

Comparative Study of Antioxidant Properties and Total Phenolic Content of Selective Herbs

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Research Article

Keywords: Antioxidant activity, DPPH assay, FRAP assay, Total phenolic content, Tridax procumbens, Catharanthus roseus, Datura inoxa, Asian pigeonwings, Lantana camara, Medicinal plants

Posted Date: January 9th, 2026

DOI: <https://doi.org/10.21203/rs.3.rs-8335934/v1>

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Additional Declarations: No competing interests reported.

Abstract

This comparative study investigates the antioxidant properties and total phenolic content (TPC) of five medicinally important herbs: *Tridax procumbens*, *Catharanthus roseus*, *Datura innoxia*, Asian pigeonwings (*Clitoria ternatea*), and *Lantana camara*. These herbs are extensively utilized in traditional medicine systems across Asia for their diverse therapeutic applications and potential health benefits. The antioxidant capacity was comprehensively evaluated using multiple standardized assays, including DPPH (2,2-diphenyl-1-picrylhydrazyl) radical scavenging assay, FRAP (Ferric Reducing Antioxidant Power) assay, nitric oxide radical scavenging assay, and ferric thiocyanate (FTC) method. Total phenolic content was quantified using the Folin-Ciocalteu method, with results expressed as gallic acid equivalents (GAE).

Results revealed significant inter-species variations in both antioxidant activities and phenolic content. *Datura innoxia* demonstrated the highest total phenolic content (133.77 mg/mL) and exhibited superior antioxidant activity across multiple assays, including DPPH scavenging (86.54%), nitric oxide scavenging (98.93%), and FTC inhibition (95.20%). *Tridax procumbens* showed consistently high antioxidant potential with 84.05% DPPH scavenging activity, while *Catharanthus roseus*, Asian pigeonwings, and *Lantana camara* displayed moderate to good antioxidant capacities. A strong positive correlation was observed between total phenolic content and antioxidant capacity, confirming the pivotal role of phenolic compounds in the antioxidant mechanisms of these herbs. This study provides valuable insights into the comparative antioxidant potential of these medicinal plants, supporting their traditional uses and highlighting their promise as natural sources of antioxidants for pharmaceutical and nutraceutical applications. Further investigations into the specific bioactive compounds and their mechanisms of action are warranted to fully exploit their therapeutic potential.

Introduction

Free radicals and reactive oxygen species (ROS) are inevitable byproducts of normal cellular metabolism that play dual roles in biological systems. While these molecules serve essential functions in cell signaling and immune responses, their excessive accumulation leads to oxidative stress, a pathological condition implicated in the development of numerous chronic diseases including cancer, cardiovascular disorders, neurodegenerative diseases, diabetes, and premature aging. The human body naturally produces various reactive oxygen species such as superoxide anions ($O_2^{\bullet-}$), hydrogen peroxide (H_2O_2), and hydroxyl radicals ($OH^{\bullet}$) during routine metabolic processes. Although endogenous antioxidant defense mechanisms exist to neutralize these harmful species, they can become overwhelmed under conditions of increased oxidative burden.^{1,2}

Antioxidants represent a diverse group of compounds that protect cellular components from oxidative damage by neutralizing free radicals through various mechanisms, including electron donation, metal chelation, and enzymatic reduction. These protective molecules are classified into two main categories: endogenous antioxidants (such as glutathione, catalase, and superoxide dismutase) and exogenous

antioxidants obtained through diet and supplementation. The growing body of evidence supporting the inverse relationship between dietary antioxidant intake and disease incidence has intensified research interest in identifying potent natural antioxidant sources.³

Plant-derived antioxidants have emerged as particularly promising alternatives to synthetic compounds due to their safety profile, bioavailability, and multifaceted biological activities. Medicinal plants, which have been utilized in traditional healing systems for millennia, represent a vast reservoir of bioactive compounds with established therapeutic properties. The antioxidant capacity of plants is primarily attributed to their phenolic compounds, including flavonoids, phenolic acids, tannins, and other polyphenolic structures that possess the ability to scavenge free radicals and chelate metal ions.⁴

Among the numerous medicinal plants used in traditional Asian medicine, *Tridax procumbens*, *Catharanthus roseus*, *Datura innoxia*, Asian pigeonwings (*Clitoria ternatea*), and *Lantana camara* have gained considerable attention for their diverse pharmacological properties and widespread therapeutic applications. These plants have been traditionally employed to treat various ailments ranging from common infections to complex metabolic disorders, suggesting the presence of potent bioactive compounds with significant therapeutic potential.⁵

Tridax procumbens, commonly known as coat buttons or tridax daisy, is widely distributed across tropical and subtropical regions and has been traditionally used for wound healing, anti-inflammatory, and hepatoprotective purposes. *Catharanthus roseus* (Madagascar periwinkle) is renowned for its anticancer alkaloids and has been extensively studied for its antidiabetic and antioxidant properties. *Datura innoxia*, a member of the Solanaceae family, has been utilized in traditional medicine despite its toxic alkaloids, primarily for its analgesic and anti-inflammatory effects. Asian pigeonwings (*Clitoria ternatea*), known for its distinctive blue flowers, has been traditionally used as a brain tonic and for treating various inflammatory conditions. *Lantana camara*, despite being considered an invasive species in many regions, possesses significant medicinal properties and has been used for treating respiratory disorders, skin diseases, and as an antimicrobial agent.⁶

