International Research Journal of Biological Sciences ISSN 2278-3202
Vol. **15(4),** 8-18, November **(2026)** *Int. Res. J. Biological Sci.*

Natural Inhibitors of Tyrosinase and ACE enzyme, probable drug candidates

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Available online at: www.isca.in, www.isca.me
Received 28th August 2026, revised 7th September 2026, accepted 5th October 2026

Abstract

The increasing demand for natural products derived from plants has made the search for alternative medicines other than chemical drugs for various diseases an urgent need. In this regard, this research sought to establish the enzyme inhibition properties of three plant species, namely; banana peel (Musa spp.), curry leaves (Murrayakoenigii), and finger millet bran (Eleusinecoracana) and their phytochemical content. The plant samples were first washed; shade dried, milled into powder, and then extracted using a 70% hydro-alcoholic solvent. The phytochemical screening test was conducted to identify the presence of significant secondary metabolites such as phenolic compounds, flavonoids, and alkaloids in the samples using both qualitative and quantitative analysis techniques. The phenolic content of the samples was analysed using the Folin-Ciocalteu method while the flavonoids and alkaloids were tested using alkaloid reagents and Dragendorff's methods, respectively. Further investigation on the biological activities of the plant samples was done through the tyrosinase and angiotensin-converting enzyme (ACE) inhibition assays, known for their anti-melanogenic and antihypertensive properties. The tyrosinase assay was conducted using L-DOPA as the substrate with kojic acid as the reference standard while the ACE inhibitory assay was done using HHL substrate with captopril as the positive control.

Keywords: Natural plant extracts, hydro-alcoholic extracts, phytochemical screening, phenolic compounds, enzyme inhibition, Tyrosinase inhibition, Angiotensin-converting enzyme (ACE) inhibition.

Introduction

Natural products have been widely served as therapeutic agents for a long time and continue to be highly important in modern drug discovery. Currently, growing attention is given to components obtained from plants due to the high structural diversity of bioactive substances, their wide biological activities, and sustainability compared to synthetic substances. Materials such as agricultural wastes and medicinal plants which were once regarded as not useful have now became valuable sources of various phytochemicals like phenolics, flavonoids, alkaloids, and tannins that have antioxidant, anti-inflammatory, antimicrobial, antihypertensive, and enzyme inhibition properties that make them good prospects for developing new drugs[1].

Enzyme inhibition has become one of the main strategies of drug discovery since many diseases are connected with the abnormal activity of enzymes. Discovery of natural compounds capable of inhibiting disease-related enzymes allows to create safer and cheaper therapeutic agents. This research is concentrated on enzyme inhibition to develop new drugs for treating diseases related to two enzymes, namely tyrosinase, which plays an important role in the process of melanin formation and skin pigmentation, and angiotensin-converting enzyme (ACE). Tyrosinase inhibition has a number of possible applications such as hyper pigmentation management and prevention of enzymatic browning of foods while ACE inhibition is used as a strategy of managing hypertension and cardiovascular diseases[2].

The current research determines the enzyme inhibition potential of hydro alcoholic extracts produced from the peels of banana (*Musa spp.*), curry leaves (*Murrayakoenigii*) and bran of finger millet (*Eleusinecoracana*). These plants were chosen due to their high phytochemical content, accessibility, and sustainability. Banana peel and finger millet bran represent the agro-wastes that contain high amounts of phenols, flavonoids, and fiber, while curry leaves are characterized by a rich content of carbazole alkaloids and antioxidants. The variety of phytochemical composition gives the application of these plants as enzyme inhibitors[3].

For obtaining the wide spectrum of polar and moderately polar compounds, hydro alcoholic extraction with 70% ethanol was performed. Further, the obtained extracts underwent preliminary phytochemical evaluation, which included assessment of the total phenol content, flavonoids, and alkaloids, with subsequent in vitro assay of tyrosinase and ACE inhibitor activities. Overall, this study highlights the importance of utilizing inexpensive and underexplored plant resources for drug discovery. The findings may contribute to the development of natural enzyme inhibitors for applications in pharmaceutical, nutraceutical, and cosmetic industries while also promoting the value-added utilization of agricultural by-products through sustainable research approaches[4].

Materials and Methods

Sample Collection and Preparation: In this study, three plant materials were selected, which include banana peel (*Musa spp.*), curry leaves (*Murraya koenigii*), and finger millet bran (*Eleusine coracana*). The above materials were selected since they contain high amounts of bioactive components, such as phenolics, flavonoids, alkaloids, and many others, which are related with antioxidant activities and acts as inhibitors of enzymes related to many diseases. The collected samples were washed with distilled water to remove dust particles and they were then dried under shade at around 35°C for 2-4 days to avoid the degradation of heat-sensitive compounds. The dried samples were crushed and powdered individually using a clean mortar and pestle and stored in Falcon tubes at 4°C for further extraction[5].

Extraction of Bioactive Compounds: Hydro alcoholic extraction was conducted in 70% ethanol, it is a well-known efficient solvent for the extraction of both polar and moderately polar phytochemicals. In brief, 5g of each powdered sample was dissolved in 50mL of 70% ethanol (70% ethanol is prepared by adding 105mL of 95% ethanol and 45mL of distilled water). The solutions were poured into Falcon tubes and allowed to incubate on an orbital shaker for 24-48 hours at room temperature. Filtration was performed using Whatman No. 1 filter paper; after filtration, the solutions were dried in a water bath at 63°C for 30 minutes to obtain crude extracts. The prepared extracts were further used for phytochemical screening and inhibition studies[6].

Preliminary Phytochemical Screening: Qualitative and quantitative analysis was performed to detect the presence of secondary metabolites that play a role in enzyme inhibition activity. The analysis included total phenolic content using the Folin-Ciocalteu assay, qualitative flavonoids using the alkaline reagent test, and detection of alkaloids using Dragendorff's test. The tests give preliminary data of phytochemical profile of the prepared extracts and correlation of the presence of the biologically active substances in extracts with biological activity[7].

Total Phenolic Content: The total phenolic content of the plant extracts was measured by means of the FC method. This analytical procedure is based on the reduction of the phosphomolybdic-phosphotungstic acid complex in the Folin–Ciocalteu reagent by the phenolic compounds in an alkaline medium. As a result of such reactions, blue-coloured complexes are formed and quantitatively determined spectro-photometrically at a wavelength of 765nm. The assay was performed with the diluted FC reagent (1:10), 7.5% sodium carbonate solution, standards of Gallic acid (20–100µg/mL), and hydro alcoholic extracts of plants. The procedure includes mixing 0.5mL of diluted plant extracts and standard with 2.5mL of diluted FC reagent and incubating the reaction mixture for 5mins.

