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BIOACTIVE MOLECULES AND THERAPEUTIC POTENTIAL OF *SOLANUM PSEUDOCAPSICUM* FROM WESTERN HIMALAYAS, KASHMIR, PAKISTAN

Muhammad Mohin Qureshi[1], Shakeel Sabir[2*] Karamit Hussain[3], Taskeen Iqbal[4], Sajid Safeer[5], Muhammad Sohail[6], Mehreen Mushtaq[7], Ali Raza[8], Muhammad Shakeel Awan[9], Muhammad Shakil[10], Muhammad Sohail[11]

[1,3,4,5,6,11] Department of Botany, University of Azad Jammu and Kashmir Muzaffarabad, Pakistan
[2*]Department of Botany, PMAS Arid Agriculture University Rawalpindi, Pakistan
[7]Department of Botany, University of Kotli, Azad Jammu and Kashmir, Pakistan
[8]Department of Chemistry, University of Poonch Rawalakot, Azad Jammu and Kashmir, Pakistan
[10]Department of Zoology, PMAS Arid Agriculture University Rawalpindi, Pakistan

***Corresponding author:-** Shakeel Sabir
*Department of Botany, PMAS Arid Agriculture University Rawalpindi, Pakistan
Email: Shakeelsabir555@gmail.com

Abstract
Solanum pseudocapsicum L. commonly known as Jerusalem cherry or winter cherry belongs to the family Solanaceae. *S. pseudocapsicum* is an erect, branched, non-spiny, and bushy shrub. The Present research was conducted to analyze the bioactive molecules and therapeutic potential of the leaves and fruit of *S. pseudocapsicum*. The most important metabolites such as alkaloids, flavonoids, terpenoids, tannins, phlobatannins, steroids, cardiac glycosides, proteins, and carbohydrates from leaves and fruits were examined by qualitative tests. Antibacterial activity was carried out against *Escherichia coli*, *Staphylococcus aureus*, and *Klebsiella pneumoniae*, while antifungal activity was carried out against *Aspergillus niger* and *Penicillium notatum* using the disc diffusion method. The free radical scavenging ability was examined in extracts of methanol, ethanol, distilled water, and chloroform using the DPPH method. The calculated value of antioxidants was expressed as the IC_{50}.The approximate analysis determined a reasonable amount of moisture, ash, crude fiber, crude fats, proteins, and carbohydrates. From this study, it is revealed that *S. pseudocapsicum* is highly enriched with nutrients and bioactive constituents and has vital therapeutic and antioxidant potential. Therefore, it can be used in the pharmaceutical and nutraceutical industries.

Keywords: Anti-Fungal, Antioxidant, Pharmaceutical, Nutrition, DPPH.

INTRODUCTION

Solanum pseudocapsicum L. belongs to the Solanaceae family, order Solanales, in the Magnoliophyta division, of the angiosperms or flowering plant division. The Solanaceae family has 84 genera and 3000 species worldwide, and in Pakistan it is represented by 14 genera and 52. The genus commonly found in temperate and tropical regions of the world has great economic and nutritional value (Novaković et al., 2022).

S. pseudocapsicum is an erect, much branched, non-spiny bushy shrub commonly called Jerusalem cherry or winter cherry, grows to about 0.6-1.2m in height and has lanceolate or narrowly elliptical leaves. Its berries are green when not ripe and yellow, scarlet, or bright red when ripe. Their seeds are ovoid, compressed at one end and rounded at the other end and yellowish in colour (Costa et al., 2019). *S. pseudocapsicum* is a profusely branched, compact sub shrub. The leaves are narrowly elliptic and taper at both ends, with undulate margins. Flower axillary, solitary, or 4-22 in clusters. The number of seeds per berry ranges from 50 to 100 while the number of berries could be as high as 100, per plant. (Costa et al., 2019) At maturity, the berry color changes from yellow to red, this is attractive, so it is cultivated indoors as an ornamental plant.

S. pseudocapsicum is a toxic plant that is used for the treatment of boils, abdominal pain and tonics for men (Hussain et al., 2023). For early drug discovery, they are the primary source of medicine due to their ethno pharmacological properties. Approximately, 80% of people still now depend on plants for their primary health care and medication according to a survey of the World Health Organization (WHO) (Hussain et al., 2023).

The berries contain solanocapsine and other minor alkaloids (Novaković et al., 2022). The medicinal values of *S. pseudocapsicum* have been reported to include hepatoprotective (Novaković et al., 2022) antispasmodic, cytotoxic, and antihypertensive antimicrobial and antitumor properties (Hussain et al., 2023).

S. pseudocapsicum has very attractive berries and is sometimes grown in gardens as an ornamental plant. Indigenous people use this plant in their medicine, so it is imperative to disclose the therapeutic potential of this plant, as well as inspect the bioactive molecules present in it. As no such work has been conducted in Azad Jammu and Kashmir, the current study was performed to explore this issue. This work will expose the vastness of the plant that can endure it to make management gaits and expansion(Novaković et al., 2022).

MATERIALS AND METHODS

Study Area; Specimens of the respective plants were collected from the Muzaffarabad district, AJK. Muzaffarabad is the capital of Azad Kashmir. It has an area of 2496 sq. It is located at 73.22° longitude and 34.24° latitude in the northeast of Pakistan. Most of its areas have a subtropical and tropical climate range. It has an average rainfall of 1000 to 3000 mm and an average temperature of -3°C to 42°C (Sarfraz et al., 2023).

Plant Material and Extract Preparation; The fresh leaves and berries of *S. pseudocapsicum* were collected from the Muzaffarabad Azad Jammu and Kashmir districts and were identified by the plant taxonomist of the Department of Botany in March 2017. After collection, the sample was cleaned and dried at 24-26°C (room temperature). The sample was ground to a fine powder using an electrical grinder and stored in polythene bags. Finally, this sample powder was used for phytochemical analysis and antimicrobial activity. The plant specimen was deposited as voucher No. M.M.Q.001. in the Herbarium of Azad Jammu and Kashmir. The extraction was prepared following standard protocols Verma and Gupta (2015). The sample powder was mixed in each solvent at a 1:10 ratio and kept in an incubator shaker (150 rpm) for 72 hours at 60^0C (Verma and Gupta, 2015). The solutions were filtered with Whattman filter paper and the filtrates were kept in a rotary evaporator at 50 to 600C for evaporation. The dried sample extracts were stored at 4^0C until further experiments were performed. The experiment was carried out in triplicate to avoid error (Vargas-Arana et al., 2021; Verma and Gupta, 2015).