The quantitative assessment of antioxidant activity requires the employment of multiple complementary assays, as different methods measure distinct aspects of antioxidant mechanisms. The DPPH (2,2-diphenyl-1-picrylhydrazyl) radical scavenging assay is widely utilized due to its simplicity and reproducibility in measuring the ability of compounds to donate electrons or hydrogen atoms to neutralize free radicals. The FRAP (Ferric Reducing Antioxidant Power) assay evaluates the reducing capacity of antioxidants by measuring their ability to reduce ferric ions to ferrous ions. Additionally, the nitric oxide radical scavenging assay and ferric thiocyanate method provide complementary information about different antioxidant mechanisms.⁷

The determination of total phenolic content using the Folin-Ciocalteu method has become the standard approach for quantifying phenolic compounds in plant extracts, despite some limitations related to interference from non-phenolic reducing substances. This method provides valuable information about

the overall phenolic content, which often correlates strongly with antioxidant activity and serves as an important parameter for assessing the therapeutic potential of medicinal plants.⁸

Given the increasing demand for safe and effective natural antioxidants, there is a critical need for comprehensive comparative studies that evaluate the antioxidant potential of traditional medicinal plants using standardized methodologies. Such studies not only validate traditional uses but also provide scientific evidence for the development of novel therapeutic agents and functional foods. Furthermore, understanding the relationship between phenolic content and antioxidant activity can guide the selection and optimization of plant-based antioxidant sources for various applications.⁹

This study aims to conduct a comprehensive comparative evaluation of the antioxidant properties and total phenolic content of five selected medicinal herbs using multiple validated assays. The findings will contribute to the scientific understanding of these plants' therapeutic potential and support evidence-based utilization in modern healthcare systems. Additionally, network pharmacology approaches will be employed to elucidate the molecular mechanisms underlying the observed antioxidant activities, focusing on the compound rutin as a representative antioxidant molecule and its potential therapeutic targets in neurodegenerative diseases such as Huntington's disease.¹⁰

Material and Methods

Drug Procurement

The plant materials of *T. procumbens*, *Cantharantus rosea*, *Datura innoxia*, Asian pigeonwings, and *Lantana camara* plants were purchased from the local market of the Pune. Parts of plants were then washed with water and shade-dried until dry, ground into a fine powder, and further used.

Extraction method

5 g of the dried, powdered crude drug was weighed accurately and dissolved in 30 mL of a selected solvent. The extraction was carried out for 30 hours at 40°C at 150 rpm. The extract was then filtered using Whatman filter paper, dried in an air oven.¹¹

Phytochemical screening

Litmus test

Phenol changes blue litmus paper to red, confirming its acidic character. However, this acidity is much weaker than that of carboxylic acids. Unlike carboxylic acids, phenol does not react with aqueous sodium carbonate and therefore does not produce effervescence.¹²

Shinoda test

The extract solutions were prepared using 95% ethanol as the solvent. A small strip of magnesium metal was then introduced, followed by the careful addition of 3–5 drops of concentrated hydrochloric acid. The development of a deep cherry-red coloration confirmed the presence of flavonoid compounds.¹³

Lead acetate test

About 10 mg of the plant extract was treated with 0.5 mL of a 1% lead acetate solution. The appearance of a precipitate served as evidence for the presence of tannins and other phenolic constituents.¹⁴

Iodine test

To 5 mL of the plant extract placed in a test tube, a drop of sodium carbonate solution was added. The mixture was shaken thoroughly and allowed to stand for five minutes. The persistence of froth confirmed the presence of saponin compounds.¹⁵

Dragendorff's test

When 1 mL of Dragendorff's reagent was added to 2 mL of the plant extract, the formation of an orange-red precipitate was observed, confirming the presence of alkaloidal constituents.¹⁶

Estimation of total phenolic contents by Folin-Ciocalteu method

A standard calibration curve was constructed using gallic acid solutions in the concentration range of 10–100 µg/mL prepared in water. The extract solutions were prepared at a concentration of 1 mg/mL. For the assay, 1 mL of each extract was mixed with 0.25 mL of Folin–Ciocalteu reagent followed by the addition of 1.25 mL of 20% sodium carbonate solution. The reaction mixture was incubated at room temperature for 40 minutes to allow color development. After incubation, the intensity of the resulting blue color was measured at 725 nm against the gallic acid standards. The total phenolic content was calculated from the calibration curve and expressed as gallic acid equivalents (GAE) using the formula:

$$T = (C \times V) / M,$$

where T represents the total phenolic content (mg GAE/g of plant extract), C is the concentration obtained from the calibration curve, V is the volume of the extract used, and M is the weight of the plant extract in grams.¹⁷

DPPH radical scavenging assay method

Standard antioxidant solutions, such as ascorbic acid and BHA, were prepared at different concentrations. The plant extracts were dissolved in ethanol. A 0.3 mM DPPH solution was freshly prepared using absolute ethanol. For the assay, 1 mL of the DPPH solution was mixed with 3 mL of the extract solution. A control was prepared in the same manner, replacing the extract with an equal volume of standard phosphate buffer. The reaction mixtures were shaken thoroughly and incubated at room temperature for 30 minutes in the dark. After incubation, the absorbance was recorded at 517 nm.¹⁸ The free radical scavenging activity at various concentrations was calculated using the formula:

$$\% \text{ Scavenging activity} = [(\text{Absorbance of control} - \text{Absorbance of test}) / \text{Absorbance of control}] \times 100$$

Nitric oxide (NO) radical scavenging activity method

Different concentrations of the plant extract were prepared using standard phosphate buffer. For the assay, 1 mL of 10 mM sodium nitroprusside prepared in phosphate-buffered saline was mixed with 1 mL of each extract solution, while BHA was used as the reference standard. The mixtures were incubated at room temperature for 150 minutes. A control was maintained under identical conditions by replacing the extract with an equal volume of phosphate buffer. After incubation, 0.5 mL of Griess reagent was added to each reaction mixture, and the absorbance of the resulting chromophore was measured immediately at 546 nm.¹⁹ The nitric oxide scavenging activity at various concentrations was calculated using the formula:

$$\% \text{ Scavenging activity} = [(\text{Absorbance of control} - \text{Absorbance of test}) / \text{Absorbance of control}] \times 100$$

