How to Cite:
Siang, C. C., Suryadevara, N., Selvaraj, C., Appalaraju, V. V. S. S., Kumari, U., & Bajaj, S. (2022). Antioxidant and antibacterial response of hydroalcoholic extract of Plumeria alba leaves. *International Journal of Health Sciences*, *6*(S1), 13858–13876. https://doi.org/10.53730/ijhs.v6nS1.8703

Antioxidant and antibacterial response of hydroalcoholic extract of Plumeria alba leaves

Chon Chee Siang
Faculty of Pharmacy, AIMST University, Kedah 08100, Malaysia

Nagaraja Suryadevara
Faculty of Medicine, Bioscience and Nursing MAHSA University, Bandar Saujana Putra, 42610 Jenjarom, Selangor, Malaysia.

Chandrasekaran Selvaraj
Faculty of Medicine, Bioscience and Nursing MAHSA University, Bandar Saujana Putra, 42610 Jenjarom, Selangor, Malaysia.

V. V. S. S. Appalaraju
Faculty of Pharmacy, MAHSA University, Bandar Saujana Putra, 42610 Jenjarom, Selangor, Malaysia.

Usha Kumari
Faculty of Medicine, AIMST University, Kedah 08100, Malaysia

Sakshi Bajaj*
Delhi Institute of Pharmaceutical Science and Research (DIPSAR), Delhi Pharmaceutical Science and Research University (DPSRU), Pushp Vihar, New Delhi 110017, India.
*Corresponding author

***Abstract*---**Plants are the natural treasure of antioxidants and antimicrobial agents. Present study was intended to evaluate the antioxidant and antimicrobial potential of *Plumeria alba* leaves hydroalcoholic extract (PALHE). Study involved the phytochemical screening, antioxidant, and antibacterial activity of PALHE. The PALHE was prepared using 95% ethanol as solvent through maceration method. The antioxidant activity involved determination of total phenolic content (TPC) and total flavonoid content (TFC). DPPH (1,1-Diphenyl2-picryl hydrazyl) radical scavenging assay was used for the determination of antioxidant activity of PALHE. The PALHE was investigated for its antibacterial activity against *S. aureus* and *E. coli* using well diffusion method. Various phytochemical screening tests were carried out and the results revealed the presence of carbohydrates, reducing sugar, mucilage, proteins, steroids, volatile

Manuscript submitted: 18 March 2022, Manuscript revised: 9 April 2022, Accepted for publication: 27 May 2022

oil, tannins, phenolic and flavonoids in the PALHE. Besides, moderate antioxidant activity was also revealed through the result of DPPH assay over the ethanolic leaves extract of the PALHE, where the IC50 was found to be 23.96 mcg/ml. Additionally, the TPC and TFC were found to be 71.04 mg (GAE/g of total phenol in terms of gallic acid equivalent) and 75.60 mg (RE/g of total flavonoid in terms of rutin equivalent) respectively. The PALHE exhibited high inhibition potential against *S. aureus* and *E. coli.* Based on the experimental results present study concludes that PALHE possess the significant antioxidant and antibacterial activity. This study also recommends that antioxidant and antibacterial potential of *Plumeria alba* leaves should be further investigated using different solvent.

Keywords---*Plumeria alba*, total phenolic content, total flavonoid content, gallic acid, antioxidant.

Introduction

The development of microbial resistance and oxidative stress related diseases such as arthritis, diabetes, cancer, atherosclerosis, vascular diseases, metabolic syndromes and osteoporosis are becoming a major worldwide health problem. Plants are effective natural source for traditional medicines and modern medicines[1-5]. Plants are widely used in the treatment of various infectious, cellular and metabolic diseases[6-13]. Today the natural antibaceterial and antioxidant from plant source which is safe, effective and economic to replace the synthetic agents is a priority during disease treatment. Owing to the plants bearing potent biological activities several patents have been made various plant products[14-24]. Evidence suggests formulation of various polymeric, nano and other related products using plants sources[25-36]. Facts suggests that generation of free radicals in the body under some conditions may result in cellular changes and development of various metabolic disorders such as diabetes, obesity and cancer. However, large number of evidence suggest that this can be neutralized using various plants-based antioxidants. Evidence suggests that antioxidants from plants source can effectively scavenge free radicals, thereby protect the cells, delay aging, and prevents several aging related diseases[37,38]. Plants are known to exert their wide variety of medicinal effect through their phytoconstituents that are present in different parts of the plants[39-82]. Therefore, the secondary metabolite of plants as antioxidants and antibacterials are the major targets of researchers. A few studies highlighted various solvents extracts of different parts of *Plumeria alba* (such as flowers, leaves and stems) to possess high antioxidant and antimicrobial potential[83-87]. Literary investigation suggests some leaves extracts of *Plumeria alba* as an antioxidant, but still some hydroalcoholic solvent extracts of *Plumeria alba* are not yet explored for their antioxidant and antibacterial potential. Hence present study was designed to perform the phyto chemical screening and evaluate the antioxidant potential of 95% ethanolic extract of *Plumeria alba* leaves.

