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# In Vitro Antioxidant Potential of Moringa oleifera Flower, Leaf, and Pod Soup

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***Abstract:*** ***Antioxidants are essential in combating oxidative stress and supporting overall health. This study investigates the in vitro antioxidant potential of soups prepared using Moringa oleifera flowers, leaves, and pods by analyzing their nutrient composition, phytochemical content, and antioxidant activity to evaluate their functional food potential. Two soup variations were formulated with different proportions: Variation 1 contained 10 g of flowers, 5g of leaves, and 15 g of pods (10:5:15),while Variation 2 consisted of 15 g of flowers, 5 g of leaves, and 10 g of pods (15:5:10). Proximate composition was analyzed using AOAC methods, phytochemical screening and Gas Chromatography-Mass Spectrometry (GC-MS) identified key bioactive compounds, and antioxidant activity was evaluated using DPPH and FRAP assays. Sensory attributes were assessed using a 9-point hedonic scale by 50 semi-trained panelists. Results revealed that Variation 1 exhibited higher DPPH radical scavenging activity and greater levels of total phenolics, flavonoids, and anthocyanins, whereas Variation 2 showed stronger ferric-reducing antioxidant power and a more diverse range of bioactive constituents. Sensory evaluation favored Variation 2 for its enhanced appearance, flavor, aroma, and overall acceptability. In conclusion,both Moringasoupvariations offersignificantant ioxidantandnutritionalbenefits,highlightingMoringaoleifera'spotential as a functional food ingredient that promotes health while catering to different consumer preferences.***

***Keywords: Invitroanalysis, Moringaoleifera, soup, antioxidant, oxidativestress, phytochemicals, GC-MS, DPPH, FRAP,sensory evaluation.***

## I. INTRODUCTION

Oxidative stress, resulting from an imbalance between reactive oxygen species (ROS) and antioxidant defenses, is a key factor in the development of chronic diseases such as cardiovascular disorders, diabetes, neurodegenerative conditions, and cancer[1],[2],[3],[4].ROScandamage mitochondrialDNA,disruptenzymaticfunctionandcellularsignaling,andinduce cell death, with lifestyle factors further aggravating these effects.

While ROS and reactive nitrogen species (RNS) support physiological processes at normal levels, their excess leads to oxidativeandnitrosativestress,damagingcellularcomponentsandpromotinginflammation,aging,andcancer[5],[6],[7],[8]. Although the body possesses endogenous antioxidant systems, dietary antioxidants have gained attention, especially with the rise of the free radical theory of aging [9].

Moringaoleifera,knownasthe"miracletree,"isvaluedforitsadaptabilityandmedicinalproperties[10],[11].

Traditionallyusedtotreatvariousailments,itspartsarerichinbioactivecompoundswithantioxidant,anti-inflammatory,and nutritional benefits [12], [13], [14], [15], [16], [17].

Givenitsphytochemicalrichness, M.oleiferashowspotentialindietarystrategiestocombatoxidativestressandsupport health.

## II. REVIEW OF LITERATURE

### *A. OxidativeStressandDiseases*

Oxidative stress is a condition characterized byan imbalance between reactive oxygen species (ROS) and the body's antioxidantdefense mechanisms,leadingtodamageofproteins,lipids,carbohydrates,andDNA[18].Itcanoriginatefrom both internal sources, such as mitochondrial activity and inflammation, and external factors like pollution, radiation, smoking, and poor diet. Prolonged oxidative stress is closely associated with the onset of chronic diseases, including cardiovascular disorders, diabetes, cancer, and neurodegenerative conditions [19].

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### B. *Antioxidants–AnOverview*

Antioxidants are compounds that prevent or delay oxidative damage by stabilizing free radicals through electron donation[20].Theyhelp maintainredoxbalanceandprotectcellularstructures.Thebodyemploysenzymatic(e.g.,superoxide dismutase, catalase) and non-enzymatic (e.g., vitamins C and E, flavonoids, selenium) antioxidants. Given the limitations of endogenous defenses under oxidative stress, dietary intake of antioxidant-rich foods is essential. Natural sources, particularly plant-based functional foods, are gaining attention for their health-promoting potential [21].

### C. *FreeRadicalsandTheirBiologicalImpact*

Freeradicalsareunstablemoleculeswithunpairedelectronsthatreadilyinteractwithanddamagecellularcomponents, including lipids, proteins, and DNA. ROS such as hydroxyl radicals, superoxide anions, and hydrogen peroxide are byproducts of normal metabolism, particularly in mitochondria, but can increase under stress. Endogenous sources include mitochondrial respiration and enzymatic reactions, while external contributors include UV radiation, toxins, and smoking. Their accumulation contributes to aging and disease progression, underscoring the importance of antioxidant defenses [22].

### D. *Moringaoleifera–ANaturalSourceofAntioxidants*

*Moringa oleifera*, also known as the "miracle tree," is a drought-resistant plant native to South Asia and widely cultivated in tropical regions [23]. It is valued for its nutritional content and therapeutic uses, particularly in low-resource settings.Theleavesarerichinvitamins A,C,andE,and mineralssuchascalcium,iron,andpotassium [24],[25].Podsarehigh in dietary fiber and protein. *Moringa* also contains various phytochemicals like flavonoids, phenolic acids, and glucosinolates, which contribute to its antioxidant properties [26].