Reducing power ability method

The samples were prepared at varying concentrations for the reducing power assay. This method is based on the principle that a rise in absorbance with increasing concentration reflects greater reducing capability. For the reaction, 1.0 mL of the sample was combined with 2.5 mL of phosphate buffer (50 mM, pH 7.0) and 2.5 mL of 1% potassium ferricyanide solution. The mixture was incubated at 50°C for 20 minutes. After incubation, 2.5 mL of 10% trichloroacetic acid was added, followed by centrifugation at 3000 rpm for 10 minutes. Subsequently, 1.25 mL of the clear supernatant was mixed with 1.25 mL of distilled water and 0.25 mL of 0.1% ferric chloride solution. The absorbance was recorded at 700 nm. All experiments were performed in triplicate, and higher absorbance values were interpreted as greater reducing power.²⁰

Ferric Thiocyanate method (FTC assay)

Dissolve the 4 mg extract in 4 mL ethanol. Take this 4 mL extract sample. Add 4.1 mL of 2.51% linoleic acid in 99.5% ethanol, 8.0 mL of 0.02 M phosphate buffer (pH 7.0), and 3.9 mL of distilled water. Incubate this mixture in darkness at 37°C for 5 days. Take aliquots of 0.1 mL of the above reaction mixture every day. Add 9.7 mL of 75% (v/v) aqueous ethanol, 0.1 mL of 30% ammonium thiocyanate solution, and 0.1 mL of 20 mM ferrous chloride in 3.5% hydrochloric acid. After three minutes, measure

the absorbance at 500 nm. This measurement should be taken every 24 hours until the absorbance of the control reaches its maximum value. Vitamin E can be used as a positive control.²¹

The formula for % inhibition is:

Absorbance of control - Absorbance of sample/Absorbance of control×100.

Compound Target Network

Rutin is a prominent compound present in drugs that show strong antioxidant activity; thus, a network was constructed using rutin to investigate its potential against Huntington's Disease. The possible targets of the rutin drug were retrieved from the Swiss target database, and the targets involved in Huntington's disease were retrieved from the GeneCards database. Thus, after that, the common target was estimated by using the Venny database. Then, the network was constructed using the Cytoscape 3.10.4 software.²²

Protein-Protein Interaction

The estimated common target, which was received by the Venny database, was then selected and fed into a string database across multiple protein sections to obtain the protein-protein interactions of the given common targets.²³

Estimation of Hub Genes

The Cytohubba plug-in was used for the estimation of hub genes. The network formed in Cytoscape 3.10.4 software was subjected to the estimation of hub genes. Select the merged network and then activate the Cytohubba plug-in. Press the 'Analyse' option, which displays the hub genes in the given merged network.²⁴

Gene Ontology

The common targets obtained from the Venny database were subjected to the STRING database to form the PPI, followed by gene ontology analysis in the analysis section of the STRING database. Then, the Graphical representation of the biological process, Molecular function, Cellular component, and KEGG pathway analysis was downloaded, followed by an analysis of the data.²⁵

Result

Phytochemical Screening of all plants

Table No. 1 Phytochemical Screening

Plant Name	Phenol	Flavonoid	Tannin	Saponins	Alkaloids
Tridax procumbens	+ + +	+ + +	+ + +	- - -	+ + +
Catharanthus roseus	+ + +	+ + +	- - -	+ + +	- - -
Datura inoxia	+ + +	+ + +	+ + +	- - -	+ + +
Asian pigeonwing	+ + +	+ + +	+ + +	+ + +	+ + +
Lantana camara	+ + +	+ + +	- - -	- - -	- - -

Total Phenolic content by Folin-Ciocalteu method

The total phenolic content of the selected plant extracts was determined using the Folin–Ciocalteu method, and the results were expressed in mg/mL based on the average of aqueous, alcoholic, and mixed extracts. Among the tested samples, Datura inoxia exhibited the highest phenolic content, with an average of 133.77 mg/ml, indicating a strong presence of phenolic compounds. This was followed by Tridax procumbens at 86.10 mg/ml, Lantana camara at 98.01 mg/ml, Asian pigeonwings at 97.33 mg/ml, and Catharanthus roseus with an average phenolic content of 97.02 mg/ml. These results highlight the varying phenolic concentrations across species, with Datura Inoxia showing the greatest potential for antioxidant or therapeutic applications associated with phenolic compounds.

Phenolic content is determined by the formula $T = C.V/M$, where T is total phenol content of phenolic compound (milligram per gram of plant extract), C is the concentration of established from the calibration, V is the volume of extract (milligram) and M is the gram weight of plant extract.

Table No.2 Determination of Total Phenolic Content (absorbance taken at 725nm)

Sample	Total phenolic content (mg/ml)			
	Aqueous	Alcoholic	Mixture	Average
Tridax procumbence	80.1	88.69	89.53	86.10
Datura inoxa	149.2	149.26	102.66	133.77
Lantana camara	97.33	93.22	103.48	98.01
Asian pigeonwings	95	95.22	101.75	97.33
Cantharantus rosea	94.50	96.50	100.07	97.02333333

DPPH radical scavenging assay method

The antioxidant potential of the plant extracts was evaluated based on their ability to scavenge free radicals. Among the five selected medicinal plants, *Datura innoxia* demonstrated the highest percentage of scavenging activity at 86.54%, indicating strong antioxidant potential. *Tridax procumbens* closely followed this with 84.05%, while *Catharanthus roseus* and *Asian pigeonwings* exhibited moderate activities at 76.19% and 75.46%, respectively. *Lantana camara* showed the lowest scavenging activity at 71.81%. These findings suggest that *Datura innoxia* and *Tridax procumbens* possess significant antioxidant properties, which could contribute to their therapeutic efficacy.