Materials and Methods

Materials

The chemicals and solvents for the present study were procured from Merck and Sigma Aldrich. The *Plumeria alba* leaves were collected from the premise of AIMST University, Kedah, Malaysia. The healthy green leaves of *Plumeria alba* were chosen, stripped off, washed (to remove the impurities and dirt), air dried (in sunlight), crushed (into small pieces), homogenized (into powder), and finally stored in the airtight container for further investigations.

Preparation of *Plumeria alba* leves extract (PALHE)

Preparation of PALHE was based on the protocol of the standard research with minor modifications[83-93]. Briefly, the 100 g of *Plumeria alba* leaves powder was macerated with 300 ml of hydroalcoholic solution (ethanol and distilled water in a ratio of 95:05) in a conical flask using Bench Top Obital shaker at a speed of 81 cm/s for one week at room temperature. Next the mixture was filtered Whatman filter paper, and the filtrate was evaporated using rotavapor to yield the dark-brown colored PALHE.

Phytochemical screening of PALHE

The prepared PALHE was subjected to phytochemical screening as per the experimental protocol mentioned in the standard literature with slight modification[91-93].

Estimation of Total Phenolic Content (TPC) of PALHE

The PALHE was subjected to TPC determination using Folin–Ciocalteu method, using standard experimental protocol with slight modification[88-93]. Briefly, 1 mL of gallic acid (10–100 µg/mL) solution was mixed with 1 mL of 10% (w/v) Folin–Ciocalteu reagent. After 5 min, 2.0 mL of Na_2CO_3 (2.5%) was subsequently added to the mixture and incubated at room temperature for 2 hours. Similarly, PALHE solution was prepared. Next, the absorbance for standard and PALHE was measured using UV Spectrophotometer (Shimazu, UV-1800) at 750 nm. The resultant experimental data was expressed as mg/g of gallic acid equivalent in mg per gram (mg GAE/g) of dry extract.

Estimation of Total Flavonoid Content (TFC) of PALHE

The PALHE was subjected to TFC determination uisng standard protocol with slight modification[91-93.] Briefly, 1 mL of rutin solution (10–100 µg/mL) was mixed with 0.1 ml of 10 % aluminium chloride, 0.1 ml of 1 M potassium acetate solution and 2.8 ml of distilled water. Similarly, PALHE solution was prepared. The standard and PALHE mixtures were incubated for 1 hour at room temperature followed by recording of absorbance at 415 nm against blank. The resultant experimental data was expressed as mg/g of rutin equivalent in mg per gram (mg RE/g) of dry extract.

DPPH Radical Scavenging Assay

The PALHE was further subjected to DPPH (1,1-Diphenyl2-picryl hydrazyl) assay following the standard experimental protocol with minor modification[91-93]. The radical scavenging activity of PALHE was done to measure its antioxidant potential using DPPH method. Briefly, 2.5 mL of extract solution (10–100 µg/mL) in ethanol was added to 1 ml of 0.3 mM of alcoholic solution of DPPH. Similarly, standard solution of ascorbic acid was prepared. The mixtures were kept aside in a dark for 30 minutes and absorbance was recorded 518 nm. The percentage of DPPH• scavenging was estimated using following expression:

$$\% \text{ scavenging of DPPH•} = [(A_0 - A_1)/A_0] \times 100 \quad \ldots.(1)$$

where A_0 = absorbance of the control and A_1 = absorbance of the test extracts.