### E. *TherapeuticandAntioxidantPotentialandSafetyConsiderations*

*Moringa* has demonstrated significant antioxidant potential, with its leaves and flowers exhibiting high levels of phenolicsandflavonoids,outperformingmanyvegetablesinantioxidantassays suchasDPPH,FRAP,ABTS, andORAC[27], [28]. It also supports immune and metabolic health, as shown in animal studies [29]. Additionally, *Moringa* is used in green synthesis of nanoparticles with anti-inflammatory and anticancer properties [30], [31].

Toxicological evaluations indicate general safety at moderate intake levels. Aqueous leaf extracts showed no toxicity upto2000mg/kginrats[32],while higherconcentrationsof methanolicextractsrequirecaution[33].Thisstudycomplied with Food Safety and Standards Regulations (2016), using 10–20 g of flowers and leaves, and 40–80 g of pods per formulation, within recommended limits.

## III. RESEARCH METHODOLOGY

An *in vitro* experimental research design was employed to evaluate the antioxidant potential of the infused drink. The laboratoryanalysesforthepresentstudywerecarriedoutat AffycloneLaboratoriesPvt.Ltd.,anISO-certifiedfacilitylocatedin Chromepet, Chennai. SensoryevaluationwasconductedintheFoodScienceLaboratory,DepartmentofHomeScience,Women's Christian College, Chennai. Ethical clearance for the study was obtained from the Institutional Ethics Committee of the Department of Home Science, Women's Christian College, Chennai.

### A. *ProcurementandpreparationoftheMoringasoup*

*Moringa oleifera* flowers, leaves, and pods were freshly procured from a local home garden and thoroughly washed under running water to remove dirt and other impurities. Two variations of *Moringa* soup were prepared using different proportions of the plant parts. In Variation 1, the flower, leaf, and pod components were used in the ratio of 10:5:15 grams, respectively. These ingredients were combined with 30 grams of tomato, 30 grams of onion, half a teaspoon each of pepper, cumin, and salt, and a pinch of turmeric. The mixture was pressure-cooked for three whistles, cooled, and blended into a fine purée. A pinch of pepper powder was added before serving. This variation contained a higher proportion of pods compared to flowers and leaves. In Variation 2, the flower, leaf, and pod components were used in the ratio of 15:5:10 grams, respectively. Thesameadditionalingredientsandcooking procedurewerefollowed. Afterpressurecookingandblending,thesoupwas similarly seasoned with a pinch of pepper powder. This variation had a higher proportion of flowers relative to the leaves andpods.

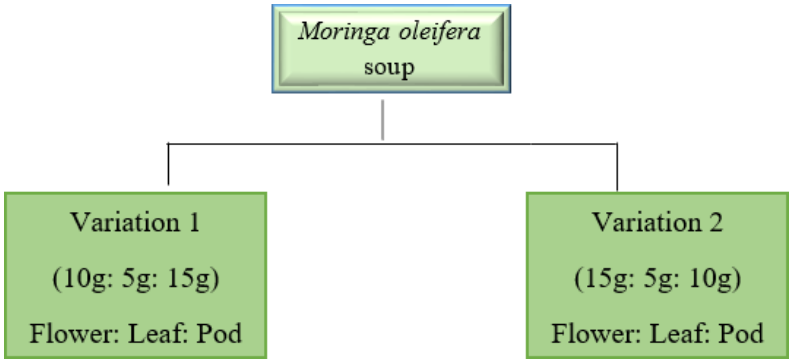



Fig.1Variationsofthe*Moringaoleifera*soup

*B. Preparationofextracts*

Theaqueousandethanolextractsfrombothvariationsofthe *Moringaoleifera*flower,leaf,andpodsoupwereprepared for comprehensive phytochemical and antioxidantanalyses.For theaqueousextract,thesoups werebroughtto agentleboiland thenfilteredusing Whatman filterpapertoremovesolidresidues.Theresultingclearfiltrateswerecollectedinsterilecontainers and used for nutrient quantification, phytochemical screening, and in vitro antioxidant assays. For the ethanol extract, equal volumesofethanol wereaddedtothesoupsamplesina1:1ratioatroomtemperature.The mixtures werethoroughlystirredand left to stand for 24 hours to facilitate the extraction of ethanol-soluble bioactive compounds. After the extraction period, the solutionswere filteredtore moveparticulatematter.Theethanolextractsweresubsequentlyanalyzedusing GasChromatography– Mass Spectrometry (GC-MS) to identify phytoconstituents [34].

*C. Assessmentofinvitroantioxidantpotentialofthe soup*

The *in vitro* antioxidant potential of both variations of the *Moringa oleifera* soup was evaluated using two well- established assays: 2,2-diphenyl-1-picrylhydrazyl (DPPH) and Ferric Reducing Antioxidant Power (FRAP). Each assay was conducted using standard protocols across a concentration range of 20 µL to 100 µL, and the IC50 values representing the concentration required to achieve 50% activity were determined for each sample.

