemical investigations of S. Jambos:

3 g of the *S. jambos* methanolic fruit extract was taken and precisely diluted in methanol (10 ml). From this crude methanolic extract of fruit, identification of phytochemicals was executed.

(a) *Analysis of alkaloids*: Exactly, 1 ml of fruit extract was blended with equal volume of potassium mercuric iodide solution (Mayer's reagent). Creamy coloured precipitate signifies alkaloids.

(b) *Analysis of saponins*: In a test tube, 1 ml of the fruit methanolic extract was vigorously shaken along with 5 ml water. Copious frothing/lather that retains for 5 min verifies saponins.

(c) *Analysis of tannins*: To 0.5 ml of the fruit methanolic extract added 3 drops of ferric chloride (5% w/v). Blue or dark green colour emergence signifies tannins.

(d) *Analysis of cardiac glycosides* (*Keller-killiani test*):

Precisely, 0.5 ml of the fruit methanolic extract was mingled with 2 ml of glacial acetic acid to prepare ferric chloride. Concentrated sulphuric acid was dropped along the sides of the test tube. Brown ring at the interface of two reacting solutions signifies the persistence of cardiac glycoside persistent.

(e) *Analysis of flavonoids*: Emergence of yellow colour on mingling 1 ml of fruit methanolic extract with 0.5 ml of sodium hydroxide (10%) indicates flavonoid occurrence in the extract.

(f) *Analysis of phenols*: About 0.5 ml of fruit methanolic extract was mingled with lead acetate solution (0.5 ml). White precipitate emergence justifies tannins.

(g) *Analysis of steroids and terpenoids* (*Salkowski test*): 1 ml of fruit methanolic extract, 0.5 ml of chloroform and concentrated sulphuric acid (0.5 ml) were reacted together. Reddish colouration signifies steroids.

(h) *Analysis of quinines*: 0.5 ml of fruit methanolic extract was reacted with three drops of potassium hydroxide solution. Quinone occurrence was depicted by red colour emergence.

(i) *Analysis of proteins*: Freshly prepared 1 ml of Ninhydrin was boiled for 2 min in a test tube along with 0.5 ml of fruit methanolic extract. Pink/purplish chromophore defines proteins,

amino acids and peptides in the extract (Iqbal *et al*., 2015; Choudhary *et al.*, 2021; Huma *et al*., 2021).

Phytochemical Quantitative analysis of S. jambos fruit methanolic extract:

Quantification of TPC (*Total phenolic content*):

The TPC content in the *S. jambos* methanolic fruit extract was executed by Folin-Ciocalteu's method with slight alterations. Exactly, 20 µl of methanolic fruit extract of varying ranges (50-350 µg/ml) was reacted with 2 ml of Folin-Ciocalteu's reagent for 5 min. Neutralization of reacting mixture was done by pouring 1 ml of 7% (w/v) sodium carbonate. The entire mixture was left without disturbance for 90 min. In the UV-visible spectrophotometer, the blue colour solution formed was read at 725 nm. The standard was gallic acid that had been made using methanol. The calculated values were expressed in milligrams (mg) of gallic acid equivalent (GAE)/ gram (g) of dry weight of the fruit extract (Singh *et al*., 2016).

Quantification of TFC (*Total flavonoid content*):

0.5 ml of methanolic fruit extract of varying ranges **(**50-350 µg/ml) was mingled with 2% w/v of 0.5 ml of aluminium chloride. Also, potassium acetate (0.1 ml prepared as 1 mol/l) was added to the reaction content. For half an hour the tube mixture was left without any interference. Using UV-visible spectrophotometer operated at 415 nm the absorbance of yellow colour appeared was monitored. The calculated values were displayed as milligrams (mg) of quercetin equivalent (QE)/ g of dry weight of the fruit methanolic extract (Ali *et al*., 2018).