Preliminary Screening for Antibacterial activity

Preparation of bacterial culture

Bacterial strains of *E. coli* were used to evaluate the inhibitory potential of the PALHE. The preparation of bacterial culture was done as per the standard protocol given in the literature[94-103]. The prepared stock culture of *E. coli* was maintained at 4°C. Subcultures were prepared by transferring loopful of microorganism colonies from stock culture into the nutrient broth and incubated for 24 hours at 37℃ in the incubator. The broth turbidity indicated the microbial growth.

Well Diffusion Method

The inhibitory potential of PALHE against *E. coli* was based on well diffusion method using standard protocol with slight modification[103]. Briefly, 20 µl of nutrient broth containing broth organism was poured into Muller Hinton agar plate. Three wells were made on the agar medium with cork borer, in one of the well 1 mg/ml of PALHE was added, whereas in other two standard (ciprofloxacin 1 µg/ml) and blank were added. The plate was incubated for 24 hours at 37°C. The diameter of zone of inhibition around wells was measured in milliliters (mm) in triplicate and average values were calculated.

Results and Discussion

Phytochemical Screening

The observations and results of phytochemical screening of PALHE are presented in the table 1. The results of phytochemical screening of PALHE, revealed the presence of various primary and secondary metabolites. In summary, the PALHE is present with carbohydrates, mucilage, fats and oils, volatile oils, anthraquinone glycosides, flavonoids, alkaloids, tannins and phenolic compounds. The flavonoids and phenolic compounds are vital for the antioxidant activity. However, alkaloids are important in antimicrobial activity. Besides that, flavonoids and phenolic

compounds exhibits anti-inflammatory and anti-cancer activities. Study reports that *Plumeria alba* possess many other medicinal properties[83-87].

Table 1: Summary of Phytochemical Screening Test

Phytochemical test	PALHE
Carbohydrates	+
Gums	-
Mucilage	+
Proteins	+
Amino Acids	+
Fats and Oils	+
Steroids	+
Volatile Oils	+
Cardiac Glycosides	-
Anthraquinone Glycosides	+
Saponin Glycosides	-
Cyanogenetic Glycosides	-
Coumarin Glycosides	-
Flavonoids	+
Alkaloids	+
Tannins and Phenolic Compounds	+

Where, (+) positive represent presence, and (-) negative represent absence

Total Phenolic Content

It has been documented that phenolic compound are important in antioxidants and also highly distributed in various plant species[83-93]. The Folin-Ciocalteu (F-C) method was used for determination of the total phenolic content of the Plumeria alba leaves extract which gallic acid was used as standard. A calibration curve was constructed by using the absorbance values obtained at various concentration of gallic acid. The F-C method showed a blue colour complex which resulted from the transfer of electrons in alkaline medium from phenolic compounds to phosphomolybedic phosphotungstic acid complexes. The table 2, showed the contents of total phenols which were determined by using FollinCiocalteu reagent in term of gallic acid equivalent (standard curve equation: $y = 0.0098x + 0.0168$, $R2 = 0.9993$). The concentration used to determine the total phenolic content was 10.0 mcg/ml. UV spectrophotometer was used to detect the absorbance at 750nm. From the gallic acid standard curve produced, gallic acid equivalent of Plumeria alba was calculated to be 71.04 mg GAE/g

Table 2: UV-absorbance value for gallic acid

No.	Concentration (µg/ml)	Absorbance of standard at 750nm			
		First Trial	Second Trial	Third Trial	Mean
1	10	0.128	0.133	0.123	0.128 ± 0.005
2	20	0.195	0.222	0.190	0.202 ± 0.017

3	40	0.480	0.307	0.410	0.399 ± 0.087
4	60	0.621	0.621	0.583	0.608 ± 0.022
5	80	0.823	0.809	0.817	0.802 ± 0.007
6	100	0.998	1.062	0.928	0.996 ± 0.067