The DPPH assayis a widelyaccepted method for assessing the free radical scavenging abilityof plant-based products. It relies on the ability of antioxidants present in the sample to donate electrons or hydrogen atoms to the stable DPPH radical, resulting in a visible color shift from deep violet to yellow. This decolorization, which corresponds to a decrease in absorbance at 517 nm, is directly proportional to the antioxidant capacity of the sample. The simplicity, rapidity, and reproducibility of the DPPH assay make it a preferred choice for evaluating natural antioxidants in food and nutraceutical [35].

In contrast, the FRAP assay measures the sample's capacity to reduce ferric ($Fe^{3+}$) to ferrous ($Fe^{2+}$) ions under acidic conditions,formingablue-coloredFe$^{2+}$-TPTZcomplex.Theintensityoftheresultingcolor,quantifiedbyabsorbanceat593nm, reflects the electron-donating capacity or reducing power of the antioxidants in the sample. This method, though limited to compoundsthatactviasingleelectrontransfer,remainsavaluableandcost-effectivetoolforcomparingtheantioxidantstrength of different samples, particularly in the context of functional food development [36].

*D. Data analysis*

Thedatacollectedfromthestudywereanalyzedtodeterminethemean,standarddeviation,andcorrelationusingMicrosoft Excel.

## IV. RESULTS AND DISCUSSION

TheresultsofthenutrientanalysisforVariation1andVariation2ofthe *Moringa oleifera*flower,leaf,andpodsoupare presented in Table I.

TABLE I

MICRONUTRIENTANDMACRONUTRIENTCONTENTOFTHE*MORINGA*SOUP

| Nutrients | Unit | Variation1 | Variation2 |
|---|---|---|---|
| Carbohydrates | g/100ml | 0.8673 | 4.897 |

| | | | |
|---|---|---|---|
| Fat | Percent/100 ml | 0.355 | 0.36 |
| VitaminA | mg/100 ml | 22 | 22 |
| VitaminC | mg/100 ml | 202.7397 | 145.8447 |
| Iron | mg/100 ml | 10.125 | 12.5 |
| Selenium | mg/100 ml | 22.216 | 20.1 |

Thespecificnutrientcompositionanalysisofthetwovariationsof *Moringaoleifera*souphighlightedkeydifferencesin their macronutrient and micronutrientcontent.Variation2emergedasthesuperiorformulationduetoitsenhancedcarbohydrate and calcium content, making it a better energy source with improved mineral availability. Although the protein content showed only a slight difference between the two variations, both remained relatively low. The fat content was consistent across both formulations,indicatingthatingredient modificationsdid notimpactthelipid profile.VitaminAlevels werehigher in Variation 1, suggesting a potential difference in ingredient retention during preparation. Iron content, though slightly reduced in Variation 2,remained withinabeneficialrange. ThesefindingssuggestthatVariation2offersa morebalancednutritionalprofile,making it a more favorable option for individuals seeking an energy-dense and mineral-rich diet.

### *A. IdentificationofbioactivecompoundsusingGC-MS*

TheGasChromatography–MassSpectrometry(GC-MS)resultsforbothvariationsoftheinfused *Moringaoleifera* drinkare presented in Tables III and IV. The analysis revealed a broad spectrum of bioactive compounds classified into various phytochemical groups, including phenols, flavonoids, lactones, fatty acids, glycosides, triterpenoids, steroids, and alkaloids. Several compounds were identified in both variations, such as 2,3-Butanediol [R-(R,R)], Glyceraldehyde, Dihydroxyacetone, Isosorbide Dinitrate, 2(3H)-Furanone, dihydro-4-hydroxy-, 1,2,3-Propanetriol, 1-acetate, Acetoxyacetic acid, nonyl ester, α-D- Galactopyranoside, methyl, Melezitose, and 4-O-Methylmannose.

Bioactive compounds uniquely present in Variation 1 included Propane, 1-isothiocyanato-; Butanoic acid, 2-methyl-3-oxo-, ethylester;6-Hydroxy-2,6-dihydropyran-3-one;Pentanoicacid,4-oxo-;2(3H)-Furanone,5-ethyldihydro-;2-Isopropyloxan-4-ol;

Phenol,3,5-bis(1,1-dimethylethyl)-[37];Heptasiloxane, hexadecamethyl-[38];and otherssuchas Agaricicacid and Acetamide derivatives.Thesecompoundsarereportedtopossessantioxidant,antibacterial,anticancer,neuroprotective,hypoglycaemic, and anti-inflammatory properties [39], [40], [41].

Variation 2, on the other hand, was characterized by compounds including 5-Oxotetrahydrofuran-2-carboxylic acid; 2-(Isobutoxymethyl)oxirane; Melibiose; 1-Deoxy-d-mannitol; Hexasiloxane, 1,1,3,3,5,5,7,7,9,9,11,11-dodecamethyl-[38]; 5,14,23-Octadecatrien-14,15-diol; and 1H-Benzoimidazole, 2-benzyl-1-isobutyl-. These compounds also exhibit antioxidant, antimicrobial,andmetabolic-enhancingeffects[42],[43],[44],althoughtheirtherapeuticbreadthappearsmorelimitedcompared to those in Variation 1.