Antioxidant activity assessment:

(a) *DPPH assay*:

By slightly modifying the already availed protocol, the DPPH radical scavenging trait of methanolic fruit extract was done. Briefly, 0.4 mM of DPPH methanolic solution (2.5 ml) was intermingled with varying ranges (5, 10, 20, 40, 80, 160 and 320 µg/ml) of methanolic fruit extract and left uninterrupted for 30 min. Spectrophotometrically, absorbance was checked at 517 nm. For reference, ascorbic acid was taken. The below mentioned calculation was applied to compute the ABTS radical scavenging impact:

% ABTS radical scavenging (RS) = [Abs0- Abs1)/ Abs0] x 100

Here, Abs0: Control absorbance; Abs1: Methanolic fruit extract absorbance (Stankovic *et al*., 2016)

(b) *2,2'-Azino-Bis* (*3-ethylbenzothiazoline-6-sulphonic acid*) *radical scavenging assay*:

ABTS assay was executed with slight amendment of previously existed protocol. Using potassium persulfate, stock solution of 7 mM ABTS was prepared in 25 ml of deionized water. Methanolic fruit extract of varying range (5 to 320 µg/ml) and reference ascorbic acid were individually mingled with 2 ml of ABTS (working solution). After 20 minutes incubation the absorbance was checked at 734 nm in a UV-visible spectrophotometer. The below mentioned calculation was applied to compute the ABTS radical scavenging impact:

% ABTS radical scavenging (RS) = [Abs0- Abs1)/ Abs0] x 100

Here, Abs0: Control absorbance; Abs1: Methanolic fruit extract absorbance (Chaves *et al.*, 2020)

Anti-diabetic activity assessment

(a) *α-Amylase inhibition assay*:

By mildly modifying the available protocol, the α-amylase activity inhibition by the methanolic fruit extract was screened. In brief, 100 µl of α-amylase solution (0.1 mg/ml) was blended with varying concentrations (10, 20, 40, 80, 160, and 320 µg/ml) of methanolic fruit extract. At 37 °C for 15 min, incubation was performed. Starch solution (100 µl) addition in the reaction mixture created initiation of reaction followed by additional incubation for 1 h, at ambient temperature. To the reaction tubes, then added 100 µl of iodine solution and 1 M hydrochloric acid (10 µl). Finally, absorbance was checked at 580 nm in a spectrophotometer. Acarbose was applied as standard reference. The below mentioned formula was executed to calculate percentage (%) inhibition:

% α-amylase inhibition= [Abs0- Abs1)/ Abs0] x 100

Here, Abs0: Control absorbance; Abs1: Methanolic fruit extract absorbance (Kavitha *et al.*, 2018).

(b) *α-glucosidase inhibition assay*:

As per the already existing protocol with little changes, the α-glucosidase inhibition by the methanolic fruit extract was checked. Using 100 mM of phosphate buffer (pH 6.8), p-nitrophenyl glucopyranoside (pNPG) was prepared. Exactly, 200 µl of α-glucosidase was pre-incubated with varying range (10, 20, 40, 80, 160 and 320 µg/ml) of methanolic fruit extract and incubated for 10 min. Then pNPG solution was added to the reaction mixture and again at ambient condition kept for 20 min. To halt the reaction, 0.1 M of sodium carbonate was poured into the test tube contents. Yellow colour was developed which was spectrophotometrically read at 405 nm. Positive control (Voglibose) was used. The below mentioned formula (Unuofin *et al.*, 2018) was executed to calculate percentage (%) inhibition:

% α-amylase inhibition= [Abs0- Abs1)/ Abs0] x 100

Here, Abs0: Control absorbance; Abs1: Methanolic fruit extract absorbance

Results

The availability of dynamic bioactive phytochemicals can be verified by the implementation of conventional methods in the phytochemical screening process. The outcomes attained are displayed in the Table 1 and Figure 1.

Phytochemicals quantified in the methanolic fruit extract of S. jambos:

The TPC in the methanolic extract of *S.jambos* was 54.88 ± 0.56 mg of GAE/g of dry weight of the fruit extract. Also, TFC was calculated to be 10.28 ± 0.21 mg of QE/g of dry weight of the fruit extract.