The absorbance was measured at 765nm by UV-Visible spectrophotometer, and the phenolic contents of the extracts were estimated from the Gallic acid standard calibration curve and expressed as mg of GAE/g of dry extract[8,9].

Flavonoid Test: Qualitative determination of flavonoids was performed by the alkaline reagent test. About 1 ml of the extract was mixed with 2-3 drops of 10% sodium hydroxide solution. The production of yellow colour confirmed the possibility of the presence of flavonoids. Addition of 2-3 drops of dilute HCl to this yellow-coloured solution made the yellow colour disappear, which confirmed the presence of flavonoids. The results were determined as positive or negative depending upon the change in colour[10].

Alkaloid Test: Dragendorff's test detects the presence of alkaloids in the samples. About 1ml of the extracts was acidified with 2-3 drops of dilute hydrochloric acid, followed by the addition of 2-3 drops of Dragendorff's reagent. Formation of orange to reddish-brown precipitates confirmed the presence of alkaloids due to the formation of an insoluble complex of alkaloids with potassium bismuth iodide in Dragendorff's reagent. The results were recorded based on the presence or absence of precipitate[11,12].

Assays for Enzyme Inhibition: Enzyme inhibition assays were performed to test the effectiveness of the selected plant extracts in inhibiting enzymes involved in disease development. Because diseases may be caused by abnormal activity of certain enzymes, the identification of natural enzyme inhibitors is an efficient strategy in drug discovery. The mentioned assays allow obtaining a simple and effective way of testing the biological activity of the tested plant extracts.

Tyrosinase Inhibition Assay: The tyrosinase inhibition assay was performed to evaluate the anti-tyrosinase potential of the hydro alcoholic extracts of banana peel (*Musa spp.*), curry leaves (*Murraya koenigii*), and finger millet bran (*Eleusine coracana*). Tyrosinase is a copper-dependent enzyme that catalyzes the oxidation of L-DOPA to dopachrome, an orange-coloured product whose formation is monitored spectrophotometrically at 475nm. Compounds capable of inhibiting tyrosinase reduce dopachrome formation, resulting in lower absorbance values. The inhibition activity of the extracts was determined by comparing the absorbance of selected samples with that of the control, and the percentage inhibition was subsequently calculated[13,14].

The assay was carried out using 50mM phosphate buffer (pH 6.8), L-tyrosine enzyme solution (1mg/ml), freshly prepared L-DOPA substrate, kojic acid (1mg/mL) as the positive control (25–400µg/mL), and the hydro alcoholic plant extracts. Briefly, 1.0mL of phosphate buffer was mixed with 500µL of either plant extract or kojic acid standard and pre-incubated for 10 min. Subsequently, 500µL of tyrosinase enzyme solution was added, followed by 500µL of L-DOPA to initiate the reaction.

Reaction mixtures were kept for incubation at room temperature for 30 mins, and absorbance was measured at 475 nm with UV-Visible spectrophotometer. The procedure was repeated for three times, and percentage inhibition of tyrosinase was calculated in relation to the control. The assay allowed us to compare the inhibitory activity of the chosen plant extracts with that of the standard inhibitor kojic acid[15].

ACE Inhibition Assay: The angiotensin-converting enzyme (ACE) inhibition assay was performed to determine the hypotensive property of the hydro alcoholic plant extracts. In this assay, ACE catalyzes the hydrolysis of Hippuryl-Histidyl-Leucine (HHL) into hippuric acid and histidyl-leucine. In the presence of compounds with ACE inhibitory properties, less hippuric acid would be formed, causing a reduction in absorbance at 228 nm. Therefore, a low absorbance value indicates higher ACE inhibition activity, and the percentage inhibition was calculated[16,17].

The test was conducted through the use of 100mM borate buffer solution (pH 8.3), ACE enzyme solution (10mg/ml), freshly prepared HHL substrate (2.5mM), captopril (1mg/ml) as a positive control (10-200µg/mL), and the hydro alcoholic extracts of the plants. Briefly, 50µL of either hydro alcoholic extract or captopril solution was mixed with 50µL of ACE enzyme and incubated at 37°C for 10 minutes. The reaction was started by adding 150µL of HHL substrate and then incubated for 30 min at 37°C. It was stopped by adding 250µL of 1 N hydrochloric acid to it, then adding 500 µL of ethyl acetate to extract hippuric acid. After mixing and centrifugation at 3000 rpm for 10 minutes, the upper layer was isolated, evaporated in a water bath, and then the remaining material was dissolved in 1 mL of distilled water. The absorbance was determined at 228 nm using a UV-visible spectrophotometer[18].

Results and Discussion

Preliminary Phytochemical Analysis: Total Phenolic Content: The Total Phenolic Content (TPC) of the hydro-alcoholic extracts of finger millet bran (*Eleusine coracana*), curry leaves (*Murraya koenigii*), and banana peel (*Musa spp.*) was evaluated using the Folin-Ciocalteu colorimetric method. Calibration curve was constructed using Gallic acid solutions with concentrations of 20, 40, 60, 80, and 100µg/ml as shown in Table-1 and Figure-1(A). Linearity of the calibration curve ($y = 0.0036x + 0.0444$; $R^2 = 0.9969$) confirmed high accuracy and reliability of the method to determine the content of phenolic compounds in plant material.

The formula can calculate the total phenolic content of the plant samples:

TPC (mg GAE/g) = $\frac{C \times V \times DF}{1000 \times W}$

Where: C=concentration from calibration curve, V=total volume of extract (50ml), DF=dilution factor (10), W=weight of plant sample extracted (5g).

Absorbance of plant extracts obtained at 765nm was transformed into concentration expressed in Gallic acid equivalents (GAE) using a calibration equation. According to the results, curry leaves possessed the highest phenolic concentration is 66.28µg/mL GAE, whereas banana peel had the second highest 54.33µg/mL GAE. Finger millet bran was characterized by the lowest concentration of phenolic compounds 39.61µg/mL GAE. Thus, the selected plant materials have different amounts of phenolic compounds as shown in Figure-1(B).

The total phenolics present in the hydro-alcoholic extracts were measured using the Folin-Ciocalteu assay and reported as mg GAE/g of all the samples analysed, the highest phenolic content was observed in curry leaves is 6.63mg GAE/g followed by banana peels is 5.43mg GAE/g and finger millet bran is 3.96 mg GAE/g.