Formula to calculate radical scavenging assay is % scavenging activity = $1 - \frac{\text{absorbance of test X}}{100/\text{absorbance of control}}$

Table No.3 DPPH Radical Scavenging Assay (Absorbance taken at 517nm)

Sample	%Scavenging Activity
Tridax procumbence	84.05
Cantharantus rosea	76.19
Datura inoxa	86.54
Asian pigeonwings	75.46
Lantana camara	71.81

Nitric oxide (NO) radical scavenging activity method

The antioxidant activity of the plant extracts was assessed through their free radical scavenging capacity. Among all the tested samples, *Datura innoxia* exhibited the highest scavenging activity at 98.93%, indicating exceptionally strong antioxidant potential. This was followed by *Tridax procumbens* at 84.29%, *Asian pigeonwings* at 82.08%, and *Lantana camara* at 78.90%, reflecting substantial antioxidant capabilities. In contrast, *Catharanthus roseus* showed the lowest activity at 66.10%, suggesting comparatively lower radical neutralization ability. These results underscore the significant antioxidant potential of *Datura innoxia*, making it a promising candidate for further pharmacological investigation.

Table No. 4NORadical Scavenging Activity (Absorbance taken at 546nm)

Sample	%Scavenging Activity
Tridax procumbence	84.29
Cantharantus rosea	66.10
Datura inoxa	98.93
Asian pigeonwings	82.08
Lantana camara	78.90

Reducing power ability method

The average absorbance of the selected plant extracts was measured to estimate their relative antioxidant or phenolic activity. Among the five samples, *Datura inoxa* recorded the highest absorbance value of 1.363, suggesting a greater concentration of active phytochemicals. This was followed by *Tridax procumbens* (1.012) and *Catharanthus roseus* (0.953), both demonstrating notable absorbance levels. *Lantana camara* showed a moderate absorbance of 0.763, while *Asian pigeonwings* exhibited the lowest value at 0.553. These findings align with previous assays, indicating that *Datura inoxa* possesses a comparatively rich phytochemical profile.

Table No. 5 Reducing power ability method (Absorbance taken at 700nm)

Sample	Average (absorbance)
Tridax procumbence	1.012
Cantharantus rosea	0.953
Datura inoxa	1.363
Asian pigeonwings	0.553
Lantana camara	0.763

Ferric Thiocyanate method (FTC assay)

The antioxidant activity of various plant extracts was further evaluated using the Ferric Thiocyanate (FTC) method. Among the tested species, *Datura Inoxia* exhibited the highest antioxidant activity, with an average inhibition of 95.20%, indicating strong lipid peroxidation-inhibitory properties. *Catharanthus roseus* and *Asian pigeonwings* followed with average values of 61.31% and 60.74%, respectively, demonstrating moderate antioxidant activity. *Lantana camara* showed an average antioxidant value of 63.77%, while *Tridax procumbens* presented the lowest activity at 50.74%. These findings reinforce the

significant antioxidant potential of *Datura inoxa*, aligning with its performance in other assays and highlighting its value in natural antioxidant research.

Formula for % inhibition is

$$\% \text{ inhibition} = \frac{\text{Absorbance of control} - \text{Absorbance of sample} \times 100}{\text{Absorbance of control}}$$

Table No. 6 FTC Assay (Absorbance taken at 500nm)

Sample	Antioxidant%			
	Aqueous	Alcoholic	Mixture	Average
Tridax procumbence	48.69	56.34	47.19	50.74
Cantharantus rosea	60.40	59.45	64.09	61.31
Datura inoxa	91.52	96.93	97.15	95.2
Asian pigeonwings	61.04	65.38	55.80	60.74
Lantana camara	48.29	48.88	58.14	63.77

Compound Target Network

We constructed an interaction network using Cytoscape 3.10.4 software linking key proteins, genes, and pathways associated with Huntington’s disease and the antioxidant Rutin. The network shows connections between disease-related proteins (red), gene nodes (yellow), and pathways (green), highlighting the complex interactions involved presented in figure no. 1. Several proteins, such as P15081 and P06868, appear central as they interact with multiple pathways, suggesting their potential as therapeutic targets. Rutin influences a wide range of genes and pathways, supporting its role in mitigating oxidative stress associated with neurodegeneration. The shared pathways between Huntington’s disease and Rutin highlight possible mechanisms through which natural antioxidants may slow disease progression. This network provides a useful base for future research and drug development.

Figure No. 1 Compound Target Network

Protein-Protein Interaction

We constructed a protein-protein interaction (PPI) network using STRING database, revealing a densely connected cluster of proteins that reflects strong cooperation in biological processes. While most proteins form complex groups, a few, such as KCNK5 and KCNH2, exhibit limited connections, suggesting specialized roles. Key hub proteins, such as PRKCA, MAPK1, EGFR, and PIK3CA, exhibit

numerous interactions, underscoring their regulatory importance and potential as therapeutic targets. The variety of coloured edges represents different interaction types, including known, predicted, and co-expressed links. This network provides valuable insight into protein cooperation and identifies key candidates for future functional studies.

Figure No. 2 Protein-protein interaction

Estimation of Hub gene

We constructed a gene hub network using CytoHubba plug in to identify key genes associated with Rutin's protective effects. Rutin sits at the center, connecting with major genes such as *hsa:7124*, *hsa:3558*, and *hsa:4318* (in red and orange), indicating their potential importance. Nodes such as *hsa:01100* and *hsa:5315* represent shared pathways. The network highlights how Rutin may act through these key genes to combat oxidative stress.