Antioxidant activity assessment:

DPPH assay:

From the experimental outcomes, it was seen that the methanolic fruit extract of *S. jambos* depicted exemplary radical nullifying act. The DPPH radical quenching impact by the fruit methanolic extract was entirely dose-based. At the experimented lowest concentration 5 µg/ml, the percentage inhibition in DPPH was 5.08 ± 0.19% and at maximum concentration (320 µg/ml), the quenching percentage of 24.64 ± 0.40% was given by the fruit extract. As the concentration gradually elevated, the percentage (%) inhibition was also progressively raised. The IC_{50} value of the fruit extract was 43.20 ± 0.91 µg/ml. Ascorbic acid also gave dose-mannered percentage inhibition. At 5 µg/ml, 25.74 ± 0.26% of inhibition occurred, whereas at 320 µg/ml, 94.49 ± 0.31% inhibition was calculated. IC_{50} value for ascorbic acid was 14.72 ± 0.21 µg/ml. The outcomes are mentioned in the Table 2 and Figure 2.

ABTS radical scavenging assay:

In our experimental outcome, the methanolic fruit extract of *S. jambos* stated paramount antiradical capacity when analysed at doses ranging from 5-80 µg/ml concentrations. On dose-basis the radical quenching potential of fruit extract on ABTS was noticed as 4.05 ± 0.12% to 64.66 ± 0.43% with an IC_{50} outcome of 50.21 ± 0.01 µg/ml. Vitamin C, a common well known standard control provided IC_{50} value of 13.22 ± 0.03 µg/ml with minimum to maximum percentage of inhibition (17.43 ± 0.31%) (Table 3; Fig. 3).

α-Amylase inhibition assay:

The hindering impact of methanolic fruit extract of *S. jambos* on α-amylase enzyme was executed out. In the achieved outcomes, it was identified that all the used fruit extract concentrations provided dose-based inhibition action ranging from 25.81 ± 0.72% to 94.79 ± 0.01% with an IC_{50} outcome of 83.02 ± 0.09 µg/ml. Acarbose, applied as standard medication for diabetes mellitus used for reference also provided inhibition percentage in dose-bases (28.61 ± 0.67% to 94.82 ± 0.01%) with IC_{50} of 21.60 ± 0.32 µg/ml (Table 4; Fig. 4).

α-glucosidase inhibition assay:

The results of α-glucosidase enzyme inhibition by the applied concentrations of fruit methanolic extract were dose-mannered. When the tested concentration of fruit methanolic extract was increased the percentage inhibition of the enzyme

Table 1: Phytochemicals noted in the methanol fruit extract of *S. jambos*

Phytochemical screened	Identified phytochemicals
Alkaloids	+
Saponins	-
Tannins	-
Cardiac glycosides	+
Flavonoids	+
Phenols	+
Steroids & terpenoids	+
Quinones	-
Proteins	+