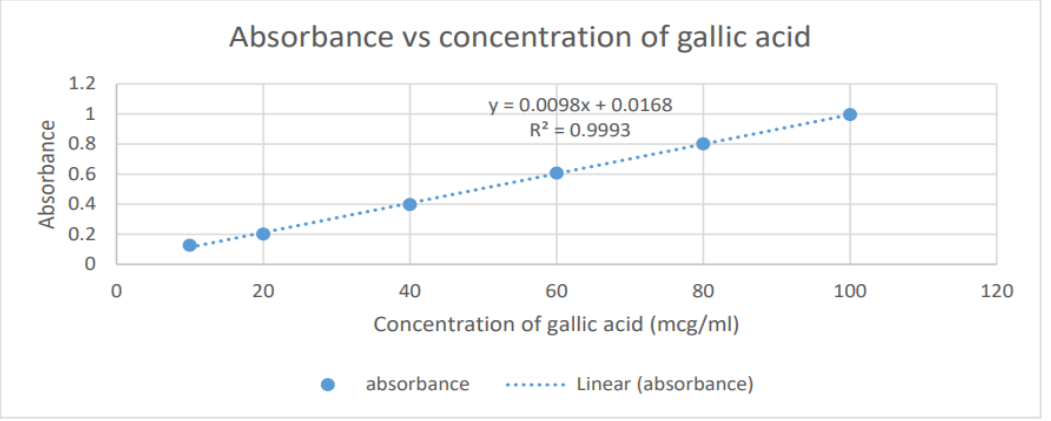

Figure 1: Standard curve of Gallic acid for total phenolic content

Table 3: UV-absorbance value for PALHE

No.	Concentration (mcg/ml)	Absorbance of sample at 750nm				Equivalent gallic acid (mg GAE/g)
		First Trial	Second Trial	Third Trial	Mean	
1	10	0.749	0.763	0.626	0.713 ± 0.075	71.04

Total Flavonoid Content

Total flavonoid content assay is a method which is used to determine the flavonoid content in extracts. The flavonoids are polyphenolic compounds which are water soluble and widely distributed in plant as their glycoside. It is also documented that flavonoids show antioxidant activity and have significant effect on human nutrition and health[83-93]. Scavenging and chelating are the process of the mechanism of action of the flavonoids. From the result obtained from the table, it was clearly showed that the increases in concentration of rutin will result in increases of the absorbance. By using the graph which constructed from the absorbance values of rutin at various concentration, the flavonoid contents of the extracts in terms of rutin equivalent (the standard curve equation: y = 0.0037x + 0.0402, R 2 = 0.9931) was calculated to be 75.60mg GAE/g. However, that the solvent used for the extraction may affect the result of the total flavonoids detected in the plant. It was found out that there the total flavonoids content detected was higher in methanolic extract rather than No. Concentration (mcg/ml) Absorbance of sample at 415nm Value Mean ± SD Equivalent rutin (mg RE/g) 1 10 0.381 0.275 0.304 0.320 ± 0.055 75.60 64 ethanolic as methanol greater cell wall penetration than ethanol (Hafizul Rahman et al 2014). Besides, a study by Dawood et al based on the literature review has shown that the flower

part of the plant has higher total flavonoid content compared to leaves part. As a result, it can be said that the total flavonoids content may differ significantly among different parts of the plant.

Table 4: UV-Absorbance value for Rutin

No.	Concentration (µg/ml)	Absorbance of standard at 415nm			
		First Trial	Second Trial	Third Trial	Mean
1	10	0.082	0.089	0.085	0.085 ± 0.004
2	20	0.113	0.125	0.118	0.119 ± 0.006
3	40	0.157	0.175	0.168	0.167 ± 0.009
4	60	0.251	0.275	0.267	0.264 ± 0.012
5	80	0.328	0.356	0.346	0.343 ± 0.014
6	100	0.403	0.418	0.412	0.411 ± 0.008

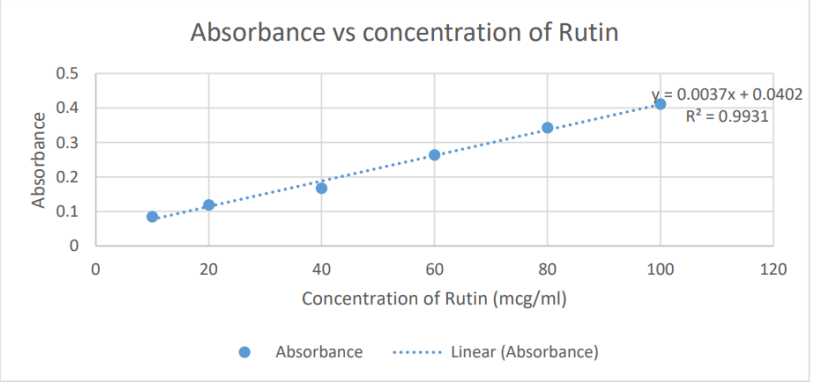

Figure 2: Standard curve of rutin for total flavonoid content

Table 5: UV-absorbance value for PALHE

No.	Concentration (mcg/ml)	Absorbance of sample at 750nm				Equivalent gallic acid (mg GAE/g)
		First Trial	Second Trial	Third Trial	Mean	
1	1	0.381	0.275	0.304	0.320 ± 0.055	75.60