Nutritional Analysis; The moisture content of the sample was determined by the fresh fruit material, while the total ash, carbohydrate, fat, fiber, and protein were determined from the shadow-

dried powdered sample as described in AOAC, 1990). The results are shown in g×100 g^{-1} of dried material (Magrati et al., 2012).

Total Moisture; The total moisture content of the sample was determined using the given method in AOAC, 1990 as defined by (Magrati et al., 2012; Verma and Gupta, 2015). One gram of fresh sample was taken in preweighed Petri plates, and then the Petri plates were placed in an oven at 100^0C to remove moisture for 4 hours. The process was repeated until the weight of the sample became constant, and the sample was cooled in a desiccator and reweighed. The total moisture content of the sample was calculated using the following formula:

$$\textbf{moisture}\ (\%) = \frac{\textbf{W1} - \textbf{W2}}{\textbf{weight of sample}} \times \textbf{100}$$

where,
W1= weight of fresh sample (before drying)
W2= weight of dried sample

Total Ash Content; One gram of dried powder sample was incinerated in a muffle furnace to determine the ash content and then charred according to the AOAC method (Islary et al., 2016; Verma and Gupta, 2015).One gram of dried sample powder was taken in a crucible (pre weighed) and placed in the muffle furnace at 550ºC until white ash was found. The crucible was then removed, covered with a lid, and placed in a desiccator to cool to avoid any trace of moisture. Finally, the crucible was weighed using a lid-free weighing balance.
The percentage of ash was calculated using the formula given below:

$$\textbf{Ash}(\%) = \frac{\textbf{weight of ash}}{\textbf{weight of sample}} \times \textbf{100}$$

Total Fat Content; The dried sample powder was taken. Two gram of powdered sample was taken on a thimble and then attached to a Soxhlet extractor. The flask (pre weighed) was poured with 300 ml of petroleum ether and refluxed for 10 to 12 hours with a heating mantle. Fat was extracted into the flask. After cooling the flask in a desiccator, the weight was taken as AOAC, 1990 (Islary et al., 2016; Magrati et al., 2012).The percentage of fats was determined by the formula:

$$\textbf{Fat}\ (\%) = \frac{\textbf{weight of fat}}{\textbf{weight of sample}} \times \textbf{100}$$

Determination of Crude Fibers; The defatted sample was used to determine the dietary fibre. One gram of defatted sample was taken into a beaker and then boiled in 200 ml of 1.25% sulfuric acid for 30 minutes. The mixture was then filtered and washed with double distilled water for neutralization of the mixture. The material was transferred to a beaker and boiled again with 200 ml of 1.25% sodium hydroxide for 30 minutes. Once again the mixture was filtered and washed with double distilled water for the neutralization of the mixture. A Gooch crucible was prepared with an asbestos matand the material from beaker was placed on the mat and washed with 15 ml of ethyl alcohol. The constant weight of the crucible was obtained by drying it in a hot air oven at a temperature of 110ºC. The fibre-cooled crucible was cooled in a desiccator and weighed (WI) on the weighing balance. The material of the crucible was ignited on a low flame until charred and then placed in a muffle furnace at 550ºC and weighed (W2)(Magrati et al., 2012). The fiber was calculated by the formula:

$$\textbf{Fiber}\ (\%) = \textbf{W1} - \textbf{W2} \times \textbf{100}$$

Determination of Proteins; The protein content was determined by the Kjeldhal method as defined by the AOAC method and described by (AOAC 2000). A total 0.5 g of plant sample was digested by adding the Kjeldhal catalyst (1 part of copper sulfate and 9 parts of potassium sulfate) and 20 ml of concentrated sulfuric acid (H_2SO_4) in a digestion chamber until the solution was clear. The blank test was also performed without sample material. After digestion was complete, it was distilled in the Kjeldhal distillation chamber. The vaporized ammonia was condensed and titrated against the known concentration (0.1 N) of hydrochloric acid (HCl) (Islary et al., 2016). The total nitrogen concentration was calculated using the formula:

$$\textbf{Nitrogen}\ (\%) = \frac{(\text{A} - \text{B})\ \text{x N of HCl x 14}}{\textbf{weight of sample}} \times \textbf{1000}$$

where,
A= Volume (ml) of HCl used in sample titration
B=Volume of (0.1) HCl used in blank titration
14= atomic weight
Finally, the protein content was calculated by multiplying the obtained nitrogen content by the protein conversion factor.

$$\textbf{Protein}(\%) = \textbf{Nitrogen}(\%) \times \textbf{6.25}$$

Carbohydrate Content Determination; Five milliliters of H_2SO_4 and 5% phenol were taken and mixed well with 1 ml of the test sample to guess the number of polysaccharides and placed for ten minutes. Against the blank, the absorbance was measured at 488 nm. After that, it is related to the standard glucose solution. A blank was prepared taking 5 ml of H_2SO_4 and 5% phenol and 1 ml of distilled water (Prabhavathi et al., 2016).

Phytochemical Determination

Tannin Content Determination; The Ciocalteu and Folin method was used for the determination of total tannins. With almost 0.25 ml of Folin Reagent, 3.75 ml of distilled water and 0.5 ml of plant sample were carefully mixed. In this solution 0.5 ml of 35% (Na_2CO_3) sodium carbonate solution was added. The Absorbance was measured at 725 nm using a UV-Vis spectrophotometer. For the standard solution tannic acid dilutions of 0 to 0.5 mg/ml were used. In 1 mg/ml of sample extract of tannic acid, tannin content has been expressed in terms of tannic acid in mg/ml of extract (Prabhavathi et al., 2016).

Phenol Content Determination; Phenols were determined by a slightly modified Folin and Ciocalteu method. Briefly, 800 µl of the Folin Ciocalteu reagent mixture and 2 ml of 7.5% sodium carbonate were added to the 200 µl of the sample extract. The total content was diluted to 7 volumes with distilled water and finally the tubes were kept for 2 hours of incubation in the dark. The absorbance was measured at 765 nm. Gallic acid dilutions were used as standard solutions. The results of phenol have been expressed in terms of gallic acid in mg/ml of extract (Prabhavathi et al., 2016).