The higher content of phenolics in curry leaves signifies a higher presence of phenolic compounds as compared to the other samples. Banana peels showed a significant content of phenolics, whereas finger millet bran had comparatively low content of phenolics. Such differences can be accounted for on the basis of different phytochemicals present in each plant material.

Table-1: Gallic acid standard curve data and total phenolic content of hydro alcoholic plant extracts.

Test tube no	Conc'n of Gallic acid (µg/ml)	Mean OD
B	0	0.0
1	20	0.120
2	40	0.188
3	60	0.249
4	80	0.327
5	100	0.407

Samples	Phenolic Conc'n of sample (µg/ml GAE)	Mean OD	Total phenolic content (mg GAE/g)
Finger millet bran	39.61	0.187	3.96
Curry leaves	66.28	0.283	6.63
Banana peel	54.33	0.240	5.43

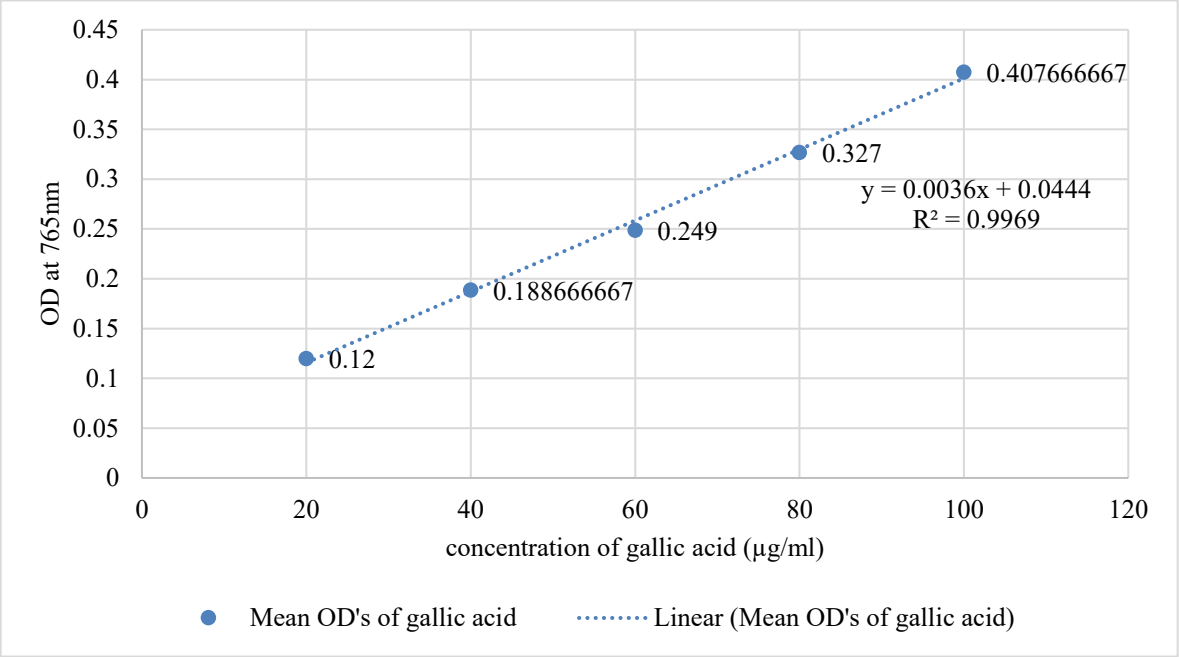

Figure-1(A): Graph of standard gallic acid curve.

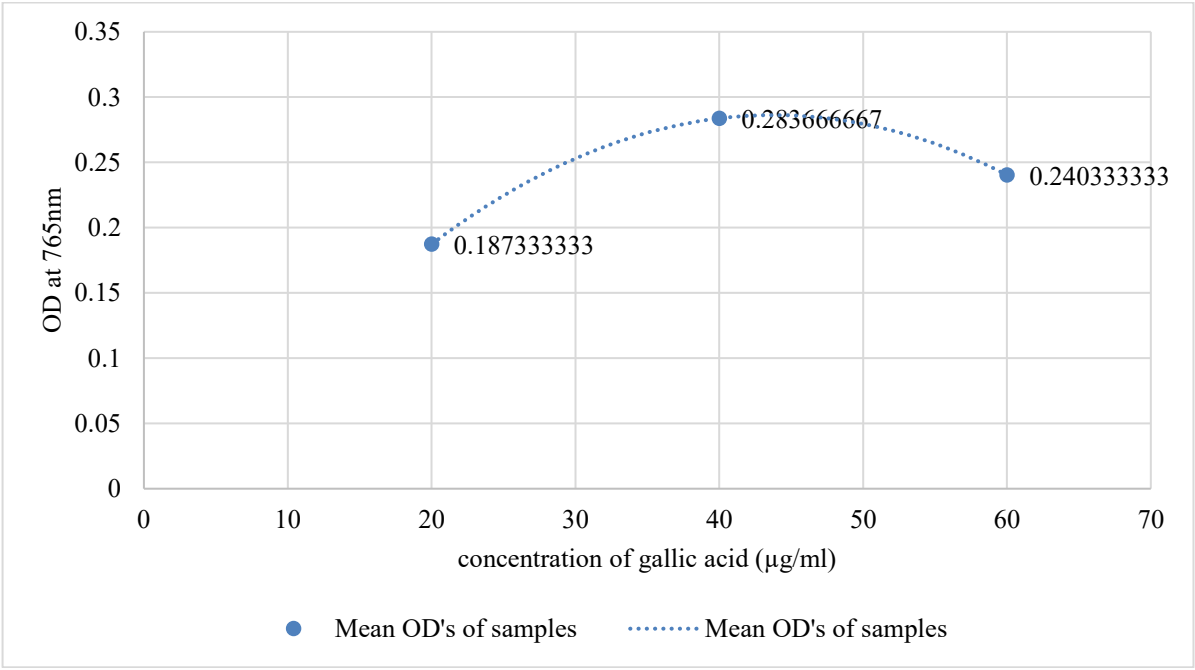

Figure-1(B): Graph of hydroalcoholic plant extracts

Flavonoid Determination: Qualitative phytochemical screening performed using alkaline reagent test indicated the presence of flavonoids in all selected plant extracts. Development of yellow colour on addition of sodium hydroxide followed by disappearance after acidification with dilute hydrochloric acid was used as a positive sign for flavonoids as indicated in Figure-2. Finger millet bran and banana peel showed a strong yellow colour formation, while curry leaves showed only a faint colour formation, thus pointing to no flavonoid content as mentioned in Table-2.