Figure No. 3 Gene Hub Network

Gene Ontology

Biological Process

The Gene Ontology (GO) analysis from STRING database of our dataset revealed that the key genes associated with rutin's action are involved in several important biological processes. These include regulation of apoptosis, cellular response to oxidative stress, and signal transduction, indicating their potential roles in cell survival and stress adaptation.

Figure No.4 Biological process enrichment

Molecular Function

In terms of molecular function, the genes were enriched in activities such as protein kinase binding, enzyme regulator activity, and antioxidant activity, suggesting their involvement in critical regulatory mechanisms at the molecular level.

Figure No.5 Molecular function enrichment

For cellular component analysis, most genes were associated with membrane-bound organelles, cytoplasm, and protein complexes, indicating their involvement in intracellular signaling and maintaining structural integrity.

Kegg Pathway analysis

The KEGG pathway analysis identified that these genes are significantly involved in pathways related to neurodegenerative diseases, including Huntington's disease, as well as oxidative stress-related signaling pathways. Importantly, pathways such as PI3K-Akt, MAPK signaling, and apoptosis were enriched, supporting the idea that Rutin may exert its protective effects by modulating these critical molecular pathways.

Figure No.6 KEGG pathway

Conclusion

This study systematically compared the antioxidant profiles and total phenolic content of five medicinally relevant herbs using standardized in-vitro assays. Significant interspecific variations were observed, with *Datura innoxia* demonstrating the highest antioxidant efficacy. It exhibited the greatest phenolic content (133.77 mg/mL), strongest DPPH radical scavenging activity (86.54%), maximal nitric oxide scavenging ability (98.93%), and highest lipid peroxidation inhibition (95.20% in the FTC assay). *Tridax procumbens* also displayed strong antioxidant potential, particularly in DPPH (84.05%) and nitric oxide scavenging (84.29%) assays. *Catharanthus roseus*, *Clitoria ternatea*, and *Lantana camara* showed moderate but relevant antioxidant activities, aligning with their traditional medicinal applications.

A strong positive correlation between phenolic content and antioxidant capacity highlights the pivotal role of phenolic constituents in oxidative stress mitigation. Network pharmacology analysis further identified rutin as a key bioactive compound with predicted neuroprotective activity in Huntington's disease, mediated through PI3K–Akt, MAPK, and apoptosis-related signaling pathways.

Overall, the findings substantiate the ethnopharmacological significance of these herbs and underscore their potential as natural antioxidant sources for pharmaceutical and nutraceutical development. Further targeted studies on compound isolation and mechanistic validation are warranted to fully explore their therapeutic relevance in oxidative stress–associated disorders.

Abbreviations

DPPH – 2,2-diphenyl-1-picrylhydrazyl

FTC – Ferric thiocyanate

TPC – Total phenolic content

PPI – Protein–protein interaction

KEGG – Kyoto Encyclopedia of Genes and Genomes

UV-Vis – Ultraviolet–visible

CSV – Comma-separated values

Declarations

Acknowledgement:

The authors thank to Management and Principal of AESCOP, Pune for providing facilities for sample preparation, extraction, and spectroscopic measurements. The authors also acknowledge the use of publicly accessible bioinformatics platforms for the computational components of this dataset.

Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

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Competing Interests

The authors declare that they have no competing interests.

Ethics Approval

Not applicable. No human or animal subjects were involved in the generation of this dataset.

Data Availability

The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

Consent to Participate

Not applicable.

Consent to Publish

Not applicable.

Clinical trial number

Not Applicable.