Alkaloid Content Determination; One gram of plant sample was mixed with 40 ml of 10% acetic acid in ethanol. Then this solution was covered and allowed to stand for four hours. To attain ¼ of the original volume, the filtrate was heated in a water bath. One by one drops of added concentrated ammonium hydroxide (NH_4OH), were added until precipitation formation. Then the entire solution was allowed to settle, and the formed ppt was rinsed with dilute NH_4OH and once again filtered.

Subsequently, the remaining residue was dehydrated and properly weighed (Prabhavathi et al., 2016).

Flavonoid content determination; By the Kocipai Abyazan (1994) method the total flavonoid content was calculated. One hundred milimitters of (80%) aqueous methanol was repeatedly extracted with 10 g of the plant sample at room temperature. For the filtration of the whole solution, Whatman filter paper no 42 (125 mm) was used. For dryness, the filtrate was shifted to a crucible, placed in an oven and weighed again, and constant weight was again obtained (Edeoga et al., 2005).

Antioxidant Assay; Using the DPPH method, the unrestricted radical rummaging activity of the *S. pseudocapsicum* extracts was determined. For the formation of the DPPH solution, 0.1 mM DPPH solution was formed in 0.5 ml of methanol and this solution was added to almost the same volume that is, 0.5 ml of extract. The solution formed in this was placed in the dark for 45 minutes. Before being placed in the dark, the solution was thoroughly vortexed. The absorbance of the blank was measured at 515 nm. The DPPH value for the scavenging activity is high if it has a lower absorbance. Using the following formula, the DPPH scavenging capacity was measured.

$$\text{Scavenging effect by using DPPH}(\%) = \frac{1-\text{As}}{\text{Ac}} \times 100$$

The absorbance of the control is denoted by "Ac" containing DPPH solution and "As" is the absorbance of the extract solution containing aqueous DPPH. Using aqueous extract for antioxidant activities, the value was measured using different concentrations and the IC_{5O} values were calculated. For reference, in the spectroscopic method, ascorbic acid has been used with concentration ranging from 100 to 1000 mg/ml (Bains and Tripathi, 2016).

Antimicrobial Activity; Both antifungal and antibacterial activity was carried out in four extracts of leaf and fruit against selected fungi and bacteria, respectively.

Tests on Microorganisms; The different extracts of the plant against fungal and bacterial strains have been used for antimicrobial activity. Microorganisms such as fungi were collected from the stock of the Department of Botany, University of Azad Jammu and Kashmir, and bacteria were obtained from the microbiology laboratory of the combined military hospital of Sheikh Khalifa Bin Zahid, Muzafarabad. Nutrient agar medium was used to culture the bacteria and PDA medium was used for fungal culture. The bacterial culture was then incubated in an oven for 24 hours at 37ºC and the fungus culture was kept in potato dextrose agar slants at 4ºC for further study. To avoid inactivity of long-standing cultures, after 30 days, the subculture was prepared.

Antibacterial Screening

Preparation of inoculum; Then these strains were revived by streaking them onto Petri nutrient agar plates and then the inoculated plates were incubated at 37ºC for 24 hours in incubator for growth. The revived cultures were then inoculated in nutrient broth contained in test tubes to prepare a spreadable medium and then incubated at 37ºC for 24 hours in an incubator shaker to obtain uniform growth (Verma and Gupta, 2015).

Well Diffusion Method; The extracts were reconstituted to final concentrations of 100 mg/ml. Nutrient agar was inoculated by a spread plate method with 100 µl of the 24 hour old bacterial inoculums. Wells (6 mm in diameter) were punched with sterile cork borer on agar and 80 µl of extracts was loaded into the wells. The inoculated plates were then incubated at 37ºC for 24 h. The antimicrobial activity was evaluated by measuring the diameter of the zone of inhibition and reported on a millimeter scale. Ampicillin was used as a control in one of the wells in each plate (Verma and Gupta, 2015).

Antifungal Screening; The disc diffusion method has been used for antifungal screening in vitro (Carson et al., 1995). For a dilution of 0.2 to 10-2, 20 ml of Sabouraud dextrose was poured into Petri dishes for fungal culture. The disc was placed in the respective shrub extracts on the plants seeded with organisms. Before application to the organism, methanol was used to liquefy the extract. This extract was fully evaporated. Blank disc for antifungal activities of leaves of *Solanum pseudocapsicum* soaked with methanol. This was followed by the freshening of the mixture used as a negative regulator. The activity of the fungus was determined by placing it at 30ºC for 72 hours. Nystatin 30 µg/disc was used as a reference and the results of different extracts were compared. To confirm the results, the experiment was repeated three times.

Statistical Analysis; Each of the tests was performed in triplicate and the information was communicated as the mean ± standard deviation (Islary et al., 2016).

RESULTS

Nutritional Analysis; The current study showed that the moisture content found in the leaf was 44.58% and 56.28% in the fruit, while the ash content was 8% and 3% in the leaf and fruit of *Solanum pseudocapsicum*, respectively. *S. pseudocapsicum* has a substantial amount of fat 18 g in the leaf and 13 g in the fruit sample. Proteins play an important structural and functional role in the body (Vargas-Arana et al., 2021). A reasonable amount of protein was reported in the leaf and fruit of *Solanum pseudocapsicum*, which were 4.7 g and 6.12 g, respectively. The most common and widely spread organic matter on earth is carbohydrates which are major source of energy for living organisms. A significant amount of carbohydrates was also found in the leaf (5.6 g) and in the fruit (6.6 g) and the taste was sour. *S. pseudocapsicum* has dietary fibre as major component. Dietary fibers have many health benefits for humans, such as lowering cholesterol in the body, risk of diabetes, and constipation (Sadef et al., 2022) *S. pseudocapsicum* has 18 g and 15 g in of dietary fibre in leaves and fruits respectively.

