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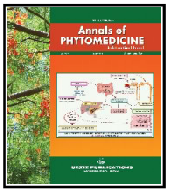

Original Article : Open Access

Ex vivo anticataract effect of *Passiflora edulis* Sims. whole fruit extract against glucose induced snowflake cataract in goat lens

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Abstract

Cataract refers to the clouding of lens that becomes opaque with ageing and metabolic processes. It obscures the passage of light through the lens to the retina of the eye. It is a slowly progressive disease which causes blindness worldwide. The objective of present study was to assess the potential anticataract activity of *Passiflora edulis* Sims. (passion fruit) extract by goat lens organ culture technique. Current *ex vivo* study was divided in five groups and each group containing six goat lenses were obtained from the abattoir and preserved in Kreb's Ringer bicarbonate buffer with a pH of 7.4. In the lens organ culture technique, the lenses were cultured for 48 h in artificial aqueous humor of glucose 55 mM to examine the morphological effects of the extract. The lens was then homogenized and centrifuged. Biochemical assessment for total protein, catalase and estimation of Na+ and K+ ions were performed. Antioxidant efficacy of whole fruit extract was evaluated by phosphomolybdenum assay, hydrogen peroxide assay and DPPH assay. The lens incubated with 50 ml/l passion fruit aqueous extract showed a partial anticataract effect while 100 ml/l passion fruit aqueous extract showed a promising anticataract effect. Observations of present study concluded that the passion fruit has a prominent anticataract effect. The *P. edulis* may be considered as one of the suitable drug candidates for the glucose induced snowflake cataract.

1. Introduction

Around 40 years of age, the proteins in the eye's lens begin to degrade and clump together. This clump causes a cloudy area on the lens, which is referred to as a cataract. The cataract worsens over time, clouding more of the lens. Protein aggregation and fibre compaction cause the disorientation of crystalline lens proteins present in them, respectively, which leads to cataract development. This increases the hardness of the lens, reduces light transmission through the eye (Caixinha *et al*., 2016). Majority of cataracts are caused by natural changes in the eyes ageing. Eye's lens remains clear at young age. According to an estimate, the International Diabetes Federation, 82 million adults between the ages of 20-79 years had diabetes in 2013. By 2035, the number is predicted to increase to 592 million. About twice as many cases of cataracts occur in people with type 2 diabetes mellitus (T2D), which makes up about 90% of all occurrences of the disease as in the general population. As indicated by numerous comprehensive population-based studies, the incidence of cataracts escalates with age, surging from 39% in the age group of 55-64 years to 92.6% in aged 80 years and above (Liu *et al*., 2017). Etiology and localization of cataracts may vary (*e.g*., hyperglycemic, fibrotic, nuclear, cortical, and subcapsular). They all have same pathogenesis: extensive cellular dysfunction brought by DNA damage, lipid peroxidation and lens cell protein alteration and aggregation brought by accumulated oxidative stress (Wishart *et al*., 2021). When diabetes is left untreated, the following process is thought to be responsible for cataract formation. Glucose builds up in the aqueous humor as well as in the blood when there is an insulin shortage with humor and through the lens, it develops as cataract. Within the lens, glucose is converted to sorbitol *via* the aldose reductase pathway. The lens swells osmotically as a result of sorbitol buildup due to slower sorbitol metabolism. When the amount of glucose in the lens increases, the sorbitol pathway is activated relatively more than the glycolytic pathway and sorbitol gets accumulated (Hashim and Zarina, 2012).

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2. Materials and Methods

2.1 Procurement of drug and instrument used

Ceftriaxone was brought from hospital pharmacy, Udayar block, Sri Ramachandra Hospital. Refrigerated centrifuge (Eppendorf centrifuge 5810 R) was utilized from Department of Biochemistry, Sri Ramachandra Medical College, SRIHER. Other chemicals, sodium chloride, potassium chloride, magnesium chloride, sodium hydrogen carbonate, sodium dihydrogen phosphate, calcium chloride, glucose, sodium phosphate buffer (pH 7.4), bovine serum albumin, hydrogen peroxide, sulfuric acid, sodium phosphate, ammonium molybdate, ascorbic acid, DPPH were purchased from Himedia Laboratories Pvt.Ltd., Chennai. Passion fruit was purchased from Kovai Pazhamudhir Nilayam, Chennai.

2.2 Preparation of artificial aqueous humor

Artificial aqueous humor was composed of sodium chloride ($NaCl_2$) 140 mM, potassium chloride (KCl_2) 5 mM, magnesium chloride ($MgC1_2$) 2 mM, sodium hydrogen carbonate ($NaHCO_3$) 0.5 mM, sodium dihydrogen phosphate (NaH_2PO_4) 0.5 mM, calcium chloride ($CaC1_2$) 0.4 mM and glucose 5.5 mM (pH maintained at 7.5) (Bhatti *et al*., 2015).