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Figures

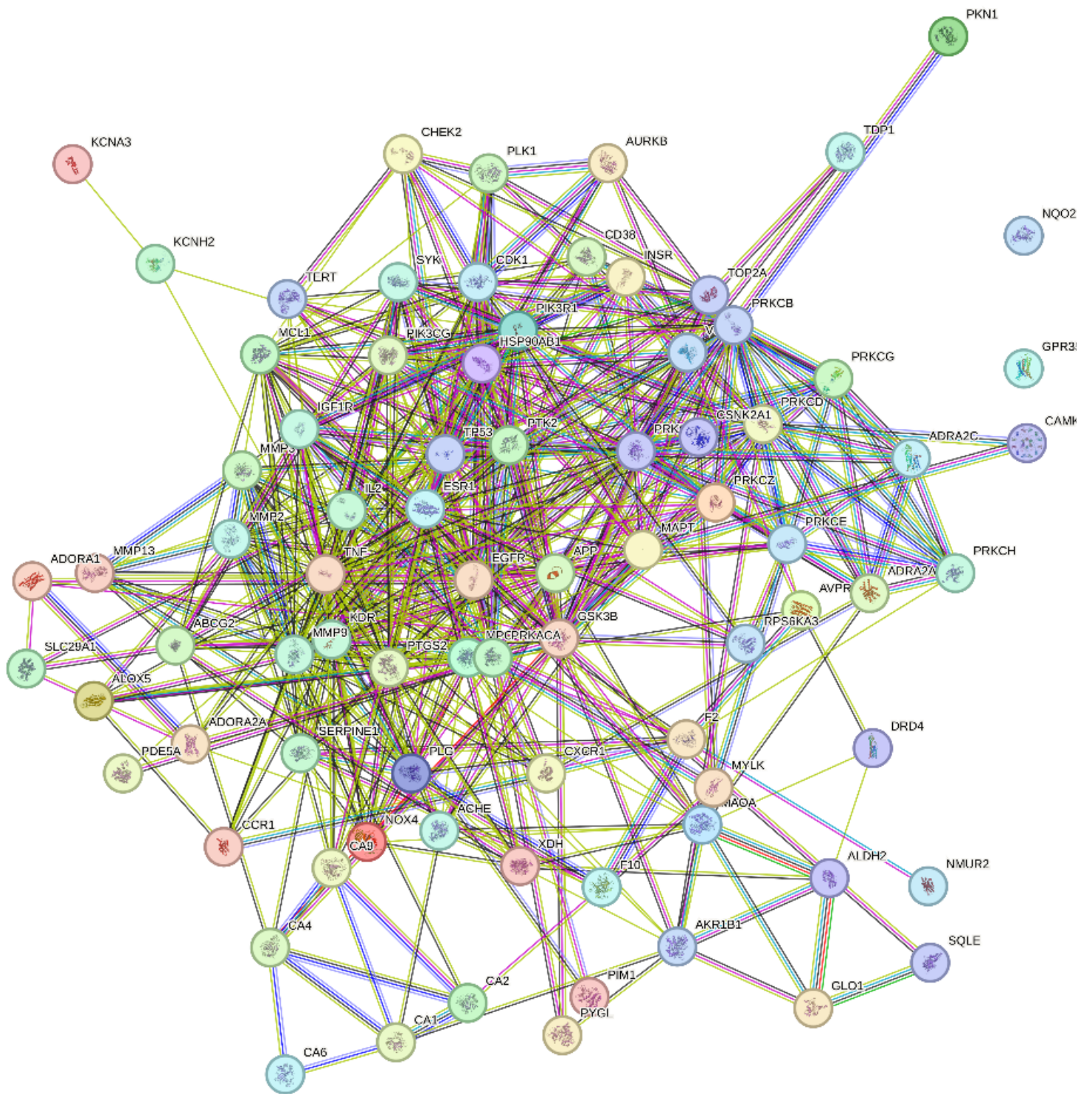


Figure 2

Protein-protein interaction