Table 1. Proximate analysis of *Solanum pseudocapsicum* leaf and fruit (g×100 g^{-1})

S. No	Nutrient content	Leaf	Fruit
1	Moisture	44.58%	56.28%
2	Ash	8 g	3 g
3	Crude fat	19 g	13 g
4	Crude fibre	18 g	15 g
5	Protein	4.72 g	6.12 g
6	Carbohydrate	5.7 g	6.6 g

Phytochemical analysis; Phytochemicals are a wide range of non-nutrient compounds found in plants that possess biological activities. These Phytochemicals have different activities, are responsible for the protection of chronic diseases and a have an important therapeutic (Qanash et al., 2022). Quantitative analysis of Phytochemicals showed the total tannins and the total phenolic contents in *Solanum pseudocapsicum*. Leaf and fruit extracts are shown in Figures 1 and 2, and the total alkaloid and flavonoid contents are shown in Table 2.

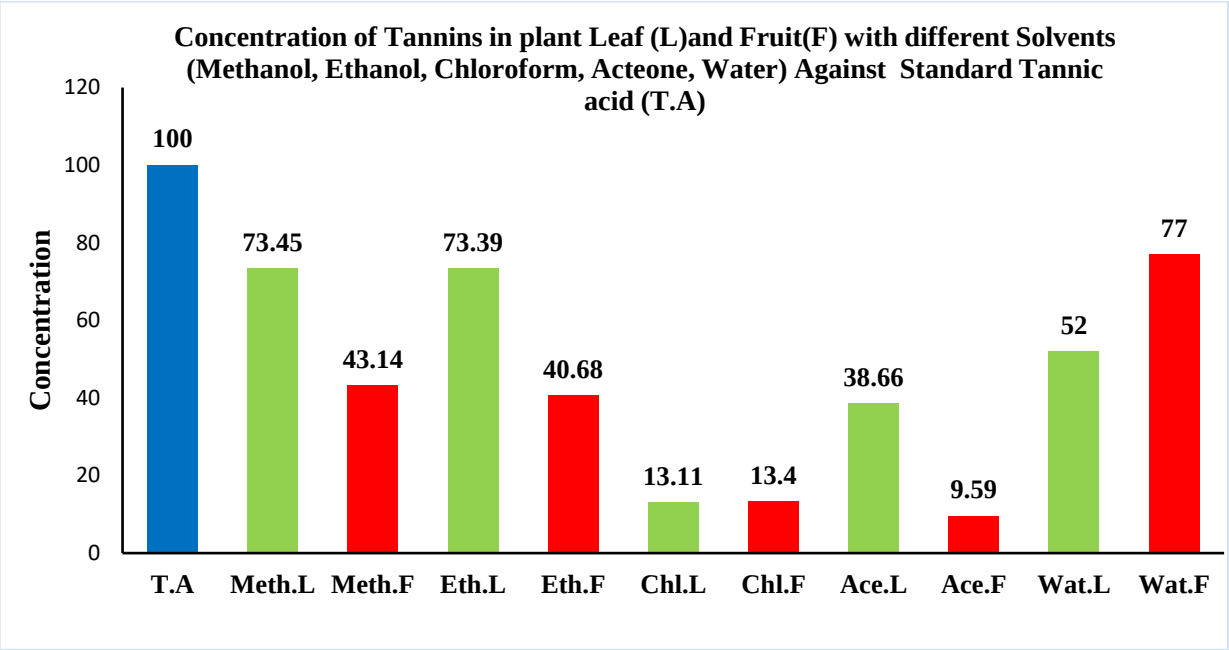

Figure 1. The concentration of tannins in all leaf and fruit extracts compared to tannic acid (T.A)

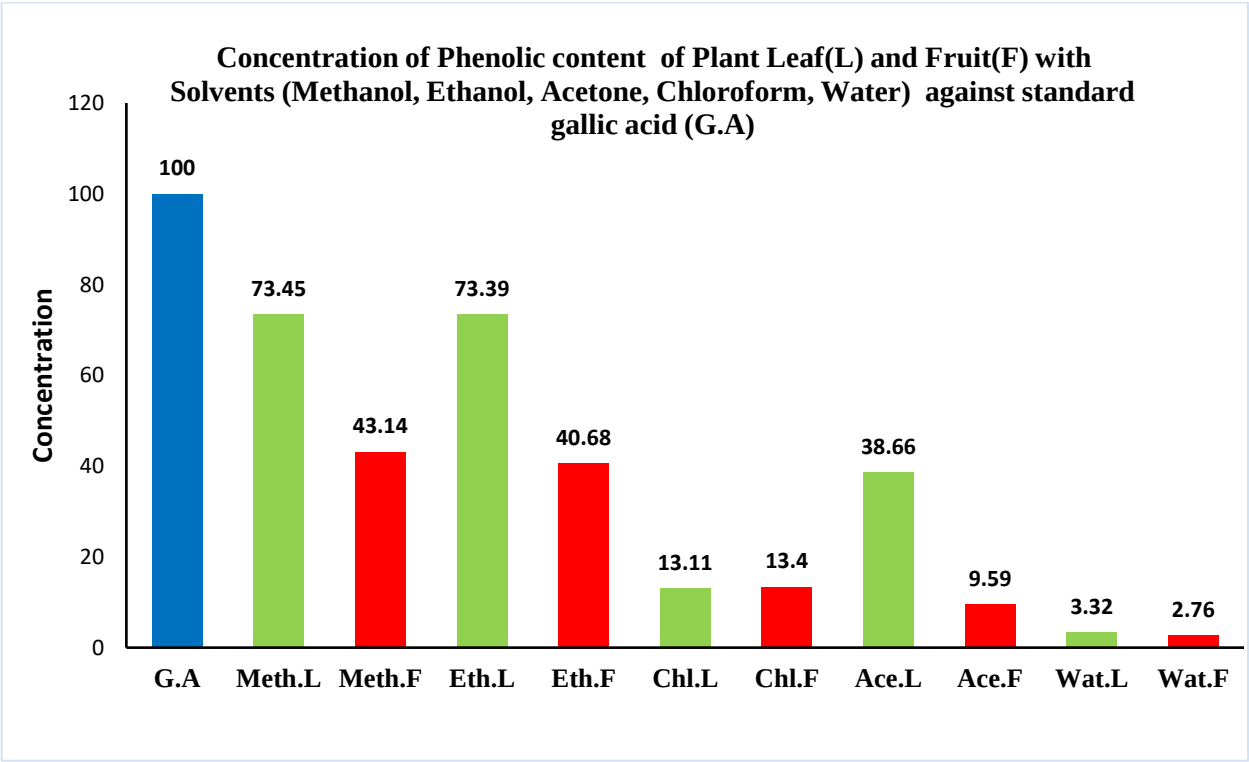

Figure 2. Phenol concentration in all leaf and fruit extracts compared to gallic acid (G.A.)

