Exploring the Therapeutic Potential of Trianthema Portulacastrum in Inflammation, Oxidative Stress, and Diabetes Management

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Research Article

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Abstract

BACKGROUND: *Trianthema portulacastrum*, a member of the Aizoaceae family, is a multipurpose medicinal plant that has long been used to treat a range of symptoms, including fever, jaundice, respiratory diseases, skin concerns, liver problems, and urinary tract infections. Hepatoprotective, diuretic, antibacterial, antifungal, antipyretic, and wound-healing qualities are also well-known. There is little scientific evidence to support its biochemical effectiveness in reducing inflammation, oxidative stress, and hyperglycemia, despite its extensive ethnomedical history. The purpose of this study was to assess *T. portulacastrum*'s antioxidant, anti-inflammatory, and antidiabetic properties using well-established in vitro tests such as heat-induced hemolysis inhibition, α-amylase inhibition, and DPPH radical scavenging.

RESULTS: Fresh leaves of *T. portulacastrum* demonstrated strong DPPH radical scavenging activity, with increasing concentrations showing inhibition levels of 12.13%, 30.85%, 43.59%, 45.95%, and 58.39%, and a total antioxidant capacity of 58.39 µg/mL. In anti-inflammatory testing, the plant exhibited 83.40 µg/mL scavenging activity in heat-induced hemolysis assay—substantially higher than the standard diclofenac (27.92 µg/mL). The α-amylase inhibitory activity also showed promising results across concentrations, ranging from 9.95% to 38.45%, compared to acarbose, which showed 13.81% to 64.72% inhibition. Notably, *T. portulacastrum* achieved a total inhibition value of 113.97 µg/mL, markedly surpassing acarbose's 12.53 µg/mL. These findings suggest that the plant exhibits significant therapeutic bioactivity relevant to the management of metabolic and inflammatory disorders.

CONCLUSION: The findings say that *Trianthema portulacastrum*'s bioactive substances can reduce inflammation, oxidative stress, and hyperglycemia. Its significant antioxidant, antidiabetic, and anti-inflammatory qualities highlight its potential as a viable choice for the creation of plant-based medications. This study confirms the plant's traditional use while also emphasising *T. portulacastrum*'s increasing importance in contemporary phytomedicine and functional food formulations intended to promote overall health and wellness.

INTRODUCTION

Medicinal plants have been used to cure a variety of diseases in ancient times. They have bioactive substances like terpenoids, flavonoids, and alkaloids which can improve human health and their medicinal potential is well known[1]. Their therapeutic qualities made them essential in many ancient medical systems like Ayurveda and ancient Chinese Medicine (TCM). As people search for natural and sustainable alternatives to synthetic drugs, the use of medicinal plants in modern healthcare has garnered a lot of interest. The therapeutic and medicinal applications of these plants are numerous and range from short-term ailments to chronic conditions. Numerous pharmacological characteristics of medicinal plants, including analgesic, anti-inflammatory, antioxidant, and antibacterial effects, have been demonstrated by studies[2].

These qualities of medicinal plants make them useful in improving general health and preventing from diseases. They are generally regarded as safe alternatives for synthetic medications with lower adverse health effects and a desirable choice for long-term health maintenance[3]. The ongoing interest in medicinal plants has led to a great deal of scientific research to both confirm their historic use and explore new therapeutic potential. There is growing evidence that these plants are effective, which highlights their importance in modern medicine and their potential as a source of novel pharmacological compounds[1].

Horse purslane, or *Trianthema portulacastrum*, is a common herb that grows annually in tropical and subtropical climates, such as Asia, Africa, and Central America.The plant is adaptable to wide range of habitats,grows quickly and thrive in a variety of soil types and climates[4]. The plant belongs to *Aizoaceae* family and has small, yellow blooms and thick, oval leaves[5].

T. portulacastrum plant has been utilized in traditional medicine to treat ailments including fever, inflammation, wounds, and digestive issues [6]. Its antibacterial, anti-inflammatory, and antioxidant qualities are due to the presence of a range of bioactive substances, such as flavonoids, alkaloids, and tannins. According to research, the plant's extracts may help fight inflammation and oxidative stress which are connected to a number of chronic illnesses, including cancer and heart disease [7].

T. portulacastrum has also been discovered to be rich in important nutrients. Vitamins like C and A as well as minerals like calcium and iron are rich in the leaves which increase their health benefits. The plant is rich in omega-3 fatty acids, especially alpha-linolenic acid which makes it a desirable functional food[5]. The current investigation analyses the therapeutic effects of *Trianthema portulacastrum* leaves.