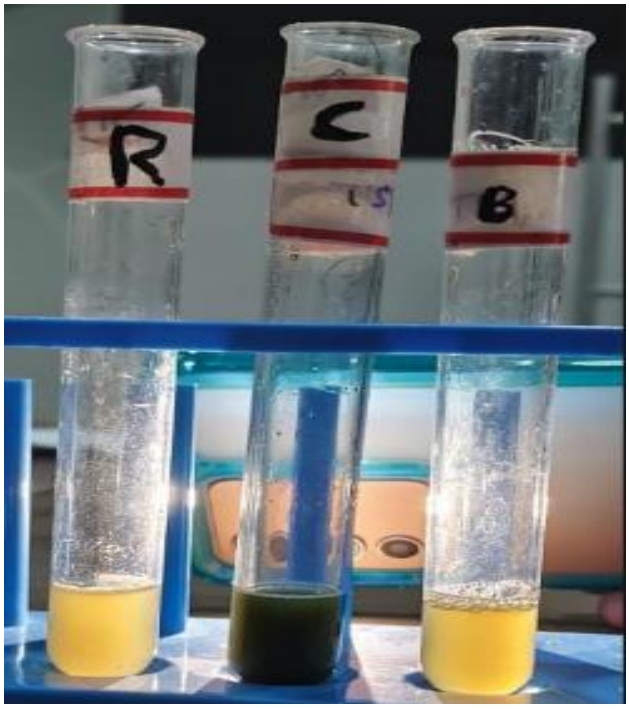

Figure-2: Formation of yellow colour.

Table-2: Flavonoid determination of hydro alcoholic plant extracts

Samples	Observation	Result
Finger millet bran	Formation of yellow colour and disappearance	Flavonoids are present
Curry leaves	No formation of yellow colour and disappearance	Flavonoids are absent
Banana peel	Formation of yellow colour and disappearance	Flavonoids are present

Detection of Alkaloids: Alkaloids were tested using Dragendorff's test on the hydro-alcoholic extracts. Presence of alkaloids was determined from the development of an orange to reddish-brown precipitate as indicated in Figure-3. From Table-3, Curry leaves gave a more pronounced precipitate compared to finger millet bran and banana peel, indicating low alkaloid content in the other two samples.

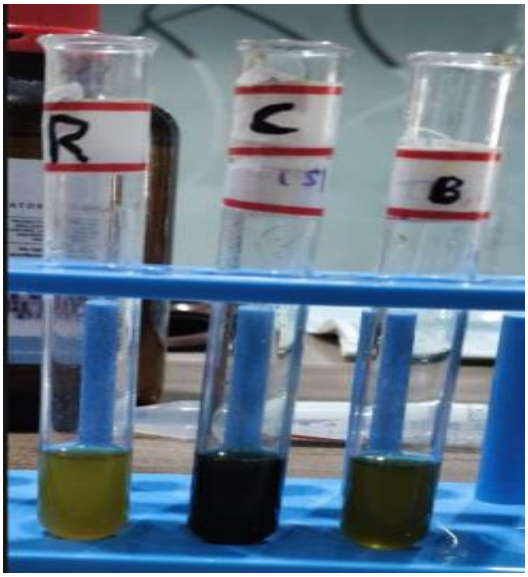

Figure-3: Formation of precipitate.

Table-3: Alkaloid determination of hydro alcoholic plant extracts.

Samples	Observation	Result
Finger millet bran	Less formation of precipitate	Alkaloids present
Curry leaves	Formation of precipitate	Alkaloids are present
Banana peel	Less formation of precipitate	Alkaloids present

Enzyme Inhibition Assay: Tyrosinase Inhibition Assay: For this study, the tyrosinase inhibition test was conducted to determine the potential of plant extract to inhibit tyrosinase, an enzyme responsible for melanin synthesis. For the positive control, kojic acid was chosen; its concentration varied between 25 and 400 µg/ml as shown in Table-4. As expected, percentage inhibition increased in proportion to the increase in kojic acid concentration as indicated in Figure-4 (A) and (B). Inhibitions of the extracts were related to the standard curve made with kojic acid. Finger millet bran had the maximum percentage of tyrosinase inhibition at 52.65% and was slightly higher than the percentage inhibition shown by banana peel at 50.34%, and the minimum percentage of inhibition was observed for curry leaves is 20.55% as shown in Figure-4(C). As per the calibration curve of Figure-4(A) ($y = -0.0005x + 0.3507$; $R^2 = 0.8798$), the kojic acid equivalent inhibitory concentrations of the samples were found to be 291.4 µg/mL for finger millet bran, 271.4 µg/mL for banana peel, and 13.4 µg/mL for curry leaves.

The percentage of inhibition was determined by the formula:

$$\frac{\text{Control OD} - \text{Sample OD}}{\text{Control OD}} \times 100$$

Table-4: Kojic acid % inhibition and kojic acid equivalent concentration % inhibition of hydroalcoholic plant extracts (1:10 dilution).

Test tube no	Conc'n of Kojic acid (µg/ml)	Mean OD	% inhibition
B	0	0.0	0
C	0	0.433	0
1	25	0.370	14.54%
2	50	0.334	22.86%
3	100	0.271	37.41%
4	200	0.241	44.34%
5	400	0.182	57.96%
Samples	Dilution	Kojic acid equivalent conc'ns (µg/ml)	Mean OD
Finger millet bran	1:10	291.4	0.205
Curry leaves	1:10	13.4	0.344
Banana peel	1:10	271.4	0.215