(+): Present; (-): Not present

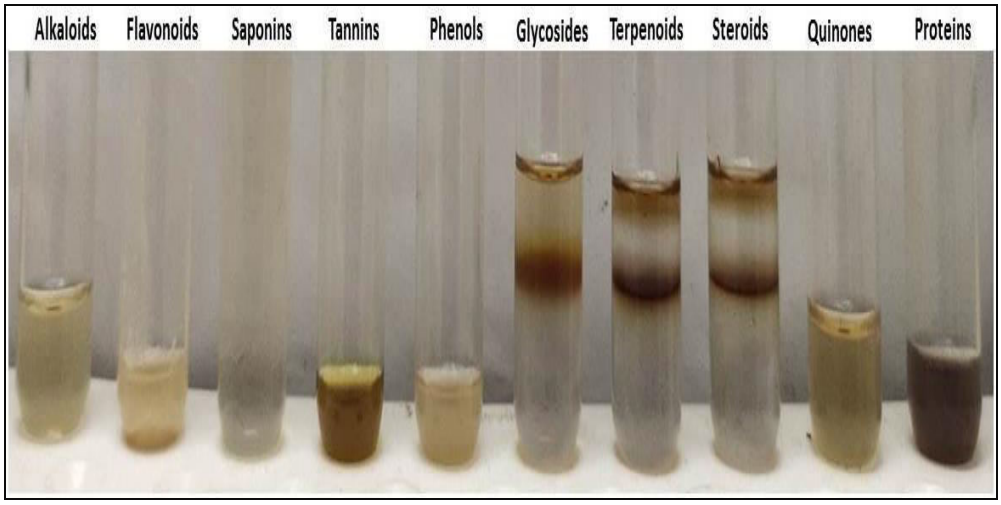

Fig. 1: Screened phytochemicals in the methanol fruit extract of *S. jambos.*

Table 2: DPPH radical quenching impact of methanol fruit extract of *S. jambos* in percentage (%) inhibition

Concentration (µg/ml)	Methanolic extract of *S. jambos* (% inhibition of DPPH)	Vitamin C (Reference)
5	5.08 ± 0.19	25.74 ± 0.26
10	9.48 ± 0.26	43.69 ± 0.31
20	10.45 ± 0.31	59.90 ± 0.40
40	16.97 ± 0.31	73.92 ± 0.40
80	20.36 ± 0.33	76.62 ± 0.12
160	20.70 ± 0.29	87.80 ± 0.33
320	24.64 ± 0.40	94.49 ± 0.31
IC_{50}	**43.20 ± 0.91**	**14.72 ± 0.21**

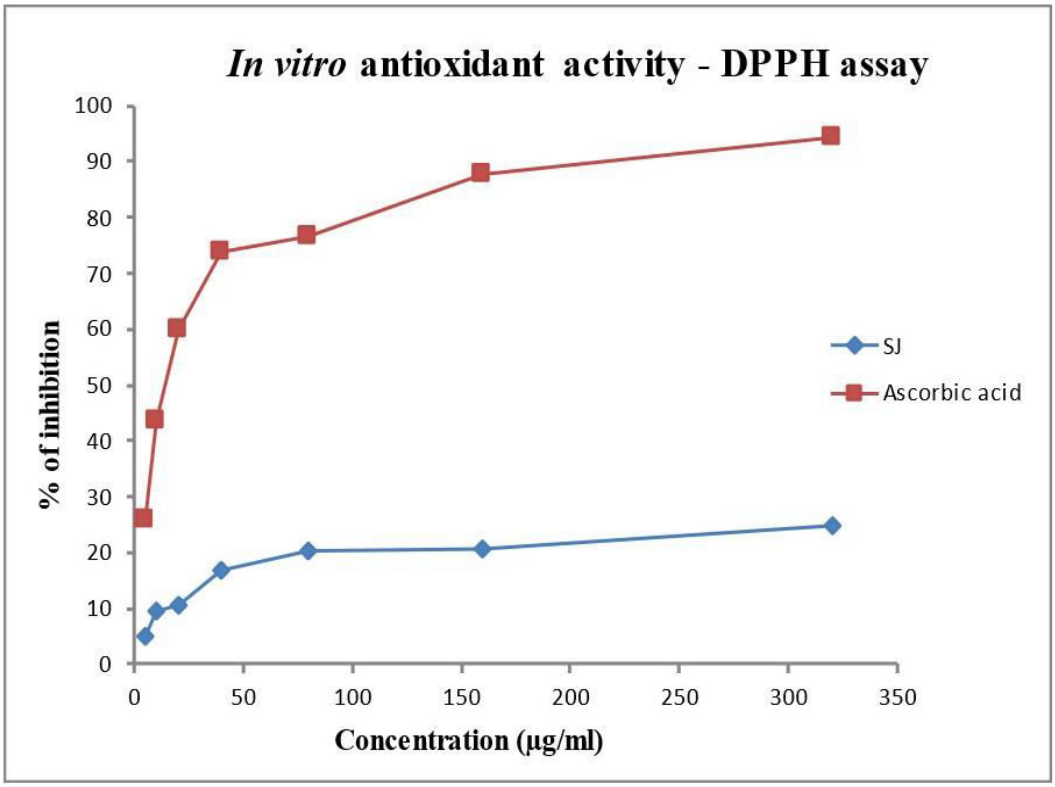

Fig. 2: DPPH radical quenching impact of methanol fruit extract of *S. jambos* in percentage (%) inhibition.