Overall,thefindingsindicatethatVariation1exhibitsamorecomprehensiveandpotentprofileofbioactiveconstituentswith established antioxidant and pharmacological activities. Therefore, Variation 1 may offer superior protection against oxidative stress and related pathologies such as cardiovascular diseases, neurodegenerative disorders, cancers, and diabetes mellitus [45], [46].

### *B. Quantificationofphytochemicals*

The phytochemical composition of the two *Moringa oleifera* soup variations is detailed in Table II. Variation 1, containing 10gofflowers,5gofleaves,and15gofpods,demonstratednotablyhigherlevelsoftotalphenoliccontent(47.452±3.219mgGAE/100ml)andtotalflavonoids(26.904±8.454mgQE/100ml)comparedto Variation2(15gflowers,5gleaves,10gpods), whichrecorded lower values ofphenolics (33.616 ±21.575 mgGAE/100 ml) and flavonoids (21.587 ±10.183 mg QE/100 ml). Interestingly, Variation2exhibitedagreatertotalantioxidantcapacity(558±4.588mgAAE/100ml)thanVariation1(491.684±19.601mgAAE/100ml).

These findings indicate that while Variation 2 may contain certain compounds with stronger immediate radical-scavenging activity, the higher levels of phenolic and flavonoid compounds in Variation 1 suggest a more robust and sustained antioxidant potential. Research shows that these compounds playa crucial role in providing antioxidant, anti-inflammatory, and therapeutic benefits, contributing to the functional properties of the formulation [47], [48].

TABLEII
QUANTIFICATIONOFPHYTOCHEMICALSINTHE*MORINGA*SOUP

| Phytochemicals | Variation1 | Variation2 |
|---|---|---|
| Totalphenoliccontent (mgGAE/100 ml) | 47.452±3.219 | 33.616±21.575 |
| Totalflavonoids (mgQE/100ml) | 26.904±8.454 | 21.587±10.183 |
| Anthocyanincontent (mgCGE/100ml) | 491.684± 19.601 | 558±4.588 |
| Totalantioxidant content (mgAAE/100 ml) | 47.452±3.219 | 33.616±21.575 |

*C. InvitroAntioxidantpotentialoftheinfuseddrinks*

To determine the antioxidant capacityof the infused drinks, bothDPPH and FRAP assays were employed. The DPPH assay revealed a concentration-dependent increase in radical scavenging activity for both variations. However, at sample volumes rangingfrom20µlto100µl,theantioxidantresponsewasrelativelymodest.TheIC50valueswerecalculatedtobetterunderstand theireffectiveness-237.9µlforVariation1and216.88µlforVariation2.AstheIC50representsthevolumeneededtoneutralize 50% of DPPH radicals, the lower value in Variation 2 indicates a higher antioxidant efficiency at comparable concentrations. Despite both variations demonstrating activity, the results suggest that Variation 2 is marginally more effective in combating oxidative stress through radical scavenging. The outcomes of the DPPH assay are depicted in Figure 2.

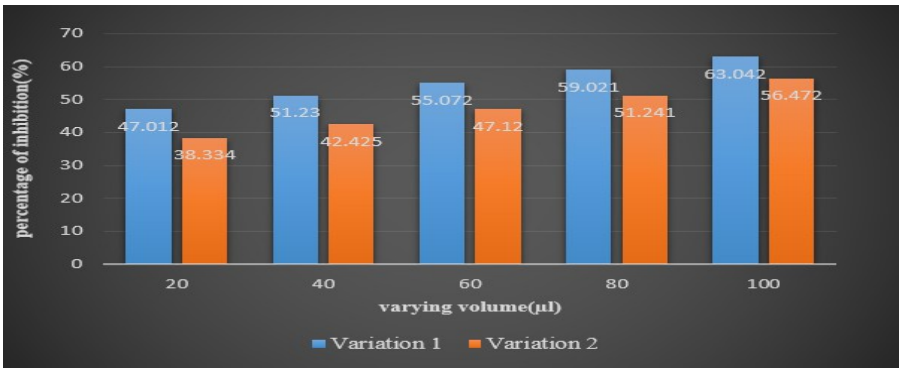



Fig.2PercentageofInhibitionofVariation1andVariation2oftheMoringasoup

Forfurtheranalysis,the FRAP assaywasconductedtoevaluatetheferricionreducingabilityofthesamples.Bothvariations demonstrated a progressiveincreaseinreducingpower with increasingconcentrations,indicatinga positivecorrelationbetween concentration and antioxidant activity. The IC50 values derived fromthe FRAP data were 39.44 µl for Variation 2 and46.64 µl for Variation1, implyingthat Variation2 exhibits greater reducingcapability byachieving50% ofmaximumactivityat a lower dose. These findings suggest that Variation2 possesses a stronger ferric reducingantioxidant potential, which maybe attributed to the presence of active compounds that function efficiently at lower concentrations. The FRAP assay results are illustrated in Figure 3.