2.3 Preparation of fruit extract

Whole fruit weighing 750 g of *P. edulis* were taken and washed in distilled water and cleaned. They were sliced into four pieces and thoroughly blended in a mixer. Juice was collected from the mixture, followed by vacuum filtration was carried out. The fibers were separated from the juice using a centrifugation, the supernatant was obtained and utilized in the experiment. 50 ml/l was prepared taking 2.5 ml of fruit extract /50 ml of artificial aqueous humor and 100 ml /l was prepared taking 5 ml of fruit extract/50 ml of artificial aqueous humor.

2.4 Isolation of lens-by-lens organ culture technique

Fresh goat eyeballs were procured from the abattoir subsequently taken in a container filled with artificial aqueous humor adjusted to pH 7.5 (Patil *et al*., 2016). The lenses were isolated using a posterior approach during dissection (Moghaddam *et al*., 2005; Kumar *et al*., 2007). The isolated lenses were incubated in artificial aqueous humor which had glucose content of 10 mM in baseline with an osmolality of 255-295 mOsm. For generating glycation, a supra physiological dose of glucose (55 mM) was added to increase its concentration. This increased glucose concentration forms polyols by metabolizing through sorbitol pathway, which causes hydration and oxidative stress leads to development of cataract (Chitra *et al*., 2020). Culture media were treated with 5 mg/ml of ceftriaxone to prevent microbial contamination (Ramesh *et al*., 2013).

The study was carried in five groups with six lenses in each group as following:

- Normal – Artificial aqueous humor
- Toxic control – Glucose (55 mM) + Artificial aqueous humor
- Standard – Glucose (55 mM) + Ascorbic acid (80 µg) + Artificial aqueous humor
- Extract I – Glucose (55 mM) + *Passiflora edulis* extract (50 ml/ l) + Artificial aqueous humor
- Extract II – Glucose (55 mM) + *Passiflora edulis* extract (100 ml/l) + Artificial aqueous humor.

The lenses were cultured for 48 h and morphological assessment was made for general opacity and disruptional changes.

2.5 Preparation of lens homogenate

After being incubated for 48 h at room temperature, the lenses from each group were taken out and 10% of the total lenses were prepared in a 0.1 M sodium phosphate buffer (pH 7.4). In a cooling centrifuge, the homogenate was spun for 30 min at 40°C at 10000 rpm (Hajarnavis and Bulakh, 2020).

2.6 Morphological characteristics of lens

The morphological characteristics of lenses were assessed by placing them on a wired mesh with their posterior surface in contact with the mesh. Opacity of the lenses was observed by examining the visible square in the lens, and the opacity was graded on a scale from 0 (absence) to +++ (extensive thick opacity).

2.7 Biochemical tests

2.7.1 Total soluble protein estimation (Lowry's method)

Biochemical tests were conducted, including the estimation of total soluble protein using Lowry's method (Waterborg, 2009). Reagents A and B were prepared, consisting of 2% sodium carbonate in 0.1 sodium hydroxide and 0.5% copper sulfate in 1% sodium potassium tartarate, respectively. An alkaline copper solution (Reagent C) was prepared by combining 50 ml of reagents A and 1ml of B, and Folin's reagent (Reagent D) was diluted with 0.1 N NaOH. Bovine serum albumin (BSA) was used as standard.

For the total soluble protein estimation, BSA were pipetted into labeled tube, with distilled water serving as the blank. Reagent C was added to all tubes, followed by thorough mixing and 10 min incubation. Subsequently, reagent D was added to all the tubes, and the mixture was incubated at room temperature in the dark for 30 min. Absorbance was measured at 660 nm, and standard curve was constructed to quantify protein concentration. Similarly, lens homogenate samples were treated and total soluble protein concentrations were derived.

2.7.2 Catalase activity

Catalase activity in lenses was assessed using a colorimetric method based on protocol narrated by Hadwan and Khabt (2018). The lens homogenate were incubated with hydrogen peroxide, and the enzymatic reaction was stopped with ammonium molybdate. The intensity of the yellow complex formed was measured at 405 nm.

Following formula was used to calculate catalase activity,

(A blank 1 – A sample) / (A blank 2 – A blank 3) * 271

where A represents absorbance values. These biochemical tests provide insights into the morphological and biochemical characteristics of the lenses under study (Ozmen *et al*., 2002).