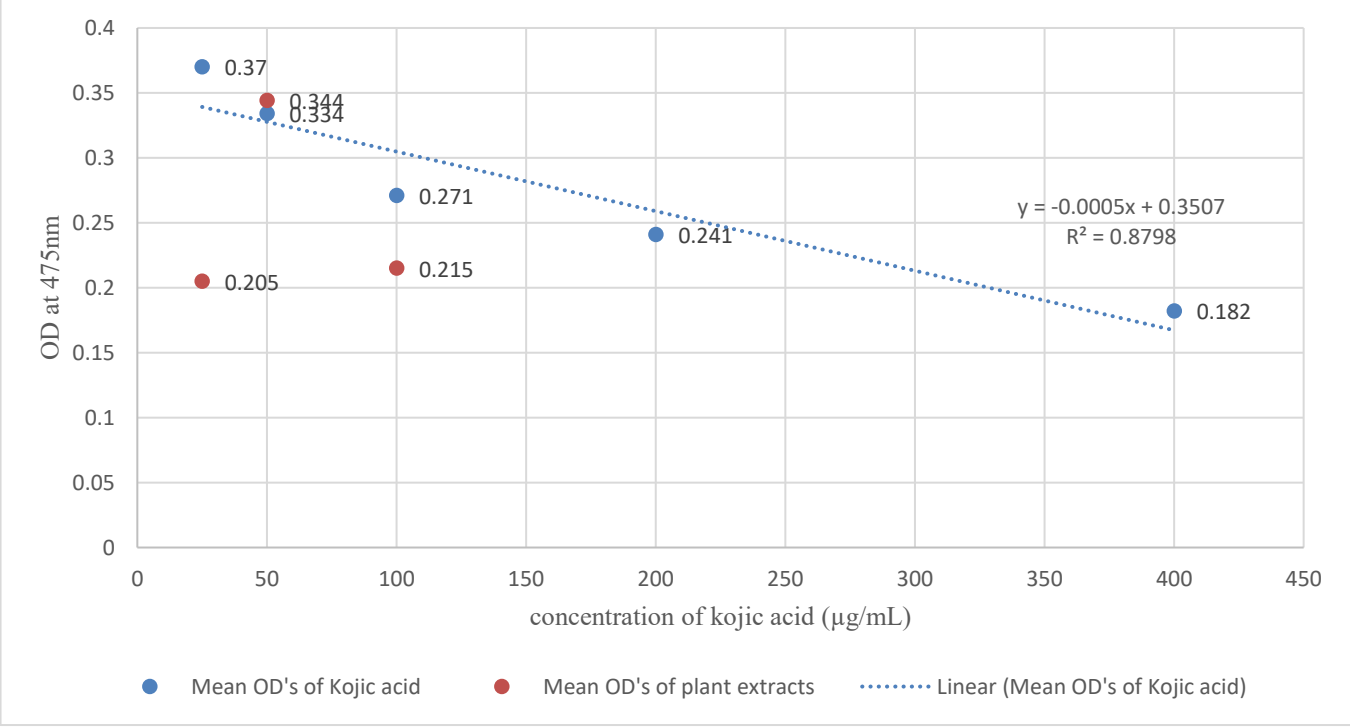

Figure-4(A): Graph of standard kojic acid curve.

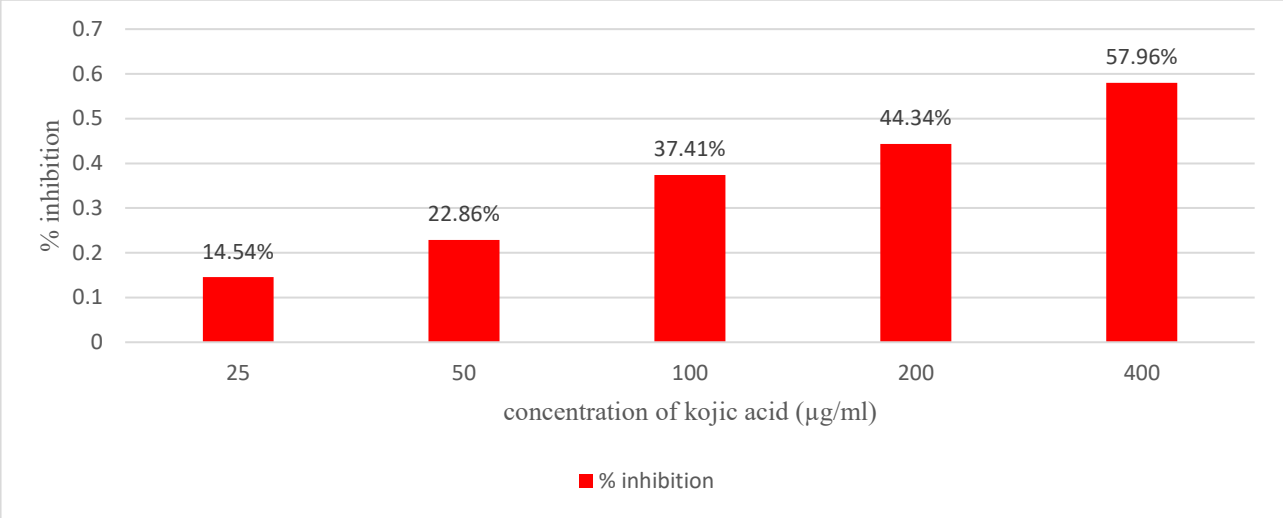

Figure-4(B): Graph of kojic acid % inhibition activity.

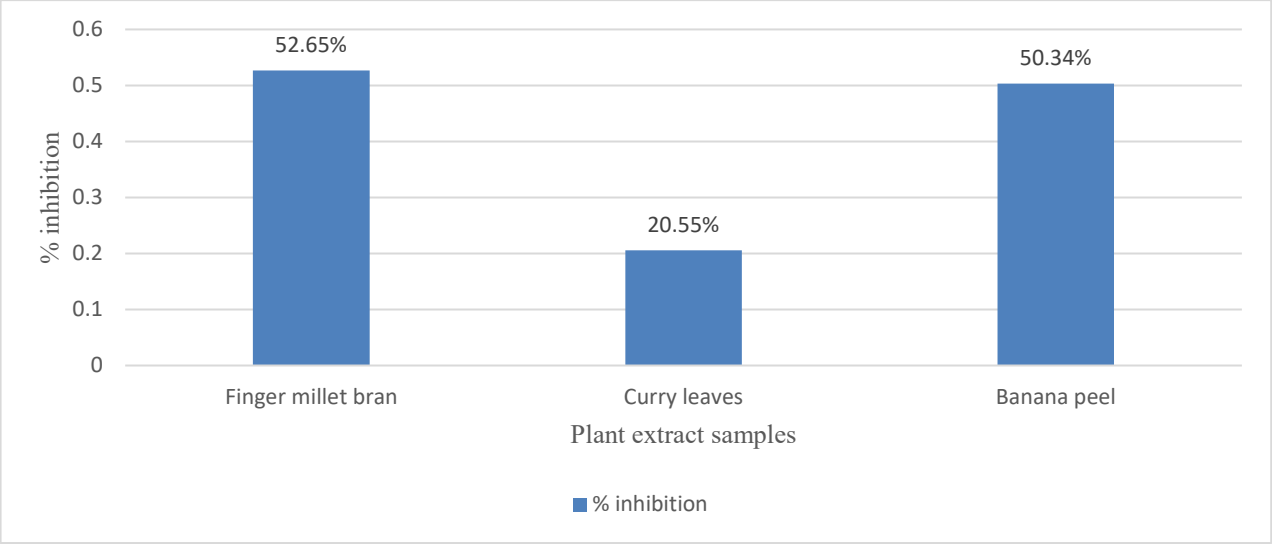

Figure-4(C): Graph of tyrosinase % inhibition activity of hydroalcoholic plant extracts.