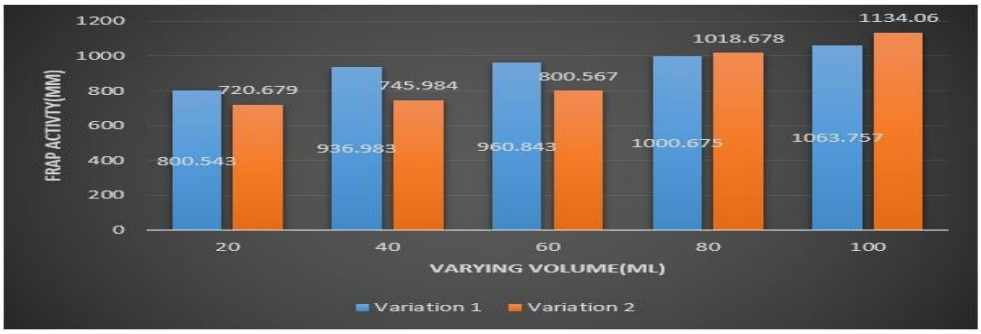



Fig.3FRAPactivityofVariation1andVariation2oftheMoringasoup

## V. CONCLUSION

Based on the results from nutrient analysis and antioxidant assays (total antioxidant capacity, DPPH, and FRAP), Variation 1 exhibited superior radical scavenging activity compared to Variation 2, whereas Variation 2 demonstrated significantly greater ferric reducing power. Consequently, both *Moringa* soup variations possess considerable antioxidant potential, with Variation 2 showing a slightly enhanced profile. Furthermore, sensory evaluation revealed that Variation 2 outperformed Variation1 interms ofappearance, flavor, color,odor, andoverall acceptability. Therefore, the ultimate choice of *Moringa* soup formulation may be guided by individual consumer preferences.

## VI. ACKNOWLEDGMENT

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## REFERENCES

[1] Fenga,C.,Gangemi,S.,Teodoro, M.,Rapisarda,V.,Golokhvast, K.,Docea,A. O.,Tsatsakis,A. M.,&Costa,C.(2017).8-Hydroxydeoxyguanosineas a biomarker of oxidative DNA damage in workers exposed to low-dose benzene. Toxicology reports,4, 291–295.https://doi.org/10.1016/j.toxrep.2017.05.008

[2] Docea, A. O., Gofita,E., Goumenou,M.,Calina,D.,Rogoveanu,O.,Varut,M., Olaru,C., Kerasioti,E.,Fountoucidou,P.,Taitzoglou, I., Zlatian,O.,Rakitskii,V.N.,Hernandez,A.F.,Kouretas,D.,&Tsatsakis,A.(2018).Sixmonthsexposureto areallifemixtureof13chemicals'belowindividualNOAELsinducednonmonotonicsex-dependentbiochemicalandredoxstatuschangesinrats.Foodandchemicaltoxicology:aninternationaljournalpublished for the British Industrial Biological Research Association, 115, 470–481. https://doi.org/10.1016/j.fct.2018.03.052

[3] Tsatsakis,A. M., Docea,A. O., Calina, D., Buga,A. M., Zlatian, O., Gutnikov, S., Kostoff, R. N., &Aschner, M. (2019). Hormetic Neurobehavioraleffects of low dose toxic chemical mixtures in real-life risk simulation (RLRS) in rats. Food and chemical toxicology : an international journalpublished for the British Industrial Biological Research Association, 125, 141–149. https://doi.org/10.1016/j.fct.2018.12.043

[4] Kostoff,R.N.,Heroux,P.,Aschner,M.,&Tsatsakis,A.(2020).Adversehealtheffectsof5Gmobilenetworkingtechnologyunderreal-lifeconditions. Toxicology letters, 323, 35–40. https://doi.org/10.1016/j.toxlet.2020.01.020

[5] Phaniendra, A., Jestadi, D. B., & Periyasamy, L. (2015). Free radicals: Properties, sources, targets, and their implication in various diseases. IndianJournal of Clinical Biochemistry, 30(1), 11–26. https://doi.org/10.1007/s12291-014-0446-0

[6] Nita,M.,&Grzybowski,A.(2016).TheRoleoftheReactiveOxygenSpecies andOxidativeStressinthePathomechanismoftheAge-RelatedOcularDiseases and Other Pathologies of the Anterior and Posterior Eye Segments in Adults. Oxidative medicine and cellular longevity,2016, 3164734.https://doi.org/10.1155/2016/3164734

[7] Reuter,S.,Gupta,S.C.,Chaturvedi,M.M.,&Aggarwal,B.B.(2010).Oxidativestress,inflammation,andcancer:Howaretheylinked?FreeRadicalBiology and Medicine, 49(11), 1603–1616. https://doi.org/10.1016/j.freeradbiomed.2010.09.006

[8] Kashyap, P., Kumar, S., Riar, C. S., Jindal, N., Baniwal, P., Guiné, R. P. F., Correia, P. M. R., Mehra, R., & Kumar, H. (2022). RecentAdvances inDrumstick(Moringaoleifera)LeavesBioactiveCompounds:Composition,HealthBenefits,Bioaccessibility,andDietaryApplications.Antioxidants,11(2), 402. https://doi.org/10.3390/antiox11020402

[9] Conti, V., Izzo, V., Corbi, G., Russomanno, G., Manzo, V., De Lise, F., Di Donato, A., & Filippelli, A. (2016). Antioxidant Supplementation in theTreatment of Aging-Associated Diseases. Frontiers in pharmacology, 7, 24. https://doi.org/10.3389/fphar.2016.00024

[10] Fuglie,L.J.(1998).Producingfoodwithoutpesticides:LocalsolutionstocroppestcontrolinWestAfrica (1sted.).ChurchWorldService.