Based on the background information the current study was carried out to

- Estimate the antioxidant activity of *Trianthema portulacastrum*
- Estimate the anti inflammatory activity of *Trianthema portulacastrum*
- Estimate the anti diabetic activity of *Trianthema portulacastrum*

MATERIALS AND METHODS

The current study was conducted to evaluate the *in vitro* antioxidant activity, *in vitro* anti inflammatory activity and *in vitro* anti diabetic activity of *Trianthema portulacastrum* leaves.

Collection of the sample

The *Trianthema portulacastrum* leaves were collected from a village in Tirupur district, Tamilnadu in the month of August, 2024. The *Trianthema portulacastrum* L. was identified and authenticated by Scientist ‘F’ & Head of Office Dr. M. U. Sharief, Botanical Survey of India, Coimbatore and the letter no. BSI/SRC/5/23/2024-25/Tech. /418 for *Trianthema portulacastrum* L. The collected leaves were

thoroughly washed in running water to remove the debris. The leaves were allowed to dry a room temperature to remove surface water.

In vitro antioxidant activity

Compounds known as antioxidants scavenge free radicals and guard against oxidative damage. They render free radicals innocuous by providing them with an electron. By slowing down the lipid peroxidation process, which is the primary reason why food products deteriorate during processing and storage, antioxidants increase the shelf life. Using the DPPH radical scavenging test (DPPH), the antioxidant capacity of fresh *Trianthema portulacastrum* L. leaves was evaluated.

The antioxidant activity of the extract was evaluated using Blois's (1958) method of hydrogen donation or radical scavenging with the stable radical DPPH. Methanol was used to lower the level to 100 µL after sample extracts were collected at various quantities. The standard aliquots (BHA, BHT, rutin, and quecertin) and the sample were shaken vigorously after approximately 5 mL of a 0.1 mM methanolic solution of DPPH was added. To make the negative control, 100 µL of methanol was combined with 5 mL of 0.1 mM methanol solution DPPH. For twenty minutes, the tubes were let to stand at 27°C. At 517 nm, the absorbance of the sample was measured in relation to the blank, which is methanol.IC50, or the sample concentration needed to block 50% of the DPPH content, was used to express the samples' radical scavenging potential.

In vitro Anti inflammatory activity

Heat-Induced Hemolysis

This approach was first presented by Shinde *et al.* (1999), and Hennech *et al.* (2018) employed it with minor adjustments. A 10% HRBC (1.0 ml) and a variety of plant extracts (1 mg/ml) (1.0 ml) are added to each tube and thoroughly mixed to create the reactional mixture (2 ml). One milliliter of HRBC and one milliliter of diclofenac sodium at different concentrations (10 to 50 µg/ml) made up the positive control. One milliliter each of saline and a 10% red blood cell solution made up the negative control. Experience was gained in three stages. For 30 minutes, the resulting solution was heated to 56°C. After cooling to ambient temperature, it was centrifuged for 10 minutes at 2500 RPM.The amount of hemolysis was determined by measuring the absorbance of each solution using spectrophotometry (UVmini 1240, Shimadzu) at 560 nm after the supernatant was collected. The formula was used to determine the hemolysis inhibition %.

Percentage of inhibition = Ac – At ÷ Ac X 100

Where 'Ac' is absorbance of control and 'At' is absorbance of the test.

In vitro anti diabetic activity

Inhibition assay for α-amylase activity

The reaction was started by adding starch as a substrate (0.5% starch solution) after α-amylase was combined with extract at varying doses (50–200 µg/mL). DNS (3,5-dinitrosalicylic acid) reagent was added in two milliliters to halt the reaction after five minutes at 37°C. Following 15 minutes of heating to 100°C, 10 milliliters of distilled water were added to the reaction mixture to dilute it in an ice bath (Miller, 1959). The activity of αamylase was measured using the spectra at 540 nm. Under test conditions, the IC50 value was the quantity of α-amylase inhibitor required to inhibit 50% of enzyme activity.

RESULTS AND DISCUSSION

In vitro anti inflammatory activity of Trianthema portulacastrum L. leaves

Table 4.1
Heat-Induced Hemolysis of *Trianthema portulacastrum*

Extracts	% of Inhibition		% Scavenging activity IC_{50} (µg/mL)
Trianthema portulacastrum	50µl	21.07	83.40
	100µl	28.23	
	150µl	39.98	
	200µl	42.4	
	250µl	49.39	
Diclofenac	50µl	47.43	27.92
	100µl	51.05	
	150µl	56.38	
	200µl	63.71	
	250µl	70.45	

Table 4.1. In the *in vitro* anti-inflammatory activity screening it was observed that *Trianthema portulacasrtrum* extract showed significant activity when compared to the standard diclofenac. Heat induced hemolysis activity in fresh *Trianthema portulacasrtrum* leaves (21.07%, 28.23%, 39.98%, 42.4%, and 49.39%) and the standard diclofenac (47.43%, 51.05%, 56.38, 63.71%, and 70.45%).The total % scavenging activity of fresh *Trianthema*

portulacasrtrum leaves is 83.40 µg/mL and the standard is 27.92 µg/mL. Compared to standard diclofenac, fresh *Trianthema portulacasrtrum* leaves showed best result in 83.40 µl.