2.7.3 Estimation of Na+ and K+ ions

Sodium and potassium ions were estimated using flame photometry. Fresh distilled water was used to make the standard stock solution of ascorbic acid. The air and gas were adjusted to calibrate the photometer's flame (Banerjee and Prasad, 2020). After stabilization of flame, the instrument was turned on; the filter chamber lids were opened and proper color filters were inserted. The galvanometer's values were reset to zero by misting distilled water onto the flame. The most concentrated standard working solution was sprayed into the flame to change the sensitivity. At this point, the galvanometer's whole scale deflection was noted. Once again, distilled water was sprayed into the flame to achieve consistent galvanometer readings. Followed by the galvanometer was reset to zero. Now, the galvanometer readings were taken after spraying each of the standard working solutions into the flame three times. Similarly, the lens homogenate solution was sprayed three times into the flame, and the galvanometer values were noted. The equipment was cleaned thoroughly after every spray. Element concentrations were determined in sample using galvanometer values.

2.8 Antioxidant assays

2.8.1 Phosphomolybdenum assay

In the assessment of antioxidant activity, the phosphomolybdenum assay (Batool *et al.,* 2019) utilized 0.1 ml samples of fruit extract at varying concentrations. These samples were treated with a reagent solution comprising 0.6 M sulfuric acid, 28 mM sodium phosphate, and 4 mM ammonium molybdate. Following 90 min incubation at 95°C and subsequent cooling to room temperature, the absorbance was measured at 765 nm. Ascorbic acid served as the standard, and the antioxidant activity (% AO) was determined using the formula:

% AO = [(A standard – A sample)/A standard] * 100. Where; A represents absorbance values.

2.8.2 H_2O_2 assay

For the H_2O_2 assay, 1 ml of the extract was mixed with 4 ml of 50 mM phosphate buffer (pH 7.4) and 6 ml of H_2O_2. After vortexing for one and a half minutes, the solution was left undisturbed for ten minutes. Absorbance was measured at 230 nm, with ascorbic acid as the standard (Csepregi *et al*., 2016). The percentage of H_2O_2 scavenging activity was calculated using the formula:

% H_2O_2 Scavenging activity = [(A standard – A sample)/A standard] * 100. where; A represents absorbance values.

2.8.3 DPPH assay

In the DPPH assay, antioxidant activity of different extract concentrations was determined using 0.1 mM concentration of 2,2-diphenyl-1-picrylhydrazyl (DPPH) solution (Chang *et al*., 2001; Jain *et al*., 2023; Sruthy and Balasubramaniam, 2023; Thomas *et al.,* 2023; Deka *et al*., 2021; Kulla *et al*., 2021) . The reduction in DPPH solution absorption was measured at 517 nm after 20 min reaction period. Ascorbic acid (10 mg/ml DMSO) served as the standard. The percentage of radical scavenging activity (% RSA) for the entire fruit extracts was computed using the formula:

% RSA = (A control – A test/A control) * 100,

where, RSA represents radical scavenging activity, A control denotes the absorbance value of DPPH radical + ethanol, and A test represents the absorbance of DPPH radical + fruit extract.