Table 2. Concentrations of alkaloid and flavonoid contents in the fruit and leaf of *S. pseudocapsicum*.

S. No	Plant samples	Alkaloid	Flavonoid
01	Fruit	3.1 ± 0.92%	0.50±0.03%
02	Leaf	1.7 ±0.1%	0.43±0.01%

Antibacterial Screenings; The antibacterial activity of the leaf and fruit of *S. pseudocapsicum* exposed momentous activity against three microorganisms *Escherichia coli*, *Staphylococcus aureus* and *Klebsiella pneumoniae*. These two parts of the chloroform-derived fruit showed the highest

activity (18.0±1 mm). Both the methanol extracts of the leaf and the ethanol extracts of the fruit also had 17.66±1.52 mm activity. In all leaf and fruit extracts the bacteria tested confirmed their significant activity.

In the case of leaves, the highest inhibition zone (17.66 mm) was shown by methanol against *K. pneumoniae*. Methanol and ethanol leaf extracts show a growth inhibitory zone (16.0 mm) against *E. coli* and *S. aureus*, respectively. In the leaf, the lowest zone of inhabitation in methanol was shown by *S. aureus* (15.33±0.57). Ethanol also showed the same inhibition against *E. coli*, with the lowest inhibition in methanol (8.33 mm) against *K. pneumoniae*. In acetone, the lowest zone (07.0±1) was shown against *E. coli*. and the zone of inhibition against *K. pneumonia* was 08.0±1. In acetone, the maximum zone (11.33±0.57) was observed against *S. aureus. K. pneumonia* showed the highest values (14.66±1.15) in chloroform, while against *S. aureus* the inhibition zone was 07.33±0.57; the lowest value was shown by 06.0±1) in chloroform against *E. coli*, which was also the lowest value in all leaf extracts.

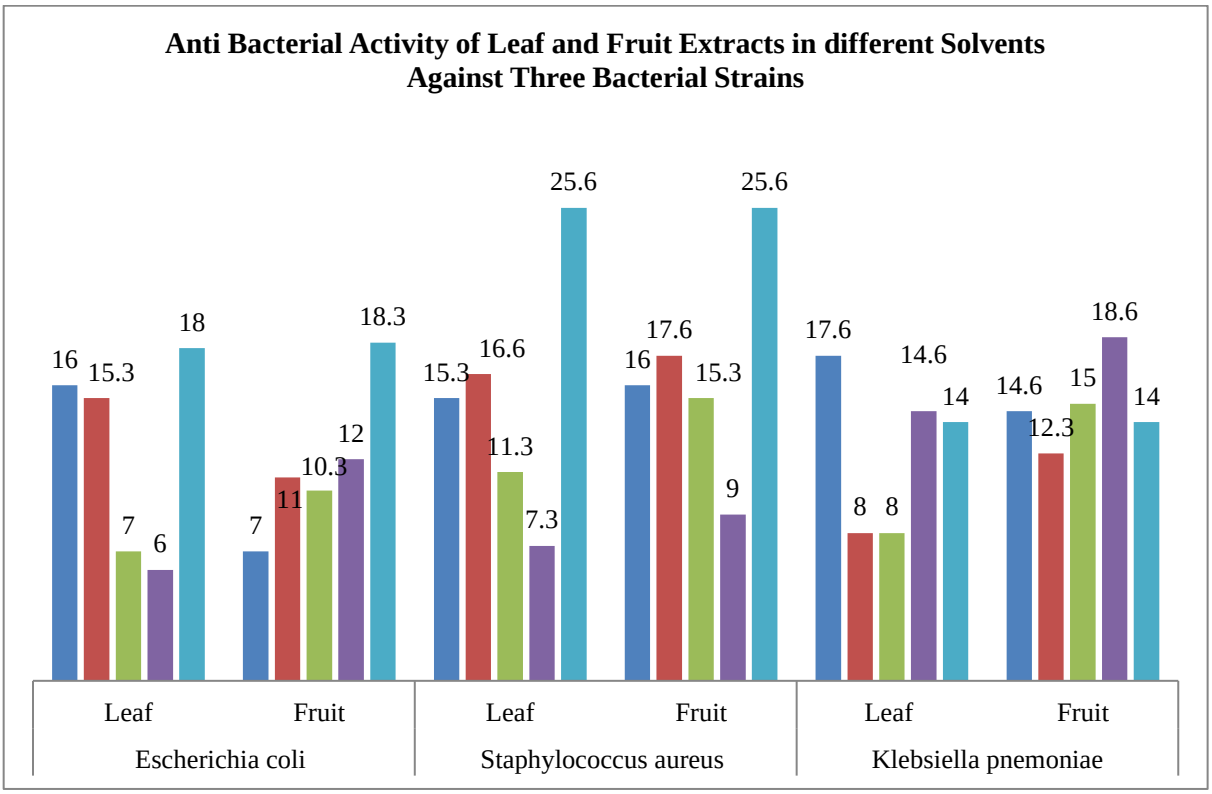

Figure 3. The antibacterial activity of the leaf and fruit of *S. pseudocapsicum*

In the case of fruit, the maximum (18.66±1.15) value was recorded against *K. pneumonia* in chloroform. In methanol, the highest zone of inhibition (16.0±1) was shown against *S. aureus* while the lowest (7.0±1) was shown against *E. coli.* In methanol, the inhibition zone against *K. pneumoniae* was (14.66±0.57). In ethanol, the highest zone of inhibition (17.66 0±1.52) was shown against *S. aureus* while the lowest (11.0±1) was shown against *E. coli.* In ethanol, the inhibition zone against *K. pneumoniae*was 14.66±0.57. In acetone, the highest inhibition zone (15.33±0.57) was shown against *S. aureus*, while the lowest (10.33±1.52) was shown against *E. coli.* In acetone, the inhibition zone against *K. pneumonia* was (15.0±1). In chloroform, the highest inhibition zone (18.66±1.15) was shown against *K. pneumoniae*, while the lowest (09.0±1) was shown against *S. aureus*. In acetone, the inhibition zone against *E. coli* was (12.0±1). In all samples separately, all three bacteria showed sensitivity to the control or standard (ampicillin). The maximum value of the control (ampicillin) observed was 24.0 mm against *S.aureus*, after which in the samples the highest zone (18.66±1.15) was recorded in the chloroform extract of the fruit. The lowest value (06.0±1)

was shown in the chloroform extract of the leaf against *E. coli*. The mean inhibition zone in the control and the sample inhibition value were recorded in the ranges of 6.0 to 24.0 mm.