[11] Chaudhary, K., & Chaurasia, S. (2017). Neutraceutical properties of Moringa oleifera: a review. European journal of Pharmaceutical and medicalresearch, 4(4), 646-655.

[12] Stohs,S.J.,&Hartman,M.J.(2015).ReviewoftheSafetyandEfficacyofMoringaoleifera. Phytotherapyresearch:PTR,29(6),796–804.https://doi.org/10.1002/ptr.5325

[13] Gopalakrishnan, L.,Doriya,K.,& Kumar, D.S. (2016).Moringaoleifera: A review onnutritive importance and itsmedicinal application.FoodScience and Human Wellness, 5(2), 49–56. https://doi.org/10.1016/j.fshw.2016.04.001

[14] Zhang, Y., Peng, L., Li, W., Dai, T., Nie, L., Xie, J., Ai, Y., Li, L., Tian, Y., & Sheng, J. (2020). Polyphenol Extract ofMoringa OleiferaLeavesAlleviates Colonic Inflammation in Dextran Sulfate Sodium-Treated Mice. Evidence-based complementary and alternative medicine: eCAM,2020,6295402.https://doi.org/10.1155/2020/6295402

[15] Gopinath,L. R., Jeevitha, S., Gokiladevi,T., &Archaya, S. (2017). Isolation and Identification oftherapeuticcompoundsfromMoringa oleifera andits antimicrobial activity. IOSR-JPBS, 12, 1-10.

[16] Aekthammarat, D., Pannangpetch, P., & Tangsucharit, P. (2019). Moringa oleifera leaf extract lowers high blood pressure by alleviating vasculardysfunction and decreasing oxidative stress in L-NAME hypertensive rats.Phytomedicine: international journal of phytotherapy andphytopharmacology, 54, 9–16. https://doi.org/10.1016/j.phymed.2018.10.023

[17] Mallenakuppe,R.,Homabalegowda,H.,Gouri,M.D.,Basavaraju,P.S.,&Chandrashekharaiah,U.B.(2019). History,taxonomyandpropagationofmoringa oleifera-a review. SSR Institute of International Journal of Life Sciences, 5 (3), 2322–2327.

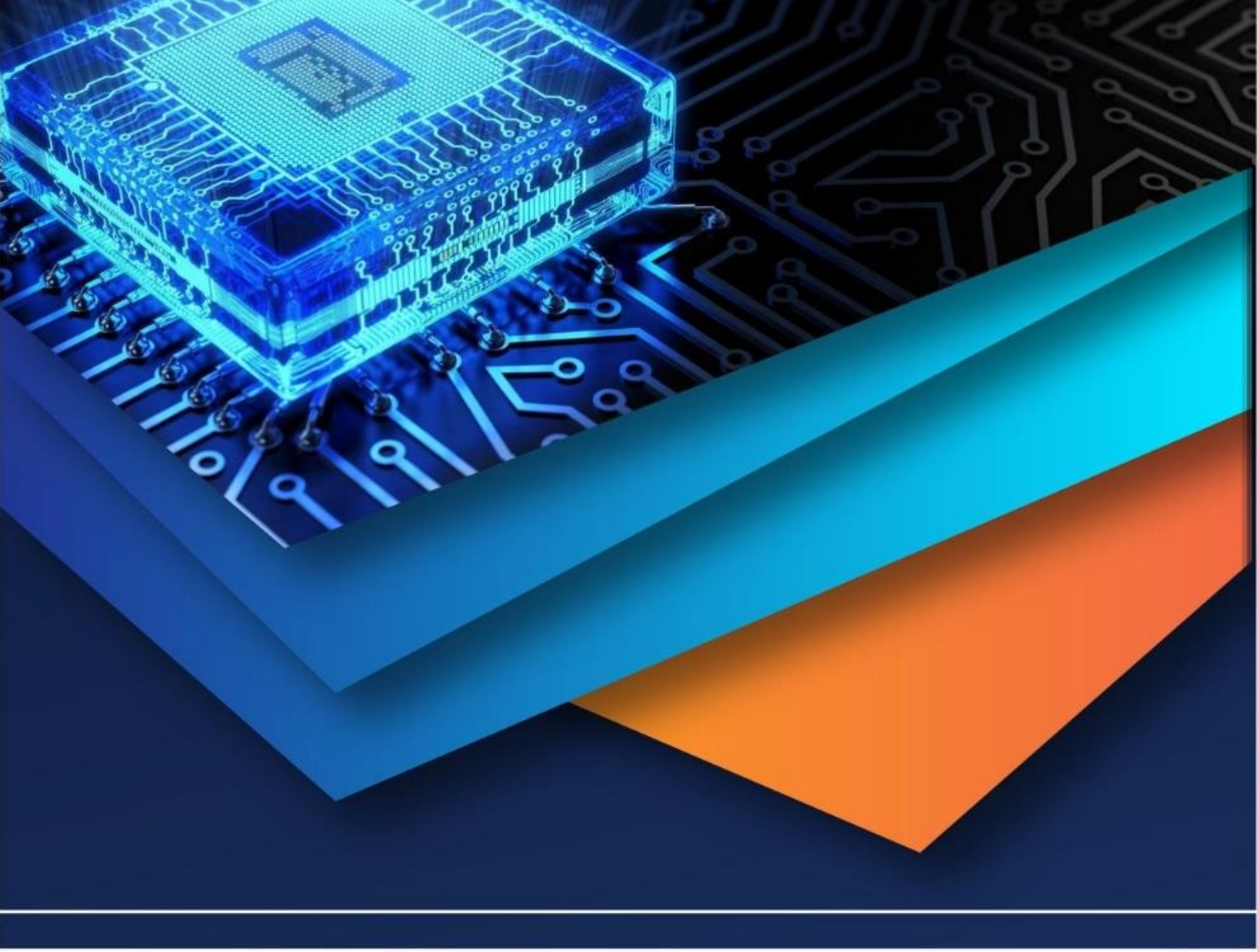
[18] McCordJ.M.(2000).Theevolutionoffreeradicalsandoxidativestress.TheAmericanjournalofmedicine,108(8),652–659.https://doi.org/10.1016/s0002 9343(00)00412 -5