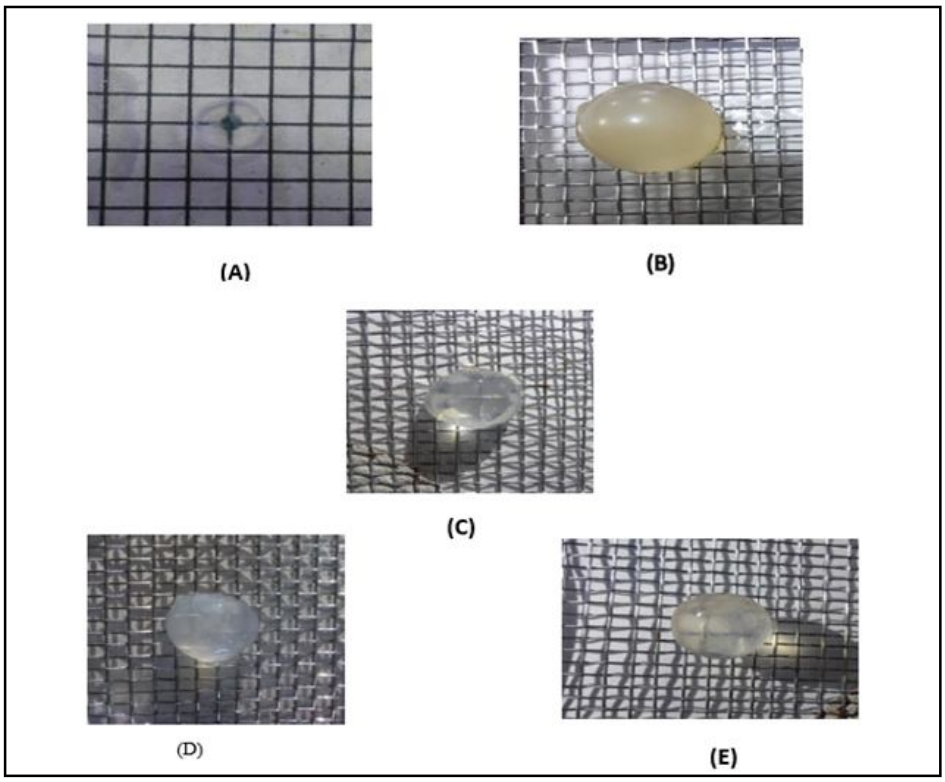
2.9 Statistical analysis

Statistical analysis was performed using Graph pad prism version 9.0. Results of biochemical studies and antioxidant studies were presented as mean ± SD (n=6). The analysis was carried out by unpaired t-test to show statistical significance between groups at $p<0.05$ level followed by ANOVA using Dunnet's test.

3. Results

3.1 Morphological characteristics of lens

Morphological effect of fruit extract was performed (Figure 1) for its general opacity and disruption. Lens treated with both the concentration of fruit extract did not show any disruption in the lens morphology. However, the opacity of lens was affected in the toxic control group. The extract treated at both the concentration improved the lens opacity in dose dependent manner. The 50 ml/l concentration showed diffused opacity whereas, 100 ml/l concentration showed slight opacity (Table 1).



A-Normal lens: B-Toxic control; C-Standard; D-Fruit extract 50ml/l; E-Fruit extract 100ml/l

Figure 1: Morphological characteristics of lens.

Table 1: Opacity grading of lens morphology

S.No.	Treatment groups	Opacity grading
1.	Normal (A)	0
2.	Toxic control (B)	+++
3.	Standard (C)	+
4.	Extract (I) (50 ml/l) (D)	++
5.	Extract (II) (100 ml/l) (E)	+

0: Absence, +: Slight degree, ++: Presence of diffuse opacity, +++: Presence of extensive thick opacity

3.2 Biochemical tests

3.2.1 Total soluble protein estimation (Lowry's method)

Total soluble protein estimation revealed in normal group as 337.46 (mg/ml), in toxic control as 250.57 (mg/ml), in standard group as 331.33 (mg/ml), in test (50 ml/l) as 299.85 (mg/ml) and test (100 ml/l) as 342.07 (mg/ml) (Table 2). These findings proved anticataract effect of *P. edulis* fruit extract in dose dependent manner. The toxic group showed disorientation of crystalline proteins with the reduction in total soluble protein (Figure 3). Previous studies confirmed that the lens soluble proteins play an important role in cataract studies. Hence, as reported by its total protein estimation, the fruit extract contributed to its effectiveness in cataract.

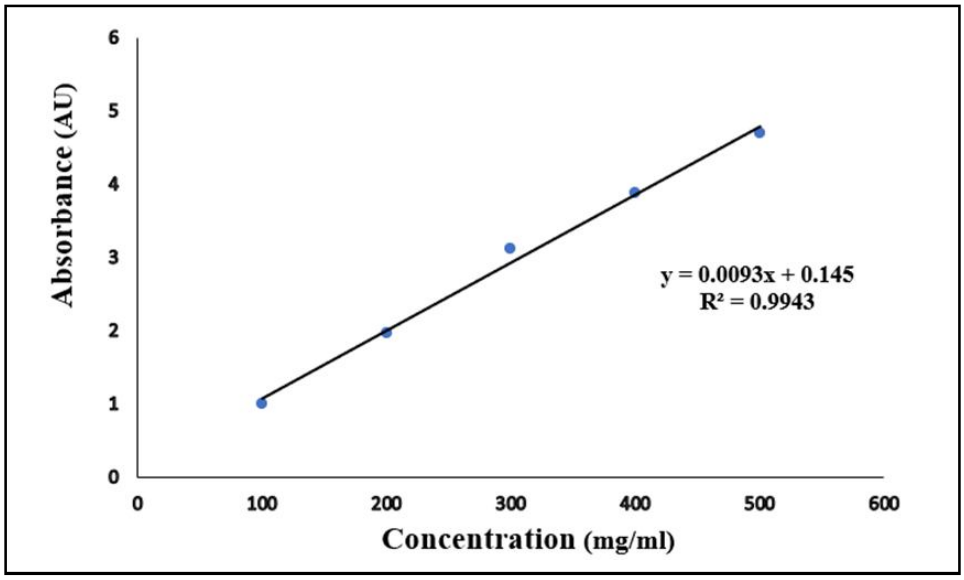
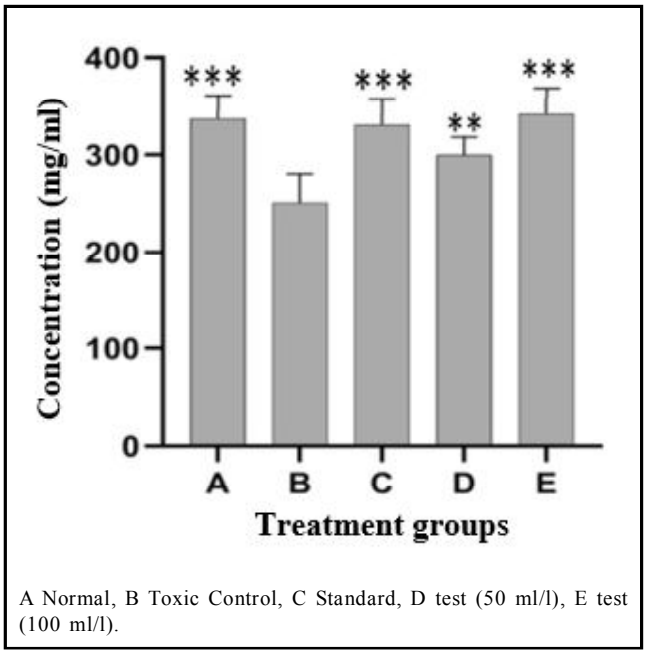