DPPH Scavenging Assay

The DPPH is an organic free radical which is stable. However, at the spectrum of 515-528 nm, DPPH accepts a free radical species or an electron as they lose their absorption spectrum. DPPH assay is the most common and familiar technique for determine and evaluate the antioxidant free radical scavenging activity[104]. This is because it is simple and easy to carry out. Table 6 presents the summary of DPPH scavenging by standard ascorbic acid. The antioxidant activity of the leaves of Plumeria alba ethanolic extract was assessed by % DPPH (1, 1-diphenyl-2picrylhydrazyl) scavenging method. The DPPH antioxidant assay was conducted

according to the procedure described. Ascorbic acid was served as a reference standard for this experiment. The result obtained are given in the following tables and figure. These days, it is important to discover new classes of compound with antioxidant ability to overcome various diseases such as cardiovascular disease, atherosclerosis, lung diseases and cancer as these diseases are resulted by the oxidative damage caused by the free radical to numerous biological substances, including DNA, protein, and lipid membranes. Some synthetic antioxidant such as butylated hydroxyanisole (BHA), butylated hydroxytoluene (BHT), and tertbutylated hydroxyquinone (TBHQ) have been added to foodstuff. However, there are several studies proved that these synthetic antioxidant may possess harm to human body. As a result, it is essential to produce antioxidant which is natural based to overcome such problem and protect human body from reactive oxygen species. DPPH is a stable nitrogen cantered free radical which can be effectively scavenged by antioxidants and shows strong absorbance at 518nm. The change in absorbance of DPPH radicals caused by the extracts was due to the reaction between antioxidant molecules and the extracts, which resulted in the scavenging of the radical by the hydrogen donation. Extend of DPPH radical scavenged determined by the decreases in the intensity of violet colour in the form of IC50. In the present study, it was used to evaluate the radical-scavenging effects of Plumeria alba leaves powder extract. The absorption decreases as antioxidants donate protons to this radical. It was observed that increases in the concentration of the extract will result in higher percentage of antioxidant activity. However, the ethanolic extract of the Plumeria alba leaves has shown lower antioxidant activity as compared to standard used in the assay which is ascorbic acid. The IC50 values observed for standard and extract was 3.89 mcg/ml and 23.96 mcg/ml.

Table 6: DPPH Radical Scavenging Assay value for Ascorbic acid

No.	Concentration (µg/ml)	Percentage of Antioxidant Scavenging Activity			
		First Trial	Second Trial	Third Trial	Mean±SD
1	1	0.6283	0.5375	0.5829	0.5829 ± 0.0454
2	2	0.4614	0.4581	0.4598	0.4597 ± 0.0016
3	4	0.3850	0.2966	0.3408	0.3408 ± 0.0442
4	6	0.0932	0.1188	0.1060	0.1060 ± 0.0128
5	8	0.0133	0.0154	0.0144	0.0144 ± 0.0011
6	10	0.0144	0.0080	0.0097	0.0097 ± 0.0017

Table 7: DPPH Radical Scavenging Assay value for PALHE

No.	Concentration (µg/ml)	Percentage of Antioxidant Scavenging Activity			
		First Trial	Second Trial	Third Trial	Mean
1	1	0.8681	0.8096	0.7633	0.8137 ± 0.053
2	2	0.8047	0.7442	0.7720	0.7736 ± 0.0302
3	4	0.7549	0.7417	0.7590	0.7519 ± 0.0090
4	6	0.7484	0.7048	0.7477	0.7336 ± 0.0250
5	8	0.6804	0.6921	0.7151	0.6959 ± 0.0177
6	10	0.6769	0.6413	0.6899	0.6694 ± 0.0252