The results indicate that total phenolic content does not directly correlate with tyrosinase inhibitory activity. While curry leaves contained the highest phenolic content, finger millet bran exhibited greater tyrosinase inhibition.

It suggests that enzyme inhibition is influenced by the type, structure, and synergistic interactions of bioactive compounds rather than the total phenolic content alone[19].

The hydroalcoholic extracts showed varying degrees of tyrosinase inhibitory activity. This is because of the variation in the bioactivity of the phytochemical compounds. In this case, the extracts were diluted at the ratio of 1:10; hence, it was impossible to determine their concentrations. Therefore, the results are based on the percentage inhibition, while the concentrations of Kojic acid equivalents determined using the standard curve were only relative. Of all the tested samples, finger millet bran had the most tyrosinase inhibition activity, followed by banana peel, while curry leaves had the least inhibitory activity. The better performance of finger millet bran could be due to the presence of phenolic acids, flavonoids, tannins, and other phytochemical compounds with higher binding affinity for the active copper site of tyrosinase. Though curry leaves had higher amounts of phenolics, the less inhibitory activity shows that enzyme inhibition does not depend on the amount of phenolics but rather on the structure of the phytochemicals.

ACE Inhibition Assay: The ACE inhibition capability of the hydro alcoholic extracts was determined through the use of captopril as the standard inhibitor at 10, 25, 50, 100, and 200 µg/mL concentrations, as shown in Table-5.

A calibration graph was prepared using Excel, using the percent inhibition of captopril as shown in Figure-5 (B). The standard graph revealed good linearity with the regression formula y = −0.0021x + 0.6756, with an R^2 value of 0.98 as shown Figure-5(A). Banana peel extract has been found to have the highest inhibition activity among the other extracts at 56.11%, followed by finger millet bran with 50.52% inhibition, while curry leaves had the least at 23.56% as shown in Figure-5 (C). From the calibration graph, the captopril equivalent inhibitory concentrations were calculated to be 161.2µg/mL for banana peel, 140.8µg/mL for finger millet bran, and 42.2µg/mL for curry leaves.

The percentage of inhibition was determined by the formula:

$$\frac{\text{Control OD} - \text{Sample OD}}{\text{Control OD}} \times 100$$

Table-5: Captopril % inhibition and captopril equivalent concentration % inhibition of hydroalcoholic plant extracts (1:10 dilution).

Test tube no	Dilution	Captopril equivalent conc'ns (µg/ml)	Mean OD	% inhibition
Finger millet bran	1:10	140.8	0.380	50.52%
Curry leaves	1:10	42.2	0.587	23.56%
Banana peel	1:10	161.2	0.337	56.11%
Test tube no	Conc'n of captopril (µg/ml)		Mean OD	% inhibition
B	0			0
C	0		0.768	0
1	10		0.670	12.76%
2	25		0.642	16.40%
3	50		0.535	30.33%
4	100		0.458	40.36%
5	200		0.269	64.97%

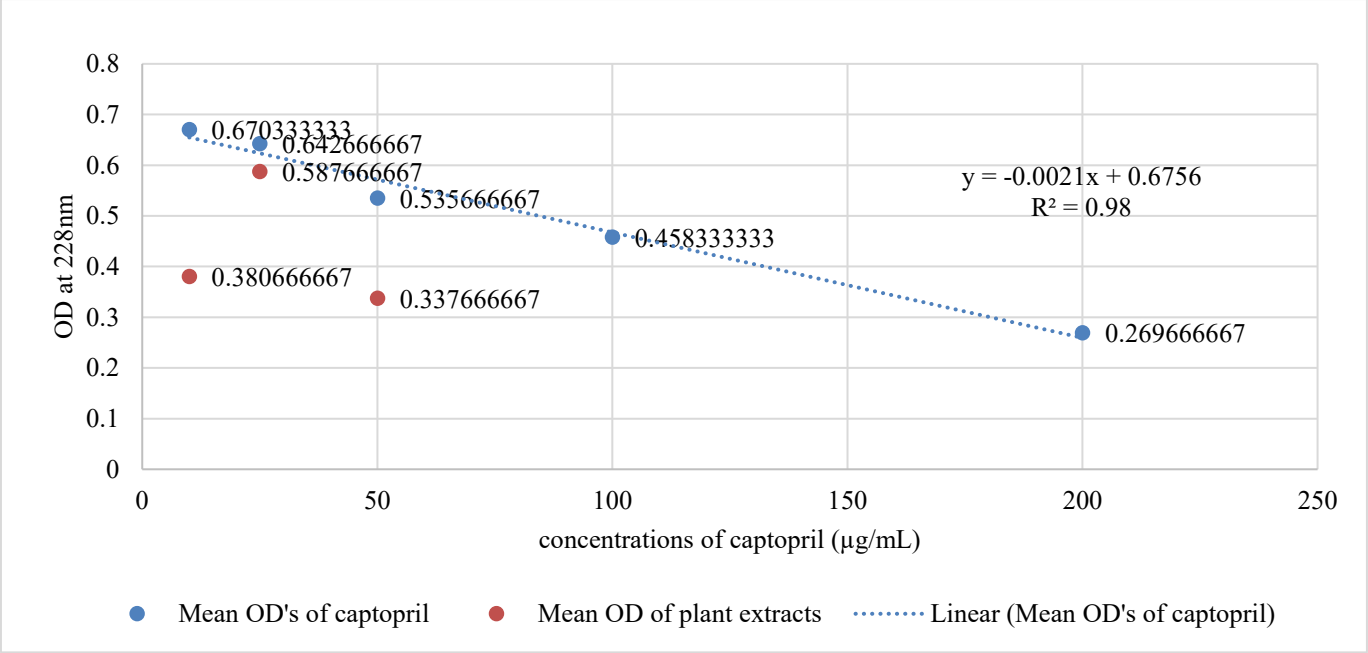

Figure-5(A): Graph of captopril standard curve.