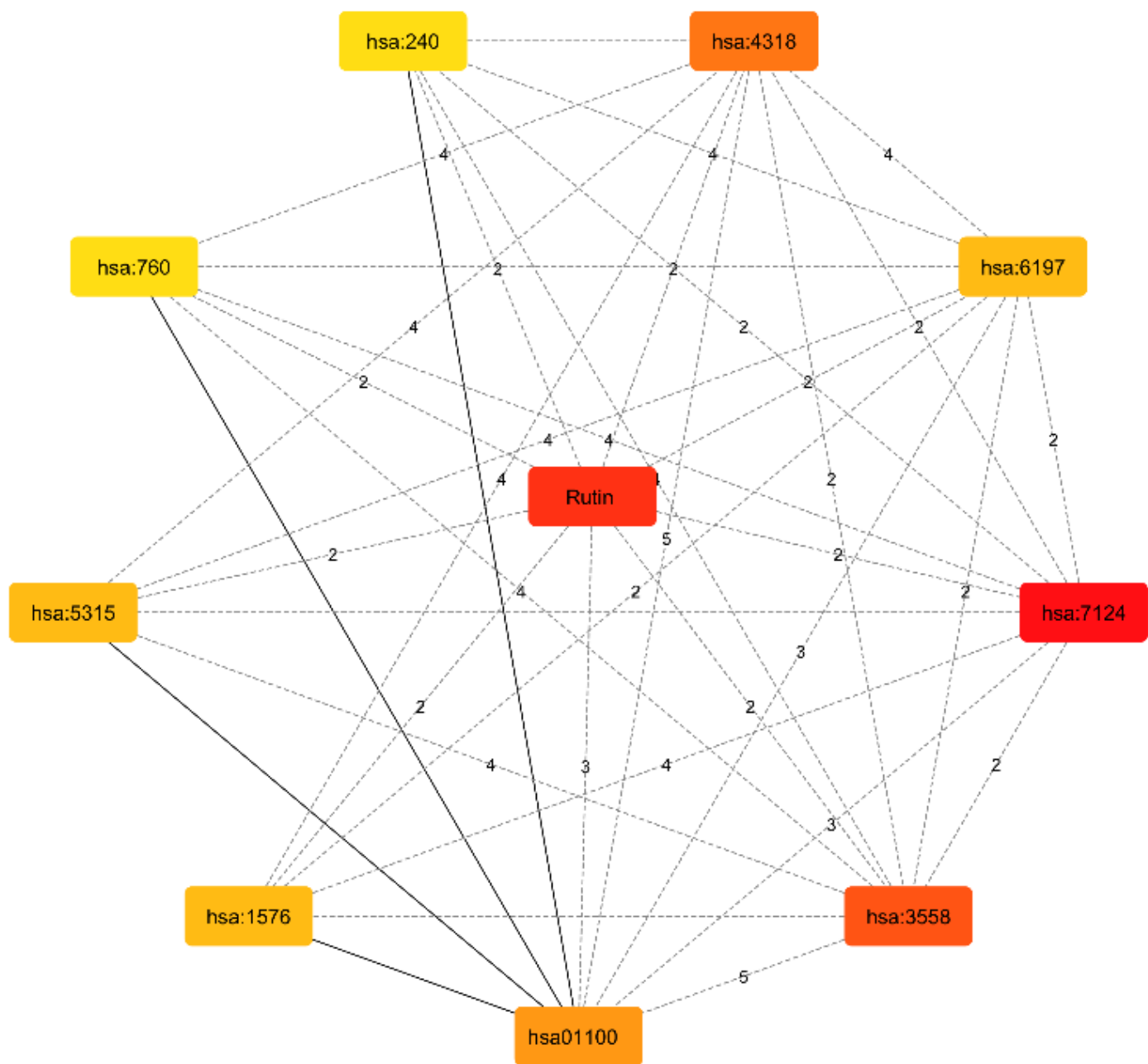


Figure 3

Gene Hub Network

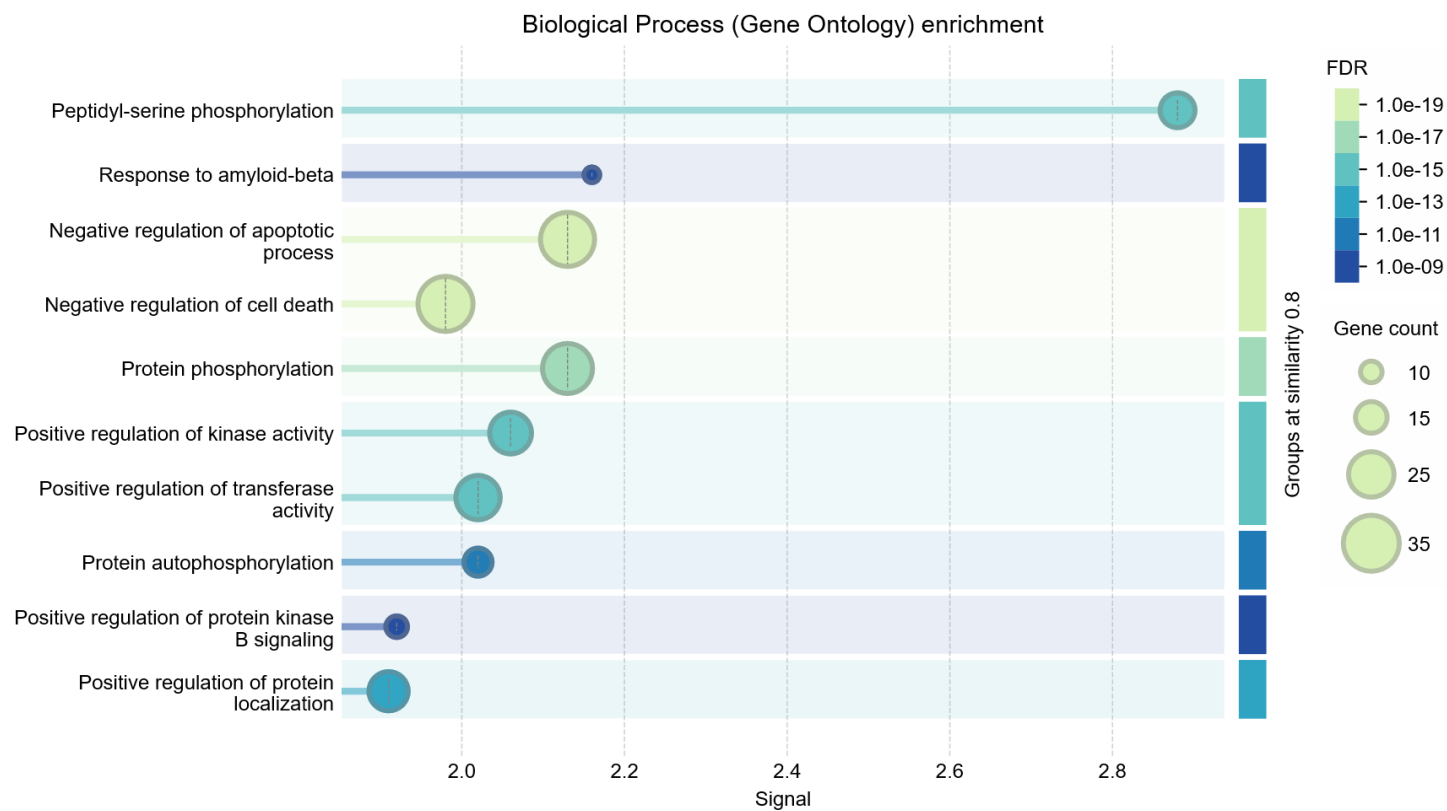


Figure 4

Biological process enrichment