Antifungal Activity; The antifungal activity of *S. pseudocapsicum* was carried out against *Aspergillus niger* and *Penicillium notatum*. The highest zone of inhibition was observed against *A. niger* 18±0.57 while the lowest growth inhibition 9.66±1.57 was the lowest against *P. notatum*. In the case of leaves the highest zone was observed in the methanol extract. Ethanol and acetone show moderate values, while chloroform shows the lowest zone of inhibition against *A. niger*. Against *P. notatum*, the highest zone was observed in methanol. Ethanol and methanol show moderate inhibition, while the lowest inhibition was observed against chloroform, as shown in the fig.

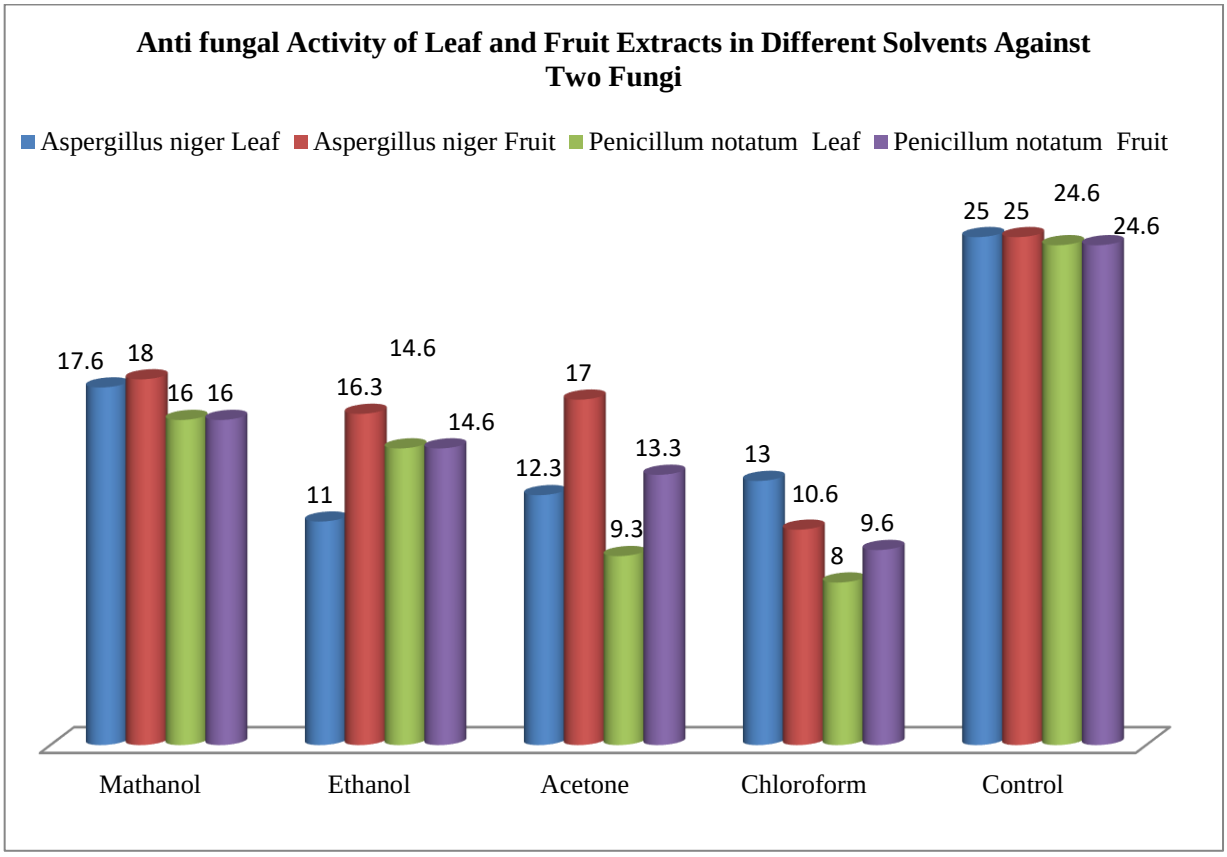

Figure 4. The fungal activity of the leaf and fruit of *S. pseudocapsicum*

In the case of fruit, the highest zone was observed in the methanol extract. Ethanol and acetone show moderate values, while chloroform shows the lowest zone of inhibition against *A. niger*. Against *P.notatum*, the highest zone was observed in methanol. Ethanol and methanol show moderate inhibition, while the lowest inhibition was observed against chloroform. The findings revealed an association between antimicrobial activity and the biochemical constituents of plants. Compounds such as terpenoids and phenolics have antimicrobial potential (Kačániová et al., 2022) also reported that alkaloid phenolic compounds and tripenoids inhibit or retard the growth of microorganisms (Akarca, 2022).

Antioxidant Activity; Antioxidants are the most important substances that delay or prevent oxidation of cells. Reactive oxygen species are very harmful to the body because they initiate a chain of destructive reactions when their concentration increases in the body. These free radicals can be scavenged by antioxidants by donating their electrons to free radicals; in this way they inhibit or prevent the body from destructive damage. In a healthy, sound, and good body, most antioxidants are produced within the body, but some of them are obtained from natural plants. Antioxidant

activity was observed in the DPPH as a reference molecule. The absorbance was measured in all extracts using a spectrophotometer.