Figure 2: Standard curve of bovine serum albumin.



A Normal, B Toxic Control, C Standard, D test (50 ml/l), E test (100 ml/l).

Figure 3: Total soluble protein concentrations (Lowry's method).

Table 2: Total soluble protein concentrations

S. No.	Treatment groups	Concentration (mg/ml) (Mean ± SD)
1	Normal (A)	337.46 ± 22.89***
2	Toxic control (B)	250.57 ± 29.94
3	Standard (C)	331.33 ± 25.59***
4	Extract (I) (50 ml/l) (D)	299.85 ± 17.18**
5	Extract (II) (100 ml/l) (E)	342.07 ± 24.95***

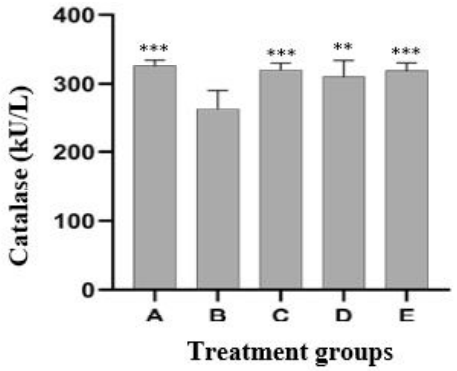
3.2.2 Catalase activity

Catalase plays a crucial role in the lens's intrinsic enzymatic defense mechanism, responsible for detoxifying H_2O_2. Present study revealed lower level of catalase in toxic control lenses compared to the normal group (Figure 4). However, lenses added with the fruit extract, exhibited a significant increase in enzyme levels, indicating the preservation of antioxidant enzyme integrity (Table 3).

3.2.3 Estimation of Na^+ and K^+ ions

During the estimation of Na^+ and K^+ ions in homogenate solution with the help of flame photometry, higher amount of Na^+ and lower amount of K^+ ions were estimated in toxic control (Figures 5, 6)

which tends to form cataract in toxic control whereas, in fruit extract incubated goat lens showed lower amount of Na^+ ions and higher amount of K^+ ions (Table 4). Intracellular and extracellular lens water electrolyte balance is essential for lens membrane permeability. Membrane permeability directly relates the lens opacity. Generally, the dominant ion Na^+ is extracellular cation and K^+ is intracellular cation. In lens, the concentration of potassium should be high compared to sodium and vice versa in serum. This regulates the osmotic pressure of lenses through Na^+/K^+ ATPase pump. The elevation of sodium could be due to ageing, or protein denaturation. It may increases during diabetes also.