Preliminary antibacterial Screening

In present study, the PALHE was evaluated for its antibacterial response using well diffusion method[105]. The results so obtained are given in table 8. A The incidences of bacterial resistance towards conventional antibiotics raises the demand for evaluation of alternative antimicrobials[103]. As per the literature available over different parts of Plumeria alba plant and very less literature was available over antimicrobial potential of Plumeria alba plant leaves. Hence, investigators of present study planned to evaluate the in-vitro inhibition potential of PALHE *S. aureus* and *E. coli* using well diffusion method. The PALHE was prepared using hydroalcoholic solvent. The PALHE was investigated for inhibitory potential (using well diffusion method) and phytochemical screening. The PALHE was investigated for its zone of inhibition against *S. aureus* and *E. coli.* The PALHE showed good inhibitory effect over the growth of *S. aureus* and *E. coli.*

Table 8: Zone of inhibition of PALHE

	Zone of inhibition (in mm)	
	S. aureus	*E. coli*
PALHE	22	20
Ciproflox acin	25	25
Control	--	--

Conclusion

Present study was intended to study the primary and secondary metabolites, total phenolic content, total flavonoid content, antioxidant and antibacterial activity of PALHE. The present study establishes that PALHE possess carbohydrates, mucilage, fats and oils, volatile oils, anthraquinone glycosides, flavonoids, alkaloids, tannins and phenolic compounds. These compounds may allow PALHE with potential antioxidant, antimicrobial, anti-inflammatory and anti-cancer

activity. The total phenolic content and total flavonoid content in the present study support this statement. Present study concludes that hydroalcoholic extract of *Plumeria alba* leaves possess significant antioxidant and antibacterial potential. Present study recommends that in future further isolation and metabolic studies should be performed to establish the antioxidant mechanism and antibacterial potential of PALHE.

Conflict of interest

The authors have no conflicts of interest regarding this investigation**.**

Acknowledgments

We gratefully appreciate AIMST University, Malaysia; MAHSA University, Malaysia; and DPSRU India, for their support for successful completion of this study.

References

1. Priyanka Pandey, & Bhagyashree Despande. Antioxidant Activity in the Leaves and Petals of *Calendula Officinalis* Linn. *Asian Pacific Journal of Health Sciences*, 2022;*9*(2), 130–132.
2. Ting BYS, Fuloria NK, Subramanyan V, Bajaj S, Chinni SV, Reddy LV, Sathasivam KV, Karupiah S, Malviya R, Meenakshi DU, Paliwal N, Priya K, Fuloria S. Biosynthesis and Response of Zinc Oxide Nanoparticles against Periimplantitis Triggering Pathogens. Materials. 2022; 15(9):3170. https://doi.org/10.3390/ma15093170
3. Thayumanavan G, Jeyabalan S, Fuloria S, Sekar M, Ravi M, Selvaraj LK, Bala L, Chidambaram K, Gan SH, Rani NNIM, Begum MY, Subramaniyan V, Sathasivam KV, Meenakshi DU, Fuloria NK. Silibinin and Naringenin against Bisphenol A-Induced Neurotoxicity in Zebrafish Model—Potential Flavonoid Molecules for New Drug Design, Development, and Therapy for Neurological Disorders. Molecules. 2022; 27(8):2572. https://doi.org/10.3390/molecules27082572
4. Al-Daihan S, Aldbass A, Alotebi L, Bhat R. Antioxidant and antimicrobial activity of whole seed extracts of Perseaamericana Mill. IJPBR, 2016;4(04):15-8.
5. Ee JW, Velaga A, Guad RM, Subramaniyan V, Fuloria NK, Choy KW, Fuloria S, Wu YS. Deciphering Synsepalum dulcificum as an arising phytotherapy agent: Background, phytochemical, ad pharmacological properties with associated molecular mechanism. Sains Malaysiana, 2022; 51(1): 199. http://doi.org/10.17576/jsm-2022-5101-16
6. Jha S, Malviya R, Fuloria S, Sundram S, Subramaniyan V, Sekar M, Sharma PK, Chakravarthi S, Wu YS, Mishra N, Meenakshi DU, Bhalla V, Djearamane S, Fuloria NK. Characterization of Microwave-Controlled Polyacrylamide Graft Copolymer of Tamarind Seed Polysaccharide. Polymers. 2022; 14(5):1037. https://doi.org/10.3390/polym14051037
7. Gupta G, Almalki WH, Kazmi I, Fuloria NK, Fuloria S, Subramaniyan V, Sekar M, Singh SK, Chellappan DK, Dua K. Current update on the protective effect of naringin in inflammatory lung diseases. EXCLI J. 2022; 21:573. https://www.excli.de/index.php/excli/article/view/4752