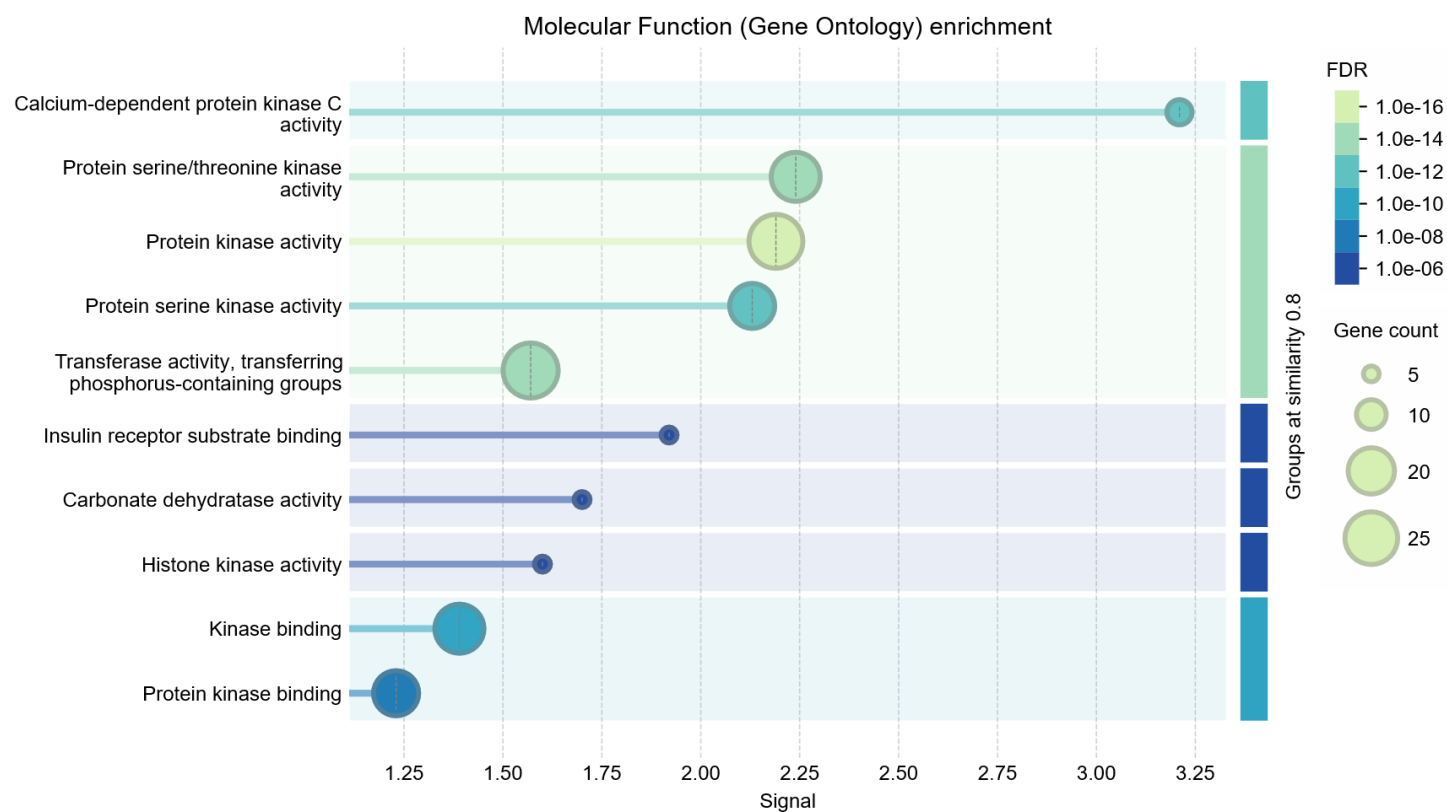


Figure 5

Molecular function enrichment

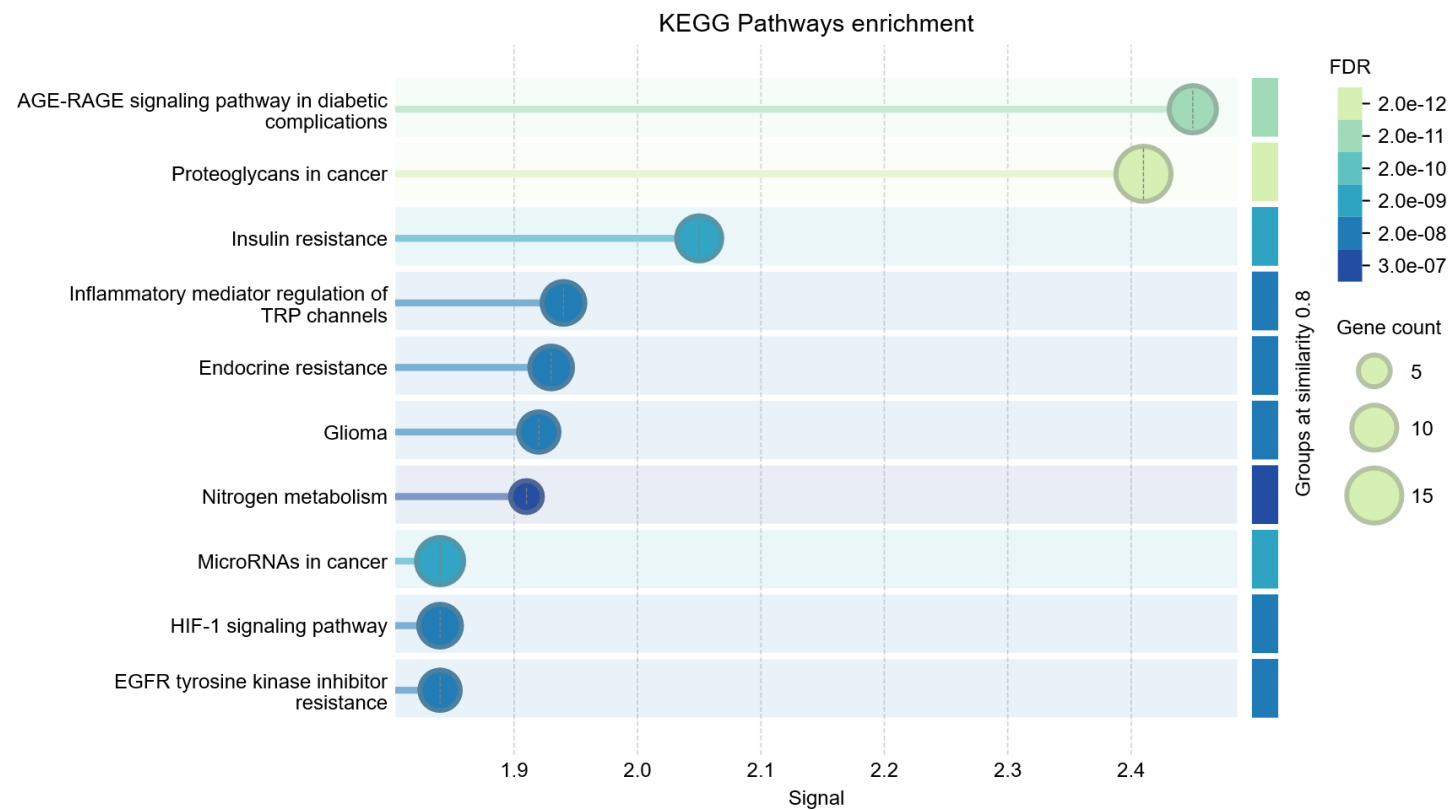


Figure 6

KEGG pathway