In vitro anti oxidant activity of Trianthema portulacastrum leaves

Table 4.2
DPPH radical scavenging activity of *Trianthema portulacastrum*

Extracts	% of Inhibition		% Scavenging activity IC_{50} (µg/mL)
Trianthema portulacastrum	50µl	12.13	68.29
	100µl	30.85	
	150µl	43.59	
	200µl	45.95	
	250µl	58.39	
Rutin	5µl	15.14	4.44
	10µl	19.36	
	15µl	36.61	
	20µl	59.97	
	25µl	76.05	
BHT	5µl	18.89	5.56
	10µl	34.27	
	15µl	44.71	
	20µl	63.84	
	25µl	67..13	

Table 4.2.: It indicates the *in vitro* antioxidant activity of *Trianthema portulacasrtrum* leaves. DPPH radical scavenging activity of *Trianthema portulacasrtrum* leaves (12.13%, 30.85%, 43.59%, 45.95%, and 58.39%) The total is DPPH radical scavenging activity of *Trianthema portulacasrtrum* leaves (58.39 µg/mL).

In vitro anti diabetic activity of Trianthema portulacastrum leaves

Table 4.3
α-amylase activity of *Trianthema portulacastrum*

Extracts	% of Inhibition		% Scavenging activity IC_{50} (µg/mL)
Trianthema portulacastrum	50µl	9.95	113.97
	100µl	15.91	
	150µl	23.62	
	200µl	31.21	
	250µl	38.45	
Acarbose	10µl	13.81	12.53
	20µl	28.70	
	30µl	43.66	
	40µl	52.53	
	50µl	64.72	

Table 4.3. Depicts the ability of fresh *Trianthema portulacasrtrum* leaves to prevent diabetes. Fresh leaves of *Trianthema portulacasrtrum* with varying levels of α-amylase activity (9.95%, 15.91%, 23.62%, 31.21%, 38.45%) and Acarbose (13.81%, 28.70%, 43.66%, 52.53%, 64.72%).Acarbose has a scavenging activity of 12.53 (µg/mL) while fresh *Trianthema portulacasrtrum* leaves had a total of 113.97 (µg/mL).

DISCUSSION

The current study highlights the importance of *Trianthema portulacastrum* in natural medicine and the development of functional foods by showcasing its strong therapeutic potential in reducing oxidative stress, inflammation, and diabetes. The findings offer strong support for both its historical use and its potential as a plant-based medicine in the future.

Antioxidant Activity and Its Implications

An accumulation of reactive oxygen species (ROS) leads to oxidative stress, which is a major factor in the development of many chronic diseases, including cancer, heart disease, and neurological conditions. Free radicals are neutralised by antioxidants, which shield the body from oxidative harm[10].

The DPPH radical scavenging assay shown that *T. portulacastrum* has significant antioxidant activity and is capable of effectively neutralising free radicals, with an inhibition range ranging from 12.13–58.39%. Comparing its overall antioxidant capacity (68.29 µg/mL) to well-known synthetic antioxidants such as rutin and BHT demonstrates its effectiveness. *T. portulacastrum* has potent antioxidant qualities due to bioactive substances such flavonoids, alkaloids, and tannins [1]. Because flavonoids may provide hydrogen atoms to stabilise unstable molecules, they are especially crucial for scavenging free radicals[7].

These results are consistent with earlier research showing plant-based antioxidants have the ability to lower oxidative stress and fend off chronic illnesses[4].

Its abundance of bioactive phytochemicals, such as flavonoids, alkaloids, and tannins, is largely responsible for its antioxidant action. Particularly, flavonoids are known to stabilise unstable molecules and lessen oxidative damage by giving them hydrogen atoms[9]. *T. portulacastrum*'s ability to scavenge free radicals is based on this mechanism. Yaqoob *et al*. (2014) reported that the total phenolic and flavonoid content ranged from 50.75 to 98.09 mg GAE/g and 41.88 to 75.12 mg QE/g, respectively, and that the IC_{50} value for *T. portulacastrum* leaf extract was as low as 6.98 µg/mL. These data support *T. portulacastrum*'s potential as a natural source of antioxidants and have a high correlation with antioxidant capacity.