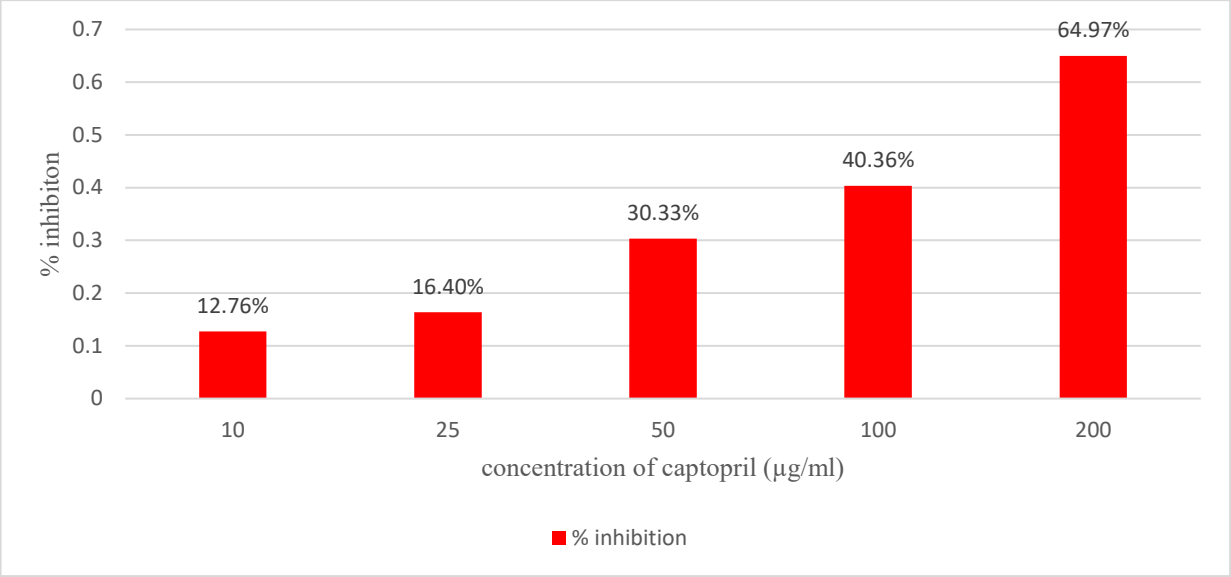

Figure-5(B): Graph of captopril % inhibition activity.

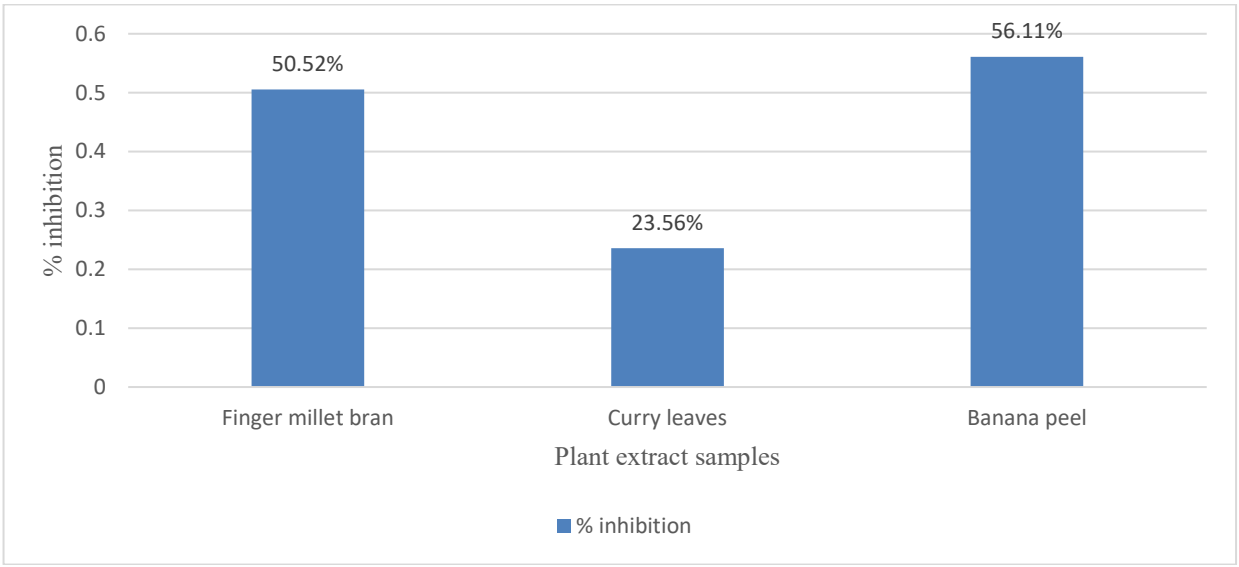

Figure-5(C): Graph of ACE % inhibition activity of hydroalcoholic plant extracts.

The hydroalcoholic extracts showed variable activities of ACE inhibition due to the variations in their phytochemical compositions. Since the activity of the extracts was measured as 1:10 diluted crude extracts, the concentrations of the extracts could not be determined; thus, the results should be analysed in terms of percentage inhibition while the concentration values of captopril obtained from the calibration graph are the relative inhibitory potencies only. The banana peel extract had the highest ACE inhibitory activity among the tested samples, which means that there are bioactive components in the extracts that have high affinities towards the active site of the ACE. The finger millet bran also has significant inhibitory activity despite its low total phenol content, which implies that some other phytochemicals such as phenolic acids, flavonoids, and alkaloids can also work together in inhibiting the enzymes. However, the curry leaves have low inhibitory activity despite their relatively higher phenolic and alkaloid contents, which suggests that enzyme inhibition involves factors other than phytochemical amounts.

Discussion: From the results obtained from the present study, it was established that there were phytochemical contents such as phenolics, flavonoids, and alkaloids in all the hydro alcoholic extracts that included finger millet bran (*Eleusine coracana*), curry leaves (*Murraya koenigii*), and banana peel (*Musa spp.*). Nevertheless, considerable variations were recorded in terms of phytochemical contents and enzyme inhibition activity. While the curry leaves had the highest total phenolic content, finger millet bran had the highest tyrosinase inhibition activity, whereas banana peel had the highest ACE inhibition activity.

It can be said that the enzyme inhibition was not entirely based on the total phenolic content in the plant extract. Rather, the activity of the phytochemicals seems to depend on the kind of phytochemical structures and their combination as well as interaction of secondary metabolites such as phenolics, flavonoids, alkaloids, etc. Therefore, the reason behind the higher enzyme inhibition activity for the finger millet bran and banana peel despite having a lower phenolic content than curry leaves could be elucidated in this manner. These findings support the use of underutilized plant materials as valuable sources of bioactive compounds for the future development of natural therapeutic and nutraceutical formulations targeting hyperpigmentation and hypertension.