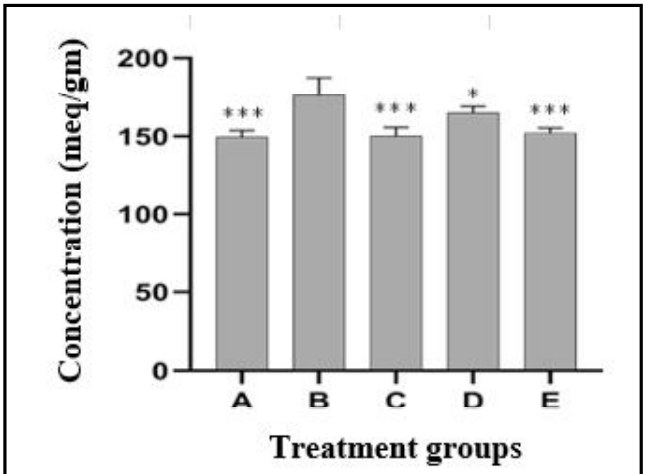


A Normal, B Toxic Control, C Standard, D test (50 ml/l), E test (100 ml/l).

Figure 4: Concentrations of catalase.

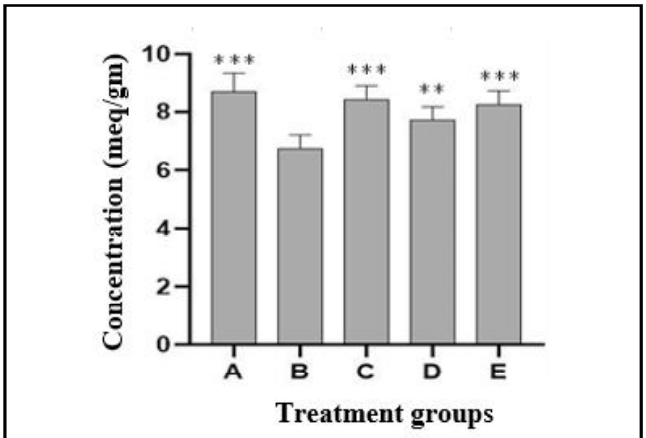
Table 3: Concentrations of catalase

S.No.	Treatment groups	Catalase activity (kU/l) (Mean ± SD)
1.	Normal (A)	326.05 ± 8.75***
2.	Toxic control (B)	263.68 ± 26.87
3.	Standard (C)	320.08 ± 10.42***
4.	Extract (I) (50 ml/l) (D)	310.52 ± 24.03**
5.	Extract (II) (100 ml/l) (E)	319.28 ± 11.56***



A Normal, B Toxic Control, C Standard, D test (50 ml/l), E test (100 ml/l).

Figure 5: Concentrations of Na^+ ions.



A Normal, B Toxic Control, C Standard, D test (50 ml/l), E test (100 ml/l).

Figure 6: Concentrations of K^+ ions.

Table 4: Concentrations of Na^+ and K^+ ions

S.No.	Treatment groups	Na^+ ions (meq/g) (Mean ± SD)	K^+ ions (meq/g) (Mean ± SD)
1.	Normal (A)	149.6 ± 4.18***	8.7 ± 0.62***
2.	Toxic control (B)	176.7 ± 11.19	6.7 ± 0.46
3.	Standard (C)	150.3 ± 5.48***	10.41 ± 0.53***
4.	Extract (I) (50 ml/l) (D)	165.1 ± 3.93**	7.9 ± 0.44**
5.	Extract (II) (100 ml/l) (E)	152.1 ± 3.27***	10.21 ± 0.50***

3.3 Antioxidant assay

3.3.1 Phosphomolybdenum assay

In this assay, the phosphate molybdenum (VI) is reduced to phosphate molybdenum (V) a green colored complex. It depends upon the electron hydrogen donating ability of antioxidant. In phosphomolybdenum assay, different concentrations of fruit extract were used and concentration dependent antioxidant activity was observed (Table 5). The phosphomolybdenum assay is valuable method for finding antioxidant activity, and present findings suggested good antioxidant scavenging activity.

Table 5: Per cent antioxidant activity of fruit extract using phosphomolybdenum assay

S. No.	Groups	Absorbance (AU) (Mean ± SD)	% AO activity
1.	Standard	0.9337 ± 0.036	4.28
2.	Fruit extract 0.2ml	0.9737 ± 0.014	11.87
3.	Fruit extract 0.4ml	0.8228 ± 0.021	52.16
4.	Fruit extract 0.8ml	0.1945 ± 0.021	79.16
5.	Fruit extract 1.0ml	0.1462 ± 0.008	84.16

3.3.2 H_2O_2 assay

Samples collected from the cataract individuals showed significant increase in hydrogen peroxide levels compared to normal lens. This could be due to the penetration of the lens fiber to affect oxidation in both membrane and cytoplasmic proteins. The levels of H_2O_2 destroyed the homeostasis of the lens membrane leading to lens opacity. Looking to dose dependent decreased H_2O_2 levels in present fruit extracts confirmed promising antioxidant scavenging activity of *P. edulis* (Table 6).