Table 3: ABTS radical quenching impact of methanol fruit extract of *S. jambos* in percentage (%) inhibition

Concentration (µg/ml)	**Methanolic extract of *S. jambos* (% inhibition of ABTS)**	**Vitamin C (Reference)**
5	4.05 ± 0.12	17.43 ± 0.31
10	6.29 ± 0.24	52.23 ± 0.37
20	11.39 ± 0.24	64.66 ± 0.37
40	31.23 ± 0.18	77.00 ± 0.24
80	41.05 ± 0.51	84.67 ± 0.31
160	45.89 ± 0.37	88.19 ± 0.37
320	64.66 ± 0.43	93.24 ± 0.18
IC_{50}	**50.21 ± 0.01**	**13.22 ± 0.03**

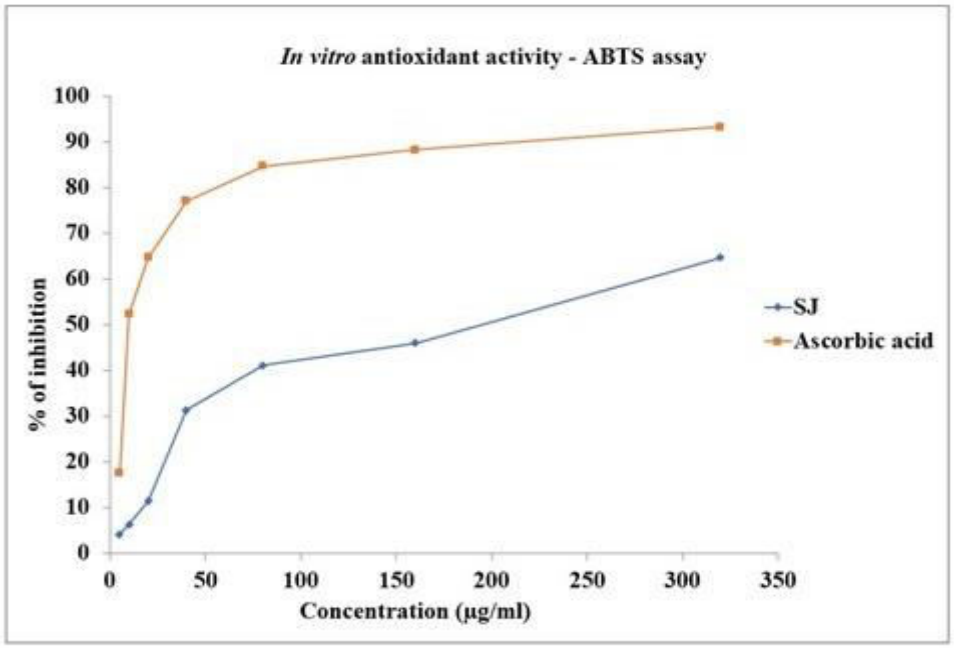

Fig. 3: BTS radical quenching impact of methanol fruit extract of *S. jambos* in percentage (%) inhibition.

Table 4: α-Amylase enzyme inhibition in percentage (%) by the methanol fruit extract of *S. jambos* in percentage (%) inhibition

Concentration (µg/ml)	Methanolic extract of *S.jambos* (% inhibition of enzyme inhibition)	Acarbose (Reference)
10	25.81 ± 0.72	28.61 ± 0.67
20	43.38 ± 0.64	54.41 ± 1.01
40	58.71 ± 0.71	63.14 ± 0.45
80	70.09 ± 0.23	77.45 ± 0.10
160	85.58 ± 0.07	88.05 ± 0.03
320	94.79 ± 0.01	94.82 ± 0.01
IC_{50}	**83.02 ± 0.09**	**21.60 ± 0.32**

by the fruit enzyme was also elevated which was as 22.59 ± 0.36% to 81.69 ± 0.60%. The fruit extract gave an IC_{50} of 32.60 ± 0.76 µg/ml. Voglibose, an Anti-diabetic drug, used as standard reference gave IC_{50} of 20.91 ± 0.16 µg/ml with 23.68 ± 0.36% to 92.06 ± 0.60% from minimum to maximum concentration of used fruit extract concentrations (Table 5; Fig. 5).