Conclusion

The results of this study indicate that extracts from finger millet bran (*Eleusine coracana*), banana peel (*Musa spp.*), and curry leaves (*Murraya koenigii*) are rich in bioactive substances that have promising inhibitory effects on enzymes. Although curry leaves possessed the highest amount of phenolics, they had comparatively weak inhibitory effects against tyrosinase and ACE enzymes, which means that enzyme inhibitory effect is not determined only by the presence of phenolic substances, but also by the type and structure of other biologically active components. The strongest tyrosinase inhibitory effect was shown by finger millet bran, while banana peel had the highest ACE inhibitor effect. Overall, it was concluded that agricultural waste and medicinal plants may be used as inexpensive and sustainable sources of natural enzyme inhibitors. The promising use of these plants as the basis for future pharmaceutical, nutraceutical, and cosmetic products should be studied further through isolation of active compounds and their characterization.

Acknowledgement

The authors are also grateful to L Jahnavi Reddy, Senior Research Associate, Credora Life Sciences, for providing the laboratory facilities, technical support, and necessary resources to successfully carry out the experimental work.

References

1. Atanasov, A. G., Zotchev, S. B., Dirsch, V. M., &Supuran, C. T. (2021). Natural products in drug discovery: Advances and opportunities. *Nature Reviews Drug Discovery*, 20(3), 200–216.

2. Rodrigues, T., Reker, D., Schneider, P. & Schneider, G. (2016). Counting on natural products for drug design. *Nature Chemistry*, 8(6), 531–541.

3. Saleem, H., Yaqub, A., Rafique, R., Chohan, T. A., Malik, D.E.S., Tousif, M. I., Khurshid, U., Ahemad, N., Ramasubburayan, R. and Rengasamy, K. R. R. (2024). Nutritional and medicinal plants as potential sources of enzyme inhibitors toward the bioactive functional foods: An updated review. *Critical Reviews in Food Science and Nutrition*, 64(27), 9805–9828.

4. Tang, W., Wang, X., Hua, Z., Zhang, L. & He, Y. (2024). Elevating enzymatic hydrolysis efficiency and ethanol yield of poplar by hydrogen peroxide assisted p-toluenesulfonic acid pretreatment. *Industrial Crops and Products*, 209, 118062.

5. El-Shiekh, R. A., Elshimy, R., Mandour, A. A., Kassem, H. A. H., Khaleel, A. E., Alseekh, S., Fernie, A. R., & Salem, M. A. (2024). Murrayakoenigii (L.) Sprengel seeds and pericarps in relation to their chemical profiles: New approach for multidrug resistant Acinetobacterbaumannii ventilator-associated pneumonia. *Applied Biological Chemistry*, 67, 35.

6. Pogorzelska-Nowicka, E., Hanula, M., &Pogorzelski, G. (2024). Extraction of polyphenols and essential oils from herbs with green extraction methods—An insightful review. *Food Chemistry*, 460, 140456.

7. Mahora, M. C., Kigundu, A. and Waihenya, R. (2024). Screening of phytochemicals, antioxidant activity, and in vivo safety profile of the hydroethanolic peel extract of Musa sapientum. *Plant Trends*, 2(1), 1–15.

8. Raposo, F., Borja, R. & Gutiérrez-González, J. A. (2024). A comprehensive and critical review of the unstandardized Folin–Ciocalteu assay to determine the total content of polyphenols: The conundrum of the experimental factors and method validation. *Talanta*, 272, 125771.

9. Pérez, M., Dominguez-López, I., &Lamuela-Raventós, R. M. (2023). The chemistry behind the Folin–Ciocalteu method for the estimation of (poly) phenol content in food: Total phenolic intake in a Mediterranean dietary pattern. *Journal of Agricultural and Food Chemistry*, 71(46), 17543–17553.

10. Banjarnahor, S. D. S. and Artanti, N. (2014). Antioxidant properties of flavonoids. *Medical Journal of Indonesia*, 23(4), 239–244.

11. Adil, M., Filimban, F. Z., Ambrin, Quddoos, A., Sher, A. A. and Naseer, M. (2024). Phytochemical screening, HPLC analysis, antimicrobial and antioxidant effect of Euphorbia parviflora L. (EuphorbiaceaeJuss.). *Scientific Reports*, 14, 5627.

12. Owor, R. O., Kawuma, C., Nantale, G., Kiyimba, K., Obakiro, S. B., Ouma, S., Lulenzi, J., Gavamukulya, Y., Chebijira, M., Lukwago, T. W., Egor, M., Musagala, P., Andima, M., Kibuule, D., Waako, P. and Hokello, J. (2024). Ethnobotanical survey and phytochemistry of medicinal plants used in the management of HIV/AIDS in Eastern Uganda. *Heliyon*, 10(11),

13. Lee, C.Y., Chen, Y.C., Huang, Y.H., Lien, Y.L. and Huang, C.Y. (2024). Cytotoxicity and multi-enzyme inhibition of Nepenthes miranda stem extract on H838 human non-small

cell lung cancer cells and RPA32, elastase, tyrosinase, and hyaluronidase proteins. *Plants*, 13(6), 797.

14. Zolghadri, S., Bahrami, A., Hassan Khan, M. T., Muñoz-Muñoz, J., Garcia-Molina, F., Garcia-Cánovas, F., & Saboury, A. A. (2019). A comprehensive review on tyrosinase inhibitors. *Journal of Enzyme Inhibition and Medicinal Chemistry*, 34(1), 279–309.

15. Peng, Z., Wang, G., Zeng, Q.H., Li, Y., Liu, H., Wang, J. J. and Zhao, Y. (2022). A systematic review of synthetic tyrosinase inhibitors and their structure–activity relationship. *Critical Reviews in Food Science and Nutrition*, 62(15), 4053–4094.

16. Chakraborty, R. and Roy, S. (2021). Angiotensin-converting enzyme inhibitors from plants: A review of their diversity, modes of action, prospects, and concerns in the management of diabetes-centric complications. *Journal of Integrative Medicine*, 19(6), 478–492.

17. Li, Y., et al. (2021). Antihypertensive potential of plant foods: Research progress and prospect of plant-derived angiotensin-converting enzyme inhibition compounds. *Journal of Agricultural and Food Chemistry*, 69(20), 5735–5750.

18. Yang, G., Zhu, Y., Shi, J., Peng, Q., Lin, Z., &Lv, H. (2024). Effects of anaerobic treatment on the non-volatile components and angiotensin-converting enzyme (ACE) inhibitory activity of purple-colored leaf tea. *Food Chemistry: X*, 23, 101649.

19. Vaezi, M. (2023). Structure and inhibition mechanism of some synthetic compounds and phenolic derivatives as tyrosinase inhibitors: Review and new insight. *Journal of Biomolecular Structure and Dynamics*, 41(10), 4798–4810.