Table 6: Per cent antioxidant activity of fruit extract using H_2O_2 scavenging activity

S. No	Groups	Absorbance (AU) (Mean ± SD)	% AO activity
1	Standard	4.3879 ± 0.128	92
2	Fruit extract 0.2 ml	3.567 ± 0.104	18.56
3	Fruit extract 0.4 ml	3.025 ± 0.148	30.8
4	Fruit extract 0.8 ml	1.529 ± 0.146	65
5	Fruit extract 1.0 ml	0.9423 ± 0.031	78.52

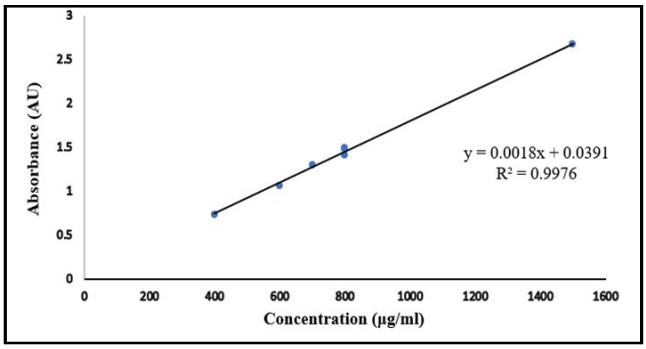


Figure 7: DPPH linear graph standard.

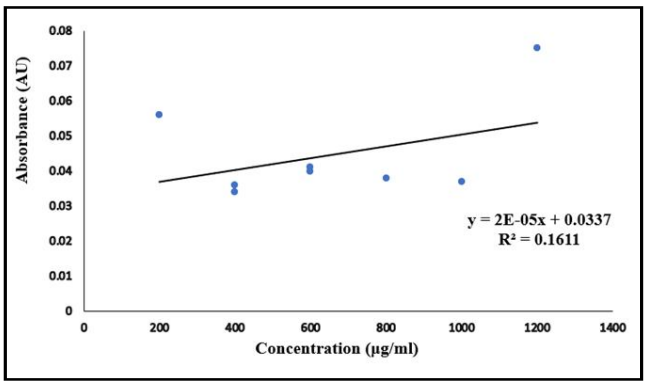


Figure 8: DPPH assay.

3.3.3 DPPH assay

The DPPH assay was used to measure the fruit extract's capacity to scavenge free radicals. The test has a rapid turnaround time and high sensitivity for determining the free radical scavenging capacity of plant extracts and compounds. One of the stable, dark violet-colored powders with a nitrogen core is DPPH. The color shifts from violet to yellow when reduced (Figures 7, 8). The degree of color change is determined by the antioxidant crude extract's or a pure compound's ability to scavenge electrons, which lowers the DPPH radical by donating hydrogen.

4. Discussion

The study delves into the potential anticataract activity of *P. edulis* extract, employing an *ex vivo* goat lens organ culture technique. The investigation primarily focuses on elucidating the morphological and biochemical impacts of the extract against glucose-induced snowflake cataract. The results contribute valuable insights into the anti-cataract properties of *P. edulis*, highlighting its prospective role as a therapeutic agent.

The morphological assessment unveils that goat lenses treated with passion fruit extract exhibit enhanced opacity compared to the toxic control group. The concentration-dependent reduction in lens opacity suggests a dose-response relationship, indicating that higher concentrations of passion fruit extract result in superior preservation of lens transparency (Table 1 and Figure 1). This observation aligns with prior research, emphasizing the significance of maintaining lens morphology to prevent cataract development (Caixinha *et al*., 2016).

The biochemical analysis encompasses total soluble protein estimation, catalase activity measurement, and the assessment of Na^+ and K^+ ions. The decline in total soluble protein in the toxic control group signifies the disorientation of crystalline proteins, a common feature in cataract development. Passion fruit extract, particularly at higher concentrations, demonstrates a protective effect by preventing protein disorientation (Table 2 and Figures 2, 3). This finding resonates with existing literature highlighting the pivotal role of lens proteins in cataractogenesis (Hashim and Zarina, 2012).

The reduction in catalase concentration in the toxic control group suggests compromised antioxidant defense mechanisms. Passion fruit extract, especially at higher concentrations, exhibits an enhancement in catalase activity, underscoring its role in preserving the lens's intrinsic enzymatic defense against oxidative stress (Table 3 and Figure 4). This observation aligns with the understanding that oxidative stress significantly contributes to cataract formation (Wishart *et al*., 2021).