Anti-Inflammatory Potential and Its Role in Chronic Disease Prevention

An essential immunological response to dangerous stimuli like infections or wounds is inflammation. Chronic inflammation, on the other hand, can play a major role in the emergence of a number of metabolic disorders, such as arthritis, heart disease, and neurological disorders [11]. Because it can worsen insulin resistance and lead to other metabolic disorders, chronic inflammation is also crucial to the pathogenesis of diabetes[12].

With results ranging from 21.07–49.39%, the study's heat-induced haemolysis experiment indicates that *T. portulacastrum* significantly lowers haemolysis. With a total scavenging activity of 83.40 µg/mL, it may be a good natural anti-inflammatory. The anti-inflammatory activity of *T. portulacastrum* may be due to the fact that alkaloids and terpenoids, in particular, have been shown to regulate inflammatory pathways by lowering the release of pro-inflammatory cytokines[6]. By contrast, the range of inhibition for the widely used nonsteroidal anti-inflammatory drug (NSAID) diclofenac was 47.43–70.45%. The plant extract demonstrated noteworthy efficacy in spite of diclofenac's higher rate of inhibition, indicating its potential as an additional or replacement anti-inflammatory medication with potentially fewer side effects [7]. One of the main causes of metabolic diseases like diabetes is chronic inflammation. *T. portulacastrum* may indirectly improve metabolic health by reducing inflammation. These results are in line with recent studies that demonstrate the strong anti-inflammatory properties of bioactive compounds derived from plants, which can either supplement or replace manufactured drugs [5].

Anti-Diabetic Properties and Potential Mechanisms

Diabetes, which is characterized by insulin resistance and poor glucose metabolism, is a rapidly expanding global health concern. With inhibition levels ranging from 9.95–38.45%, *T. portulacastrum* demonstrated considerable inhibitory effects on starch hydrolysis, according to the results of this study's α-amylase inhibition assay. The plant extract's total scavenging activity (113.97 µg/mL) was significantly higher than that of acarbose, a common anti-diabetic drug (12.53 µg/mL). This suggests that *T. portulacastrum* may have a significant role in controlling blood sugar levels following meals. The ability

of T. portulacastrum to inhibit α-amylase is particularly significant since excessive carbohydrate breakdown results in rapid glucose absorption and elevated blood sugar. Inhibiting this enzyme reduces the release of glucose and improves glycaemic management[6]. The polyphenols and flavonoids included in medicinal plants have been shown in previous studies to lower hyperglycemia by disrupting the metabolism of carbohydrates [3]. The present study confirms earlier results and suggests that *T. portulacastrum* may be utilised as a natural alternative to diabetes medication.Oxidative stress also plays a major role in the pathophysiology of diabetes 1 by promoting insulin resistance and β-cell dysfunction. The antioxidant properties of *T. portulacastrum* may also aid to mitigate the challenges related to diabetes by scavenging free radicals that harm pancreatic cells[4].

Comparative Efficacy and Future Perspectives

Even though synthetic drugs like acarbose and diclofenac have been shown to be beneficial, they often have negative side effects such gastrointestinal distress and liver damage. The results of the study indicate that *T. portulacastrum* has the potential to be a safer alternative due to its significant bioactivity and natural state. Its antioxidant, anti-inflammatory, and anti-diabetic properties all complement its all-encompassing strategy for managing metabolic disorders. Future studies should primarily concentrate on clinical trials and *in vivo* studies to validate these findings and determine the optimal dosages for therapeutic applications. Furthermore, understanding the precise molecular pathways underlying its bioactivity will be necessary to incorporate it into modern therapy.*T. portulacastrum*-based dietary supplements, functional foods, or herbal medications may offer a sustainable and effective means of combating inflammation, oxidative stress, and diabetes.

CONCLUSION

The research indicates that *Trianthema portulacastrum* leaves possess potent anti-inflammatory, antioxidant, and antidiabetic properties. A range of 21.07–49.39% was seen in the heat-induced haemolysis inhibition activity when compared to diclofenac (47.43–70.45%). With a total scavenging activity of 83.40 µg/mL, *T. portulacastrum* outperformed the norm of 27.92 µg/mL. With a peak of 58.39 µg/mL, the range of DPPH radical scavenging activity was 12.13–58.39%.The leaves also showed better scavenging efficacy (113.97 µg/mL) than acarbose (12.53 µg/mL) and α-amylase inhibition (9.95–38.45%). According to these findings, leaves of *T. portulacastrum* show promise as a natural remedy for diabetes, oxidative stress, and inflammation.