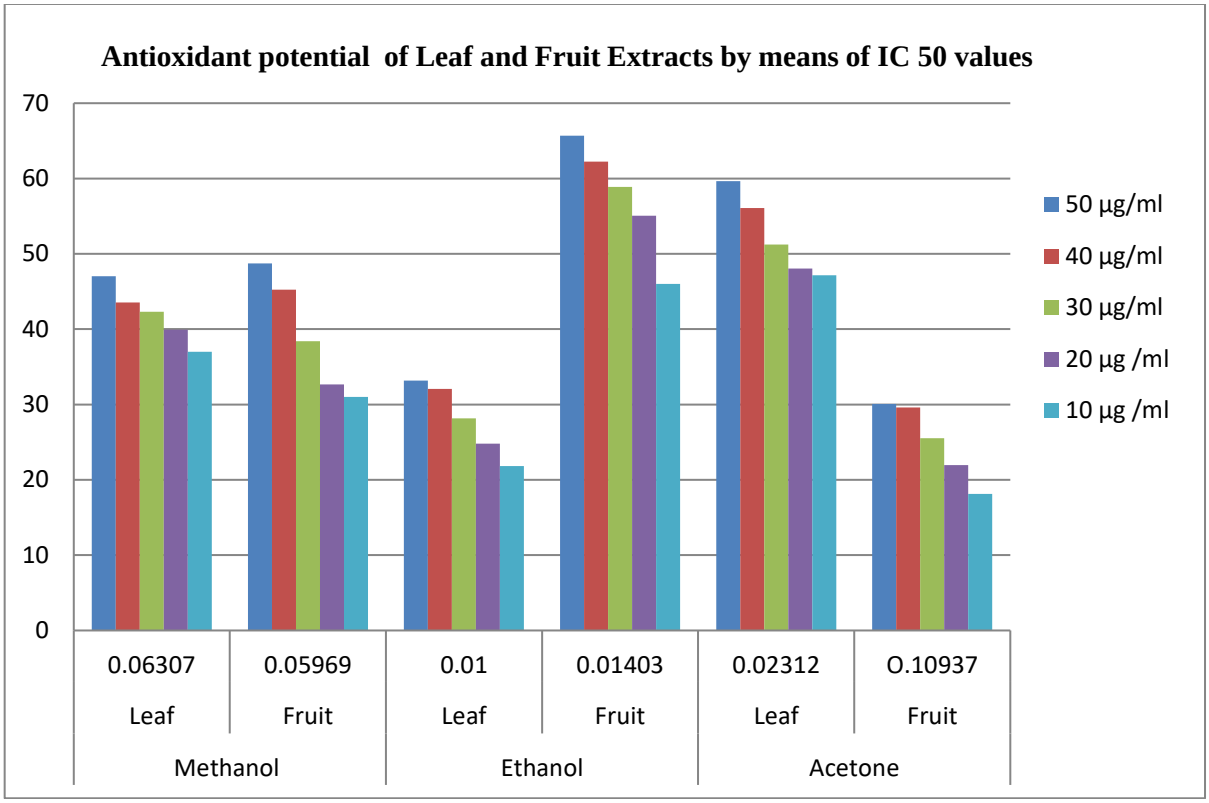

Figure 5. The antioxidant activity of the leaf and fruit of *S. pseudocapsicum*

The free radical scavenging results were calculated in terms of IC_{50}. The results indicate that the *S. pseudocapsicum* fruit shows a substantial free radical scavenging capability in extracts of methanol, ethanol acetone and chloroform with IC_{50} values of 0.06307, 0.0100, 0.02312 and 0.0110 respectively. In fruit extracts, the highest antioxidant potential was shown in ethanol (0.0100), while the lowest potential was observed in methanol (0.06307) while other extracts showed IC_{50} values of 0.02312 and 0.0110 in acetone and chloroform respectively. *S. pseudocapsicum* shows a significant free radical scavenging capability in extracts of methanol, ethanol, acetone, and chloroform with IC_{50} values of 0.05969, 0.01403, 0.109375 and 0.06225 respectively. In fruit extracts, the highest antioxidant potential was shown in ethanol (0.01403), while the lowest potential was seen in acetone (0.10937), while other extracts showed IC_{50} values of 0.05969 and 0.06225 in methanol and chloroform respectively.

DISCUSSION

The nutritional analysis of the fruit and leaves of the plant indicates that the plant is high in nutrient content. The percentage of moisture in the leaf (44.56%) and the fruit (56.28%) is high, comparable to that of the *S. anguivi* fruits that have a low moisture(4.58±0.11%) content. (Chinedu et al., 2011) reported that African eggplant fruits naturally hold 89.27±0.12% moisture. The percentage value of ash in leaf (8%) and fruit (3%) of *S. pseudocapsicum* is comparable to that of the eggplant fruit (8.89%) (Sadef et al., 2022). These findings are analogous to the results of *S. aethiopicum* (13.60%) *S. gilo* (9.50%) and *S. anguivi* (15.20%) described by (Adeyeye and Fagbohun, 2006; Sadef et al., 2022). Lipids, in addition to providing fuel for metabolism, are major components of cell membranes. The poly unsaturated fatty acids omega 6 and omega 3 are essential to avoid cholesterol incorporation in the walls of the arteries and are crucial to avoid heart disorders (Adeyeye and Fagbohun, 2006; Chinedu et al., 2011) evaluated the protein value in the fruit of *S. anguivi*

(36.35±1.63%) which was higher than the testified standards for nearly all *Solanum* sp. of the Solanaceae family for crude protein. As protein is a constituent of the membrane, it is important for structural stability. Food contains a large amount of amino acids that are very significant for humans (Qanash et al., 2022).

The leaf and fruits of *S. pseudocapsicum* contain crude fibre used to treat of cancer, diabetes, abdominal pain, and obesity (Qanash et al., 2022; Saldanha, 1995). Both leaves and fruits contain a considerable amount of carbohydrates, which are essential to maintain the blood glucose level, provide fuel to the cell, and therefore is important in metabolism. Sugars bind to lipids and proteins to form glycoproteins and glycolipids that are essential for cell signaling. Due to the low concentration of carbohydrate intake of the fruit (berry) and leaves of *S. pseudocapsicum*, no glycemic problems were caused (Lal et al., 2022).