[19] Rao,A.L.,Bharani,M.,&Pallavi,V.(2006).Roleofantioxidantsandfreeradicalsinhealthanddisease.AdvPharmacolToxicol,7(1),29-38.

[20] Sen,S.,&Chakraborty,R.(2011).TheRoleofAntioxidantsinHumanHealth. ACSSymposiumSeries,1083,1–37.https://doi.org/10.1021/bk-2011-1083.ch001

[21] Namiki M. (1990).Antioxidants/antimutagens in food.Criticalreviews in food science and nutrition,29(4), 273300.https://doi.org/10.1080/10408399009527528

[22] Ebadi,M.(2001).Antioxidantsandfreeradicalsinhealthanddisease:Anintroductiontoreactiveoxygenspecies,oxidativeinjury,neuronalcelldeathand therapy in neurodegenerative diseases. Crit. Rev. Toxicol, 38, 13-71.
[23] Fuglie,L.J.(1999).Themiracletree:MoringaoleiferaNaturalnutritionforthetropics.ChurchWorldService.Retrievedfromhttp://www.moringatrees.org/TMTmeds.html
[24] MakkarHPSandBeckerK.Nutritionalvalueandantinutritionalcomponentsofwholeandethanolextracted Moringaoleiferaleaves.AnimFeedSciTechnol.1996;63:211-228.
[25] Kasolo,J.N.,Bimenya,G.S.,Ojok,L.,Ochieng,J.,&Ogwal-Okeng,J.(2010).PhytochemicalsandusesofMoringaoleiferaleavesinUgandanruralcommunities.
[26] Mbikay,M.(2012).TherapeuticpotentialofMoringaoleiferaleavesinchronichyperglycemiaanddyslipidemia:areview.FrontiersinPharmacology,3,24.
[27] Berkovich,L.,Earon,G.,Ron,I.,Rimmon,A.,Vexler,A.,&Lev-Ari,S.(2013).MoringaOleiferaaqueousleafextractdown-regulatesnuclearfactor-kappaB and increases cytotoxic effect of chemotherapy in pancreatic cancer cells. BMC complementary and alternative medicine, 13, 1-7.
[28] Pakade,V.,Cukrowska,E.,&Chimuka,L.(2013).Comparisonof antioxidantactivityof Moringa oleiferaandselectedvegetables inSouthAfrica.
[29] SouthAfricanJournalofScience,109(3–4),1–5.https://doi.org/10.1590/sajs.2013/257989740
[30] González-Romero,J.,Arranz-Arranz,S.,Verardo,V.,García-Villanova,B.,&Guerra-Hernández,E.J.(2020).BioactiveCompoundsandAntioxidantCapacity of Moringa Leaves Grown in Spain Versus 28 Leaves Commonly Consumed in Pre-Packaged Salads. Processes,8(10), 1297.https://doi.org/10.3390/pr8101297
[31] Al-Khafaji, N. J., &Al-Hammed, M.K. (2023). Effect of individualand synergistic addition of Moringa oleifera seeds and leaves powder tobroilerdiets on some physiological and microbial traits and oxidation indicators. Research Journal of Biotechnology, 18(11), 45–55.
[32] Perumalsamy,H.,Balusamy,S.R.,Sukweenadhi,J.,Nag,S.,MubarakAli,D.,El-AgamyFarh,M.,Vijay,H.,&Rahimi,S.(2024).Acomprehensivereview on Moringa oleifera nanoparticles: importance of polyphenols in nanoparticle synthesis, nanoparticle efficacy and their applications.Journalof nanobiotechnology, 22(1), 71. https://doi.org/10.1186/s12951-024-02332-8
[33] Muhammad, S.,Ali,A., Shah, J., Hamza, M., Kashif, M.,Ajat Khel, B. K., et al. (2023). UsingMoringa oleifera stem extract for green synthesis,characterization, and anti-inflammatory activity of silver oxide nanoparticles. Natural and Applied Sciences International Journal, 4, 80–97.
[34] Ajibade, T. O., Arowolo, R., &Olayemi, F. O. (2013). Phytochemicalscreeningandtoxicitystudieson themethanolextract of theseedsofMoringaoleifera. Journal of Complementary and Integrative Medicine, 10(1), 11–16. https://doi.org/10.1515/jcim-2012-0003
[35] Peixoto,J.R.O.,Silva,G.C.,Costa,R.A.,Fontenelle,J.L.S.,Vieira,G.H.F.,FontelesFilho,A.A.,&Vieira,R.H.S.F.(2011).Invitroantibacterialeffectofaqueousandethanolic Moringaleafextracts.Asian PacificJournal ofTropical Medicine, 4(3), 201-204.https://doi.org/10.1016/S1995-