Declarations

ACKNOWLEDGEMENT

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Figures

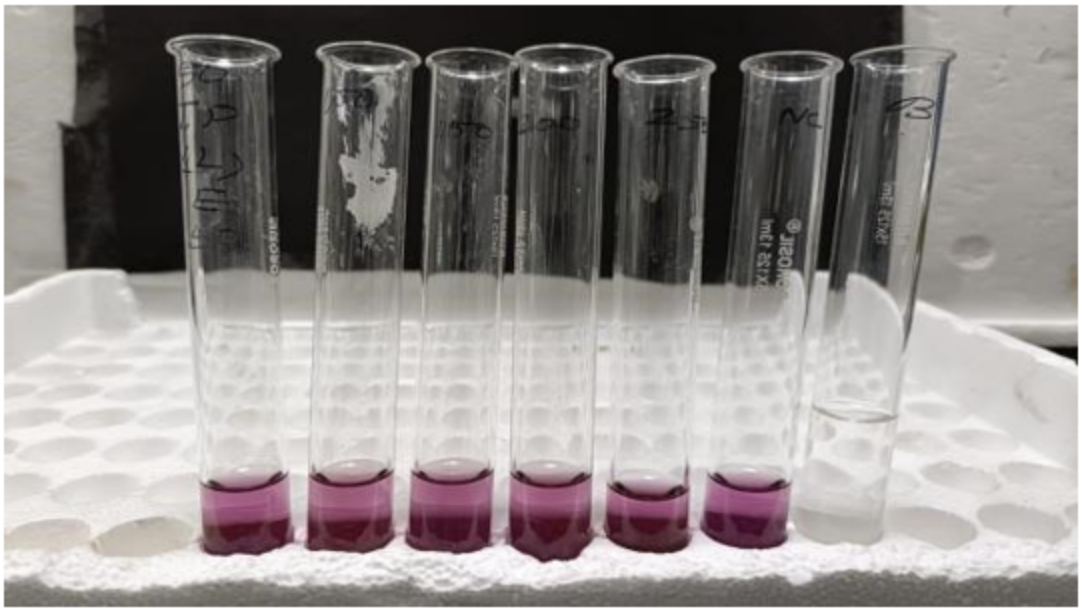

Figure 1

Fig 3.1. *In vitro* Antioxidant activity of fresh *Trianthema portulacastrum* L. leaves

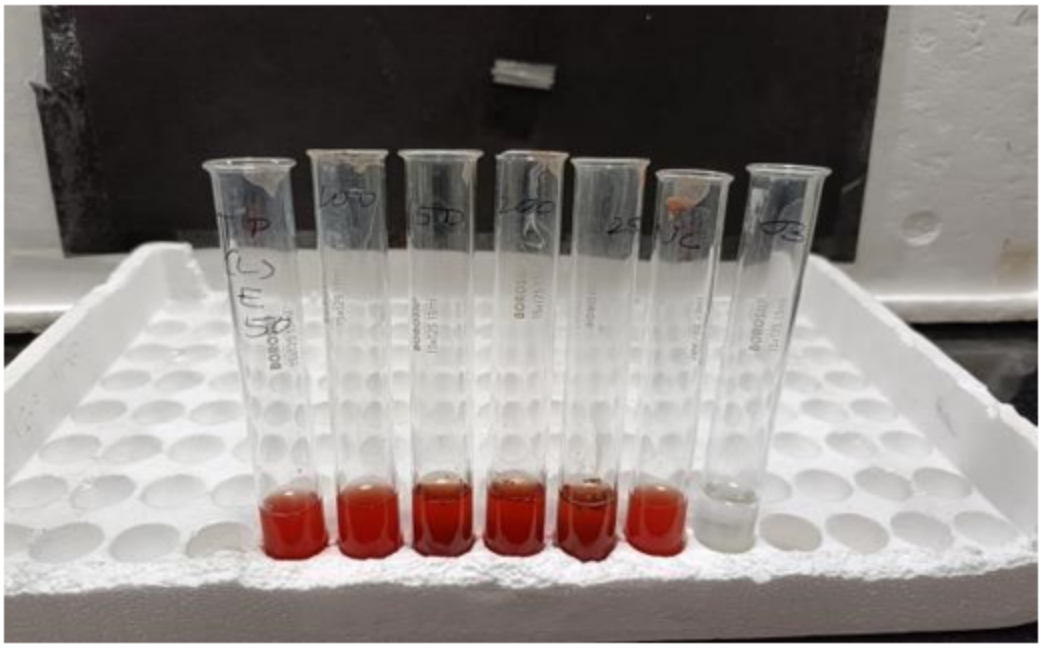

Figure 2

Fig 3.2. *In vitro* Anti inflammatory activity of fresh *Trianthema portulacastrum L.* leaves