The perturbation in Na+ and K+ ion balance in the toxic control group indicates an imbalance in lens membrane permeability, linked to cataract development. Passion fruit extract manifests a corrective effect, with lower Na+ ions and higher K+ ions, emphasizing its role in maintaining lens electrolyte balance (Table 4 and Figure 5, 6). This equilibrium regulates the osmotic pressure of lenses through the Na+/K+ ATPase pump, and the elevation of sodium could be attributed to ageing and protein denaturation (Liu *et al*., 2017).

The antioxidant assays, including phosphomolybdenum, H_2O_2 scavenging, and DPPH assays, offer insights into the extract's ability to counteract oxidative stress, a primary contributor to cataract formation. The concentration-dependent increase in antioxidant activity suggests the passion fruit extract's capacity to donate electrons and scavenge free radicals (Table 5). This aligns with the understanding that antioxidants play a crucial role in preventing oxidative damage associated with cataractogenesis (Batool *et al*., 2019). The significant reduction in hydrogen peroxide levels in passion fruit extract-treated groups indicates its potential in mitigating oxidative stress (Table 6). Elevated levels of H_2O_2 contribute to lens opacity, and the extract's ability to scavenge H_2O_2 underscores its antioxidative properties (Csepregi *et al*., 2016).

The DPPH assay confirms the extract's capability to scavenge free radicals, with the color change, indicating the reduction of DPPH radicals (Figure 8). This aligns with the broader understanding that free radical scavenging is crucial in preventing oxidative damage leading to cataract formation (Chang *et al*., 2001). Several studies have explored the potential anticataract effects of natural compounds and plant extracts. While direct comparisons with *P. edulis* in goat lens studies are limited, parallels can be drawn with similar research in other models. A study by Heruye *et al.* (2020) investigated the *ex vivo* anticataract effects of *Ginkgo biloba* extract in a rat lens model. Similar to our findings, *Ginkgo biloba* demonstrated concentration-dependent improvements in lens opacity and enhanced antioxidant enzyme activity. The study suggests that both *P. edulis* and *Ginkgo biloba* extracts may share common mechanisms in preserving lens transparency (Heruye *et al*., 2020). Suryanarayana *et al.* (2005) explored the effect of curcumin, a natural polyphenol, on cataract development in diabetic rats. The study reported increased total soluble protein levels and reduced oxidative stress markers, supporting the notion that natural compounds can mitigate cataractogenesis. The parallels with our study reinforce the potential of *P. edulis* as a natural anticataract agent (Suryanarayana *et al*., 2005). Investigations into quercetin, a flavonoid present in various fruits, have shown protective effects against cataract development. The study by Abdelkader *et al*. (2015) demonstrated the ability of quercetin to prevent lens opacity and enhance antioxidant defenses in an *in vitro* lens model. The shared outcomes suggest that *P. edulis*, rich in flavonoids, may exert similar protective effects on lens health (Abdelkader *et al*., 2015). Studies on the impact of vitamin C on lens health have demonstrated its role in preventing cataract development. The research by Lim *et al*. (2020) revealed that higher dietary intake of vitamin C is associated with a reduced risk of cataract formation. While *P. edulis* does not contain vitamin C in significant amounts, its overall antioxidant profile may contribute to lens protection, as observed in our study. Lutein and zeaxanthin, carotenoids found in various fruits and vegetables, have been extensively studied for their ocular benefits. The age-related eye disease study 2 (AREDS2) demonstrated that these carotenoids, along with other antioxidants, can slow the progression of age-related cataracts (Chew *et al*., 2014). The antioxidant-rich nature of *P. edulis* suggests potential similarities in lens protection. While these comparisons provide context for *P. edulis' s* potential as an anticataract agent, it is crucial to note the unique characteristics of each plant extract and the specific mechanisms they may engage in. Further research, especially clinical trials, is necessary to establish the efficacy and safety of *P. edulis* in human cataract prevention, drawing upon the insights gained from similar studies on other natural compounds.

5. Conclusion

This study provides the valuable investigation in portraying the potential effects of passion fruit extract from *P. edulis* as an effective anticataract agent. The demonstrated dose-dependent improvement in lens opacity, coupled with antioxidant properties, positions passion fruit as a promising candidate for further research and development in the field of cataract prevention and management. Comparative analyses with other studies indicated potential shared protective effects. The research not only contributes to our understanding of cataract biology, but also highlights the importance of exploring natural compounds for therapeutic purposes. As the global population ages and diabetes rates rise, the search for innovative and accessible solutions to age-related eye conditions becomes increasingly critical. Passion fruit extract opens new avenues for developing preventive and therapeutic strategies, offering hope for improved eye health in the future.

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Conflict of interest

The authors declare no conflicts of interest relevant to this article.

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