Discussion

The cascade of oxidative chain reactions initiation and propagation was delayed or hindered by the antioxidants. Antioxidants that are both endogenous and exogenous provide a nullifying influence on ROS (Apostolidis *et al.*, 2007). Antioxidative enzymes are natural endogenous antioxidants in the living system that include catalase, glutathione peroxidase and superoxide dismutase. Aside from that, glutathione and ascorbic acid and vitamin E are non-enzymatic antioxidative molecules (Gomathi *et al.*, 2014). Oxidative stress referring to exaggerated intracellular ROS are the elementary cause of organ or tissue damage. The category of antioxidants often includes both synthetic and natural versions. Moreover, the synthetically manufactured antioxidants are prone to be carcinogenic (Kyung *et al.*, 2020).

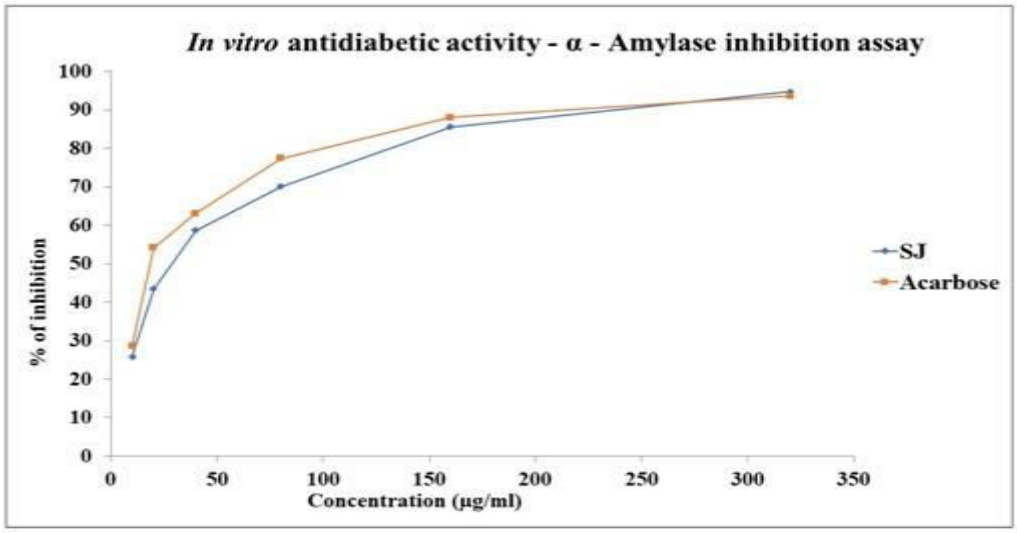

Fig. 4: α-Amylase enzyme inhibition in percentage (%) by the methanol fruit extract of *S. jambos* in percentage (%) inhibition.

Table 5: α-glucosidase enzyme inhibition in percentage (%) by the methanol fruit extract of *S. jambos* in percentage (%) inhibition

Concentration (µg/ml)	**Methanolic extract of *S. jambos* (% inhibition of enzyme inhibition)**	**Voglibose (Reference)**
10	22.59 ± 0.36	23.68 ± 0.36
20	28.33 ± 0.43	40.09 ± 0.43
40	33.08 ± 0.45	55.67 ± 0.52
80	48.84 ± 0.53	73.97 ± 0.45
160	67.78 ± 0.55	85.96 ± 0.52
320	81.69 ± 0.60	92.06 ± 0.60
IC_{50}	**32.60 ± 0.76**	**20.91 ± 0.16**