These substances have a certain biological action on the humans. Active molecules present in *S. pseudocapsicum* in a definite range are responsible for curing of various chronic diseases in the human body. The active phytochemical molecules of *S. Pseudo capsicum* were qualitatively examined separately for leaves and fruit. The therapeutic value of plants has been proven by the presence of chemical substances. Saponins and steroids have also been responsible for central nervous system (CNS) activities (Lal et al., 2022) The fruits of *S. pseudocapsicum* have proven the incidence of alkaloids, flavonoids, lignin, vitamin C, phenol, tannins, carbohydrates, and have a multitude of therapeutic potentials such as antidiabetic, anti-inflammatory and analgesic activities and are used for the activity of the central nervous system (Andre and Mir, 2004; Lal et al., 2022).

These results matched the results of (Gogoi and Islam, 2012) who found that saponins, alkaloids, flavonoid, and tannins are present in the leaves of *S. nigrum* and *S. myriacanthum*. The incidence of cardiac glycosides in our study is consistent with the results of (Chinedu et al., 2011; Lal et al., 2022) who described the incidence of cardiac glycosides in *S. microcarpum* and *S. aethiopicum*. Vitamin C acts as an anticancer agent, and can also scavenge ROS, so it also acts as an antioxidant (Kačániová et al., 2022). It increases antibody absorption, iron absorption and advances human resistance. It also prevents cardiovascular disorders such as arteriosclerosis, hypertension, cholesterol level, and blood vessel strength (Lal et al., 2022; Zhang, 2012). Phenols are the main secondary metabolites that act as antioxidants. They also have antiviral, antibacterial, anticancer, and anti-inflammatory activities (Qanash et al., 2022).

Plants are a source of bioactive components and have therefore been used to treat various fungal and bacterial disorders. These medicinal plants are important for the health of individuals and communities (Akarca, 2022; Bhimba et al., 2010). These medicinal plants have been used by locals for the treatment of dysentery, diarrhea, lung bleeding, skin diseases, blood pressure, rheumatism, and nausea. Eighty percent of people depend on therapeutic plants to treat various disorders (Geetha and Geetha, 2014). Indigenous people are aware of the therapeutic potential of medicinal plants, as they have been using them since the prehistoric era, and knowledge is passed from generation to generation.

In the latter four extracts, leaves and fruits in methanol, ethanol, chloroform, and acetone were used *in vitro* for antimicrobial study of *S. pseudocapsicum* using the disc diffusion method. For bacteria, ampicillin was used as a positive control, while for fungi a positive nystatin control was used. Antimicrobial activity was shown for all plant extracts. However, plant parts as well as microorganisms were responsible for antimicrobial screening. The ampicillin control showed the same results for the same extracts.

In both fruit and leaf, methanol shows a good inhibitory zone against all bacteria. The reason for more inhibition is that it is more polar. Polar solvents are more beneficial, as methanol and water have the ability to harvest a higher percentage of material to remove(Li et al., 2022). In all solvents used, the methanol extract was the main component of the powder (Li et al., 2022; Weissenberg, 2001). Acetone has intermediate polarities, which is why it extracts fewer component from the powder (Akarca, 2022).

In fruit extracts *K. pneumoniae* shows strong inhibition. *K. pneumonia* weakens the human defense mechanism it mostly causes infection of the urinary and respiratory systems. It also causes pneumonia, septicaemia, and diabetes (Li et al., 2022).

Plants contain countless bioactive molecules, so they have been used as antimicrobial agents. As ROS (reacting oxygen species) and free cells cause cell burdening, the excess production of the free radical defense mechanism of the body decreases. These radicals play an imperative role in the pathogenesis of deteriorating disorder (Nowak et al., 2022). By the reaction of DPPH with the antioxidant, it has been converted to α,α-diphenyl-β-picryl hydrazine. Its absorption decreases as a result of the transfer of the proton to the free radical. Therefore, the free radical scavenging ability depends upon decolorization (Li et al., 2022). As DPPH is used as a reference by comparing the scavenging ability of DPPH with the leaf and fruit of *S. pseudocapsicum*, DPPH was found to have a lower IC_{50}. However, leaves have an additional scavenging capacity than fruits since the value of IC_{50} is a degree of inhibitory concentration (Nowak et al., 2022). A substance with a lower IC_{50} means that it has a strong free radical scavenging capacity.

CONCLUSION

Herbal drugs are very important in the universe, so these plants will be a great source of medicine because they contain bioactive molecules that have been used in medicine. Some of these are using but some are way to test. The present research was conducted to analyze the bioactive molecules and therapeutic potential of the leaves and fruit of *S. pseudocapsicum*. Methanol, ethanol, chloroform, and acetone extracts have been used to perform various activities. Various primary metabolites alkaloids, flavonoids, terpenoids, tannins, and secondary metabolites such as proteins and carbohydrates have also been isolated from leaves and fruit by qualitative analysis. Antimicrobial activity, that is, antibacterial activity, was carried out against *Escherichia coli*, *Staphylococcus aureus*, and *Klebsiella pneumoniae*, while antifungal activity was carried out against *Aspergillus niger* and *Penicillium notatum* using the disc diffusion method. *K. pneumonia* shows the highest inhibition zone in the chloroform extract, whereas the lowest inhibition zone is in methanol against *E. coli*. In the leaf, the highest inhibition zone was observed in methanol against *K. pneumoniae*, while *S. aureus* showed the lowest inhibition zone in methanol. In methanol, extracts of both leaves and fruits show maximum inhibition against *A. niger*. Therefore, we can conclude that it has an active molecule that shows antimicrobial potential, and hence it can be used as a medicine.

The free radical scavenging ability was observed in all extracts, but the lowest IC_{50} was observed in ethanol. This means that it is highly antioxidant. ROS are produced in the body due to hypertension, injury, and other disorders, but they have been scavenged by antioxidants produced within the body. However, sometimes the body does not produce enough antioxidants to cope with all ROS, so antioxidants are artificially given to the body from outside. A recent study concluded that this plant is a good source of essential biochemicals. From the proximate analysis, it is also found that the plant contains a reasonable amount of moisture, ash, crude fibre, crude fat, and protein; thus, it is good for the diet.

Declaration Section:

Conflict of Interest: There are no conflicts of interest among the authors.

Ethical Approval*:* Not applicable

Data availability*:* Data underlying the results presented in this paper are not publicly available at this time but may be obtained from authors upon reasonable request.

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