[36] 7645(11)60069-2
[37] Kedare, S. B., & Singh, R. P. (2011). Genesis and development of DPPH method of antioxidant assay. Journal of food science and technology,48,412-422.
[38] Benzie, I. F., & Strain, J. J. (1996). The ferric reducing ability of plasma (FRAP) as a measure of "antioxidant power": the FRAP assay. Analyticalbiochemistry, 239(1), 70–76. https://doi.org/10.1006/abio.1996.0292
[39] Zhao,F.,Wang,P.,Lucardi,R.D.,Su,Z.,&Li,S.(2020).NaturalSourcesandBioactivitiesof2,4-Di-Tert ButylphenolandItsA nalogs.Toxins,12(1),35. https://doi.org/10.3390/toxins12010035
[40] Momin, K., &Thomas, S. C. (2020). GC–MS analysis of antioxidant compounds present in different extracts of an endemic plant Dilleniascabrella(Dilleniaceae) leaves and barks. International Journal of Pharmaceutical Sciences and Research, 11(5), 2262-2273.https://doi.org/10.13040/IJPSR.0975-8232.11(5).2262-2273
[41] Miguel M. G. (2010).Antioxidant and anti-inflammatory activities of essential oils: a short review. Molecules (Basel, Switzerland),15(12), 9252–9287.https://doi.org/10.3390/molecules15129252
[42] Al-Snafi,A.E.(2015).Therapeuticpropertiesofmedicinalplants:Areviewoftheirantibacterialactivity(Part1).InternationalJournalofPharmacy& Therapeutics, 6(3),137–158. Thi Qar University.Retrieved fromhttps://www.researchgate.net/publicatio n/313696409_THERAPEUTIC_PROPERTIES_OF_MEDICINAL_PLANTS_A_REVIEW_OF_THEIR_AN TIBACTERIAL_ACTIVITY_PART_1
[43] Olopade,E.O.,Adefegha,S.A.,Alao,J.O.,Adepoju,A.E.,Fakayode,A.E.,&Oboh,G.(2025).Ameliorativeroleofβ-caryophylleneonantioxidantbiomarkers in a paroxetine-induced model of male sexual dysfunction. Basic & Clinical Pharmacology & Toxicology.https://doi.org/10.1111/bcpt.70010
[44] Wani,S.A.,Singh,A.,&Kumar,P.(2022).Spicebioactivecompounds:Properties,applications,andhealthbenefits(1sted.).CRCPress.https://doi.org/10.1201/9781003215387
[45] Parham,S.,Kharazi,A.Z.,Bakhsheshi-Rad,H.R.,Nur,H.,Ismail,A.F.,Sharif,S.,RamaKrishna,S.,&Berto,F.(2020).Antioxidant,AntimicrobialandAntiviral Properties of Herbal Materials. Antioxidants (Basel, Switzerland), 9(12), 1309. https://doi.org/10.3390/antiox9121309
[46] Escobar,A.,Pérez,M.,Romanelli,G.,&Blustein,G.(2020).Thymolbioactivity:Areviewfocusingonpracticalapplications.PhytotherapyResearch,34(8),1837–1846
[47] Pham-Huy, L. A., He, H., & Pham-Huy, C. (2008). Free radicals, antioxidants in disease and health. International journal of biomedical science:IJBS, 4(2), 89–96.
[48] Anandakumar, P., Kamaraj, S., & Vanitha, M. K. (2021). D-limonene:Amultifunctional compound with potent therapeutic effects.Journal of foodbiochemistry, 45(1), e13566. https://doi.org/10.1111/jfbc.13566
[49] Siddhuraju,P.,&Becker,K.(2003).Antioxidantpropertiesofvarioussolventextractsoftotalphenolicconstituentsfromthreedifferentagroclimaticorigins of drumstick tree (Moringa oleifera Lam.) leaves. Journal of agricultural and food chemistry,51(8), 2144–2155.https://doi.org/10.1021/jf020444+
[50] Anwar,F.,Sajid,L.,Muhammad,A.,&Anwarul,H.G.(2007). Moringaoleifera:Afoodplantwithmultiplemedicinaluses. PhytotherapyResearch,21(1), 17–25. https://doi.org/10.1002/ptr.2023



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