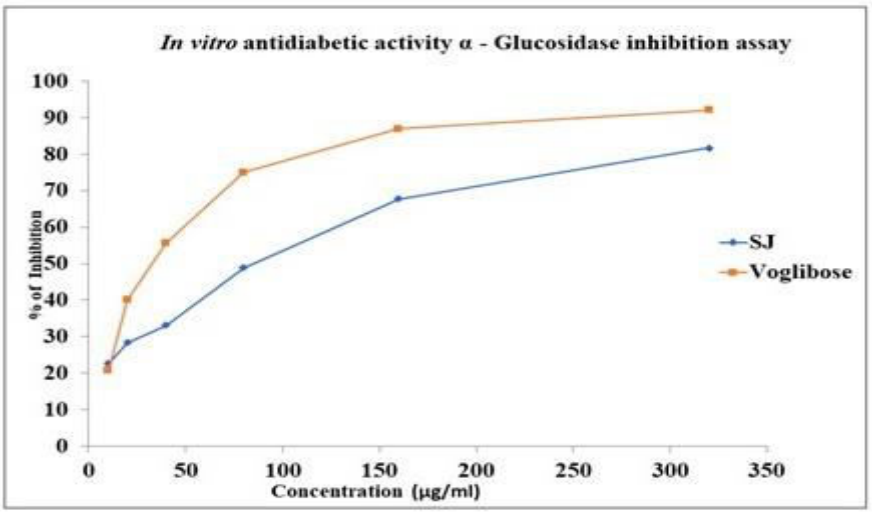

Fig. 5: α-glucosidase enzyme inhibition in percentage (%) by the methanol fruit extract of *S. jambos* in percentage (%) inhibition.

Plants are a priceless gift from nature to humankind. The assumption that each species or group of plants has distinct and specialized medicinal capabilities stems from the fact that each secondary metabolite mix is classified differently. Natural antioxidants are incredibly effective in combatting oxidative stress. The plant-based medications are considerably safer than those made from chemicals (Kedir *et al.*, 2023). The scientific investigation of plant-derived antioxidant molecules is now attracting plenty of attention (Umaru *et al.*, 2019).

Polyphenols are categories in plant-derived secondary metabolites and are prioritized antioxidants owned to superior redox traits, which is pivotal in nullifying the negative impression of undesired free radicals (ROS/RNS) (Jideani *et al.*, 2021). The chemical structure of phenolic compound and their hydroxyl groups immensely furnish its scavenging capacity thereby shielding against chronic disorders (Rahman *et al.*, 2022). Fruits as well as vegetables are magnificent naturally gifted antioxidant sources. Extensively varying antioxidants like flavonoids, terpenoids, alkaloids, phenols, ascorbic acid (Vitamin C), terpenoids and α-tocopherol (vitamin E), are identified in the plants and have a positive impact in clearing the free radicals (Karagoz *et al.*, 2015). In general terms these phyto-active metabolites are collectively termed as phytochemicals. Crude forms of extract and purified native compounds extracted from diverse kingdom of plants have experimented and showed antioxidant features (Hazafa *et al*., 2020).

Flavonoids are the most extensive polyphenolic plant compounds. Flavonoids exist in different forms (flavanols, flavones, flavanones, flavanals isoflavones and anthocyanidins) (Morales *et al.*, 2012). Flavonoids have been witnessed to be highly beneficial free radical scavengers of most oxidizing chemicals, including singlet oxygen (Panche *et al*., 2016). They are vastly incorporated in numerous pharmaceutical, cosmetic and nutraceutical formulations due to their health restoring properties (Tuli *et al*., 2022; Jejurkar and Chavan, 2023). Also, they possess pharmacological potentials like anticancer, antioxidant (Suresh *et al*., 2015; Al-Dabbagh *et al*., 2018), anti-inflammatory, anti-diabetic, neuro-protective, hepato-protective (Yadav *et* al., 2024), nephro-protective (Rao *et* al., 2024) and antimicrobial actions. The structure and the hydroxyl group of flavonoids are profoundly responsible for their antioxidative capacity which is thoroughly mediated by the electron donation via resonance stabilization of undesired free radicals (Ahmed *et al.*, 2021).