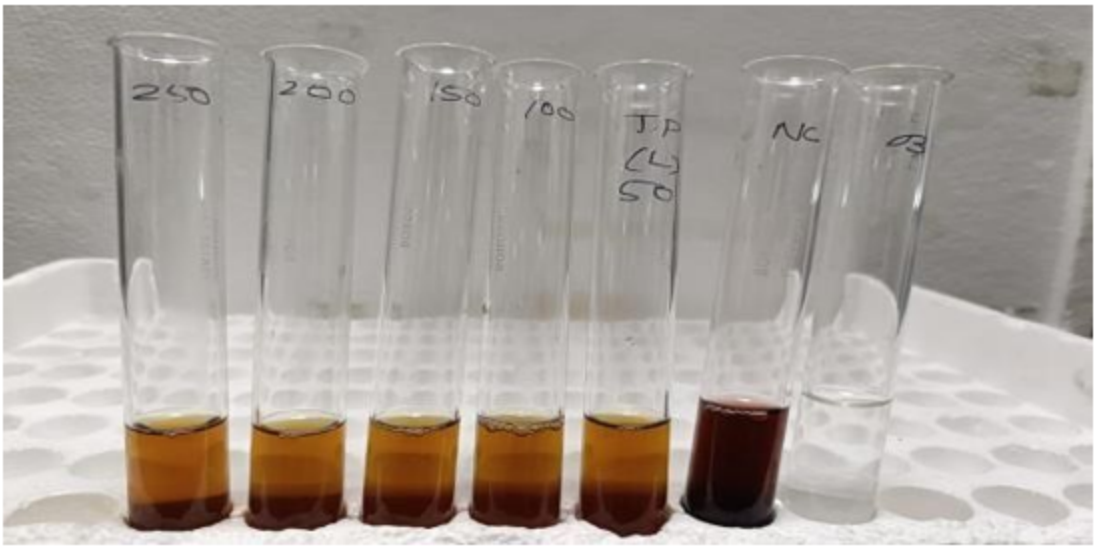

Figure 3

Fig. 3.3.*In vitro*anti-diabetic activity of fresh *Trianthema portulacastrum* L. leaves