DPPH assay is one of the appropriate and reliable experiment to assess the electron donating property of natural/plant compounds. DPPH, a nitrogen-centric stable radical with violet colour, in contact with antioxidant is discolourised to yellow through the electron/hydrogen donating nature of antioxidants (Clarke *et al*., 2013). The degree of discolouration of DPPH methanolic solution has proportionality to the antioxidant concentration in the experimented compound (Uwineza *et al.*, 2021). ABTS radical ($ABTS^{+}$) oxidized by ($K_2S_2O_8$) potassium persulfate, generates greenish/bluish chromophore. The ABTS radicals is significantly reduced in contact with hydrogen offering antioxidants (Sahreen *et al.*, 2010).

The present study clearly emphasizes on the electron donating potential of the tested fruit extract to the free radicals. Fruit extract phenolic as well as flavonoid content along with other identified phytochemicals were entirely responsible for antioxidant capacity. In the executed antioxidant assays (DPPH and ABTS assays), the polyphenols in the fruit extract would have actively transfer its hydrogen (H) atoms from their OH groups to form a complex (Polyphenol-radical complex) and thereby terminating the cascade of radical reaction (Ahmed *et al*., 2021). The DPPH and ABTS radicals are turned to non-radical forms once encountering with the polyphenolic compound's hydrogen atoms in the fruit extract.

Two glycosides, α-amylase and α-glucosidase are the enzymes of energy metabolism of carbohydrate. In the saliva and pancreas juice, α-amylase are found. Intestinal layer releases α-glucosidase (Gong *et al*., 2020). In the carbohydrate metabolism, the digestive intestinal key enzymes (α-amylase and α-glucosidase) causes upsurge in the post-prandial glucose level (Nguyen *et al.*, 2020). Chronic hyperglycemic condition is bothersome in this situation as it can further pave way for pancreatic β-cells death through apoptotic way, thus diminishing the volume of β-cell and tuning the insulin secretion in an aberrant form and influencing glucose uptake (Ojo *et al*., 2022). As oxidative stress is the major culprit for bringing diabetes mellitus, application of antioxidants will be the most superior and efficacious in the management of this disorder. Many scientists in the world are keenly researching on the medicinal plants as they are bestowed with antioxidants to provide a solution for diabetes mellitus and its based complications (Mechchate *et al*., 2021).

In the upcoming years, the pharmaceutical corporations will be able to distribute health modifying natural and safer medicines, through replacing the alterative synthetic medications. In the search for natural drugs, α-amylase are the chiefly exploited target to balance postprandial glucose parameter (Wickramaratne *et al*., 2016). Acarbose and other standardly marketed hypoglycemic drugs are probably the blockers of starch, a complex polysaccharide. They function through either promoting slower absorption or halting of consumed starch. Hydrolysing the glycosidic linkages (1, 4 glycosidic linkages) of polysaccharide (starch) or other dietary oligosaccharides into less complex forms as maltose (disaccharide), and other simpler sugars (Tundis *et al*., 2010) is also their chief targets. Natural, especially, products of plants have shown supremacy in aberrating the functioning of aforementioned glycosidases (Sudha *et al*., 2011).

Conclusion

The bioactive phyto-contents (phytochemicals) were qualitatively and quantitatively identified in the methanolic fruit extract of *S. jambos*. The phytochemical composition testing authenticated the occurrence of major secondary metabolites especially phenolic contents, along with alkaloids, flavonoids, steroids, terpenoids, proteins. The antiradical action and anti-diabetic action of the studied fruit extract was provided by the noticed phytochemicals contributing to the future usage of this fruit for generating health friendly medicines for oxidative stress-based health issues. Moreover, deep investigations are needed to find out the individual active principles and their mechanism elucidation to make plant-based medicine the profound source in the pharmaceutical markets.

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