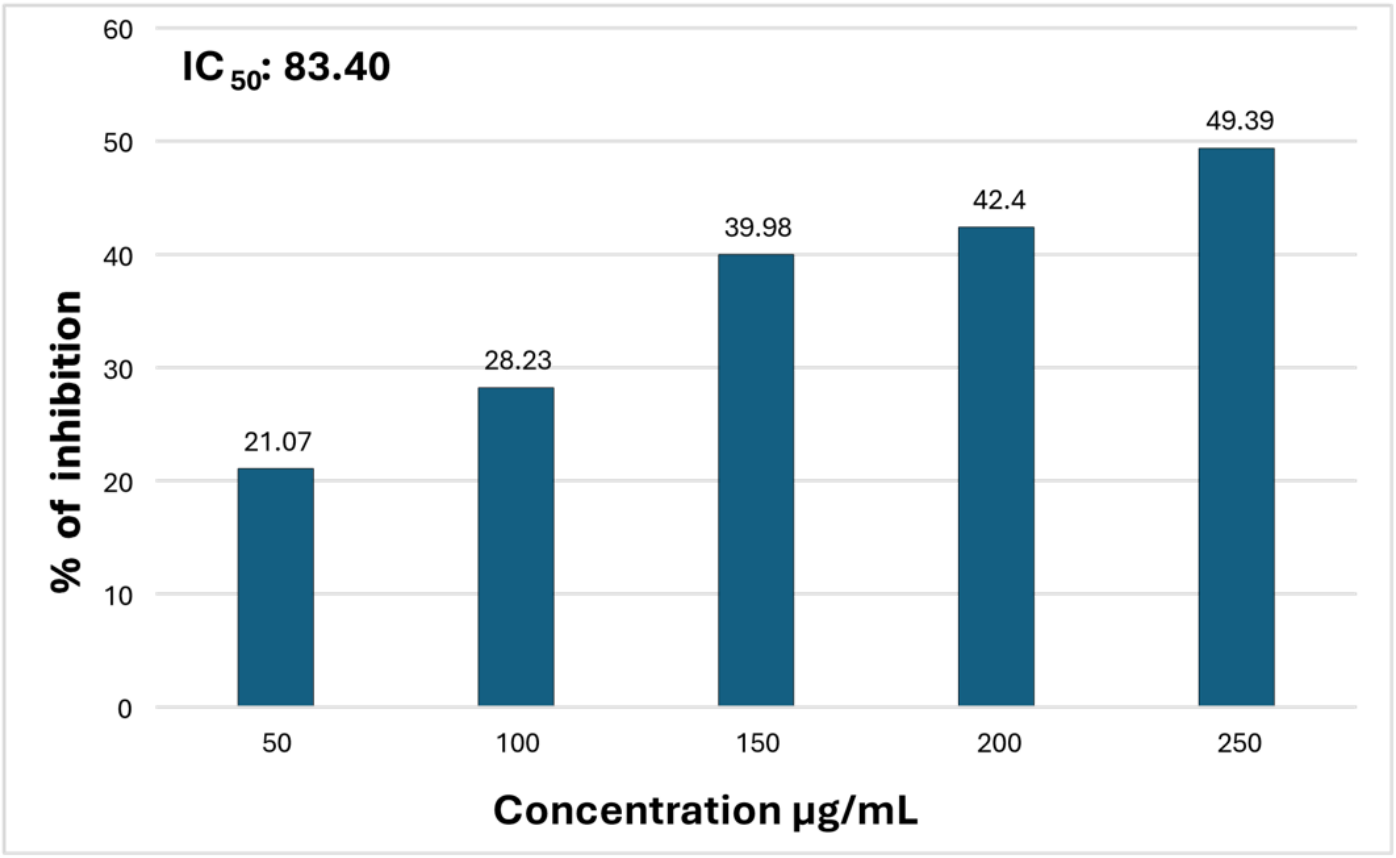

Figure 4

Fig 4.1.Heat-Induced Hemolysis of *Trianthema portulacastrum*

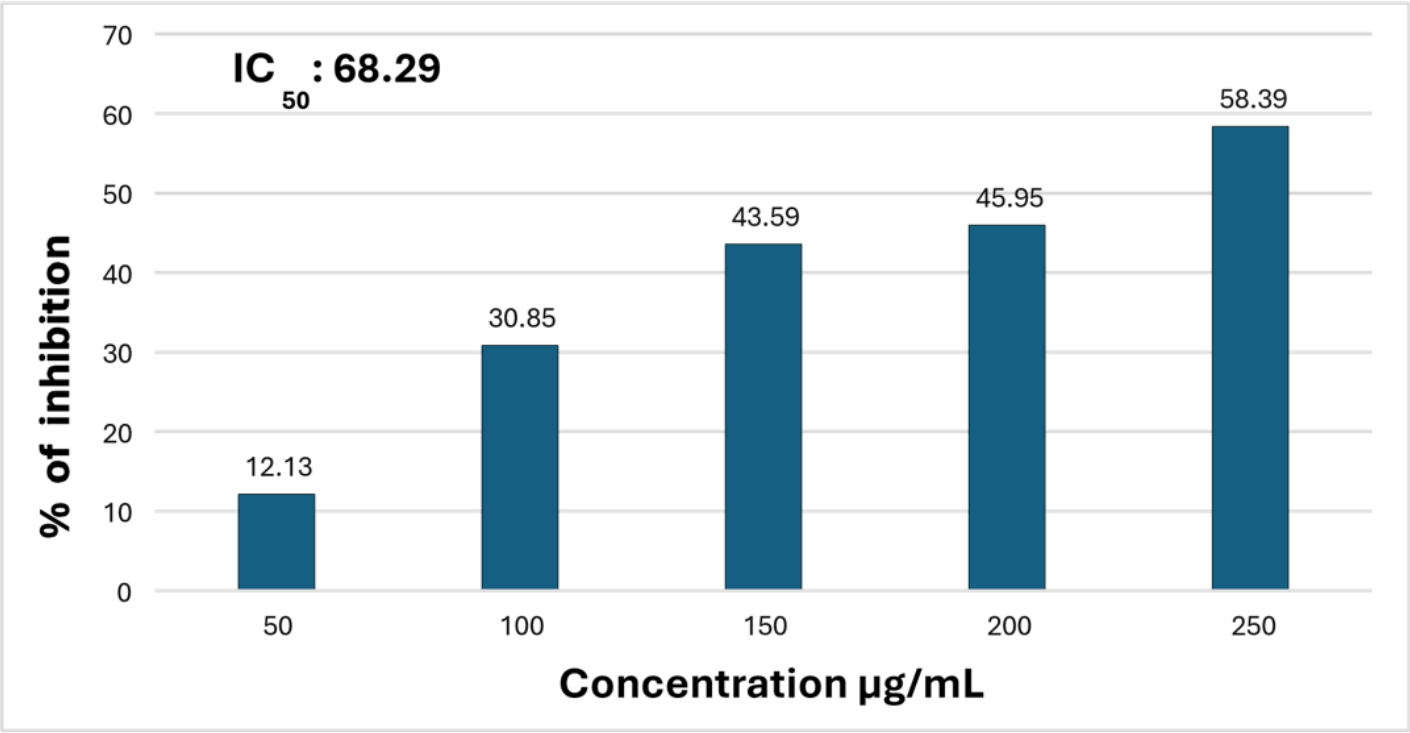

Figure 5

Fig. 4.2. DPPH radical scavenging activity of *Trianthema portulacastrum*

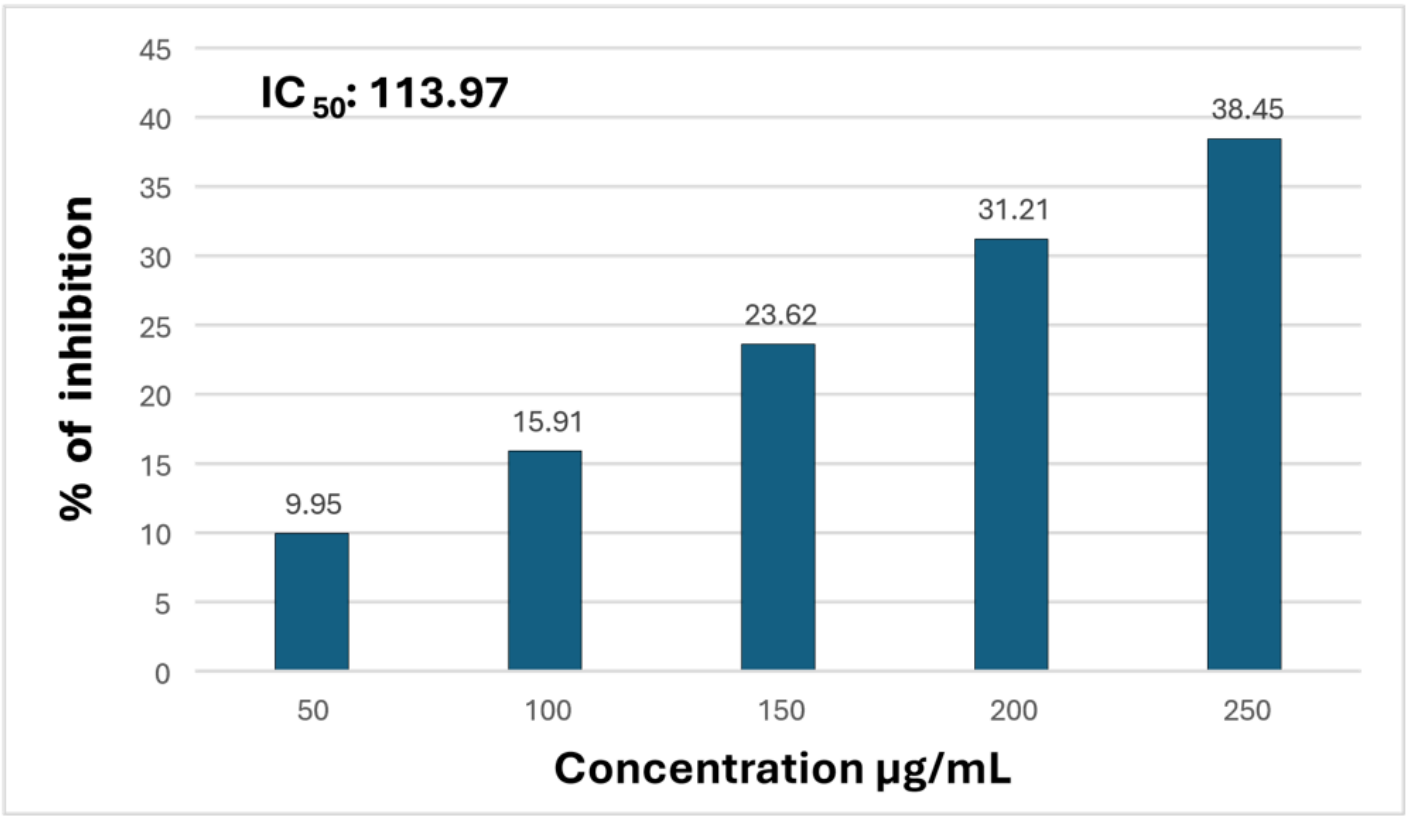

Figure 6

Fig. 4.3 α-amylase activity of *Trianthema portulacastrum*