8. Khattulanuar FS, Sekar M, Fuloria S, Gan SH, Rani NNIM, Ravi S, Chidambaram K, Begum MY, Azad AK, Jeyabalan S, Dhiravidamani A, Thangavelu L, Lum PT, Subramaniyan V, Wu YS, Sathasivam KV, Fuloria NK. Tilianin: A Potential Natural Lead Molecule for New Drug Design and Development for the Treatment of Cardiovascular Disorders. Molecules. 2022; 27(3):673. https://doi.org/10.3390/molecules27030673
9. Nasir NN, Sekar M, Fuloria S, Gan SH, Rani NNIM, Ravi S, Begum MY, Chidambaram K, Sathasivam KV, Jeyabalan S, Dhiravidamani A, Thangavelu L, Lum PT, Subramaniyan V, Wu YS, Azad AK, Fuloria NK. Kirenol: A Potential Natural Lead Molecule for a New Drug Design, Development, and Therapy for Inflammation. Molecules. 2022; 27(3):734. https://doi.org/10.3390/molecules27030734
10. Dahiya S, Dahiya R, Fuloria NK, Mourya R, Dahiya S, Fuloria S, Kumar S, Shrivastava J, Saharan R, Chennupati SV, Patel JK. Natural Bridged Bicyclic Peptide Macrobiomolecules from Celosia argentea and Amanita phalloides. Mini Rev Med Chem. 2022. doi: 10.2174/1389557522666220113122117. Epub ahead of print. PMID: 35049431.
11. Mohd Zaid NA, Sekar M, Bonam SR, Gan SH, Lum PT, Begum MY, Mat Rani NNI, Vaijanathappa J, Wu YS, Subramaniyan V, Fuloria NK, Fuloria S. Promising Natural Products in New Drug Design, Development, and Therapy for Skin Disorders: An Overview of Scientific Evidence and Understanding Their Mechanism of Action. Drug Des Devel Ther. 2022;16:23-66 https://doi.org/10.2147/DDDT.S326332
12. Fuloria S, Yusri MAA, Sekar M, Gan SH, Rani NNIM, Lum PT, Ravi S, Subramaniyan V, Azad AK, Jeyabalan S, Wu YS, Meenakshi DU, Sathasivam KV, Fuloria NK. Genistein: A Potential Natural Lead Molecule for New Drug Design and Development for Treating Memory Impairment. Molecules. 2022; 27(1):265. https://doi.org/10.3390/molecules27010265
13. Lum PT, Sekar M, Gan SH, Jeyabalan S, Bonam SR, Rani N, Mahdzir KMK, Seowa LJ, Wu YS, Subramaniyan V, Fuloria NK, Fuloria S. Therapeutic potential of mangiferin against kidney disorders and its mechanism of action: A review. Saudi Journal of Biological Sciences. 2022; 29(3), 1530. https://doi.org/10.1016/j.sjbs.2021.11.016
14. Malviya R, Fuloria NK, Fuloria S, Subramaniyan V, Meenakshi DU, Nandkumar S. Polyacrylamide Grafted Tamarind Seed Gum Formulation and Method for Preparation Thereof. Australia, 2021; 2021100876.
15. Malviya R, Fuloria NK, Fuloria S, Subramaniyan V, Meenakshi DU, Vneteddu VG, Dahiya R, Dahiya S, Narra K, Ganesan P. Nanoparticle formulation and method for preparation thereof. Australia, 2021; 2021101624.
16. Malviya R, Fuloria NK, Fuloria S, Subramaniyan V, MD Unnikrishnan, DT Patel, VV Gangadhar, K Narra, A Sanjana, M Ajay. Carboxy-methylated polymer-based drug nanosuspension formulation and method of preparation thereof. Australia, 2021; 2021102565.
17. Malviya R, Mishra PR, Mishra R, Fuloria NK, Sundaram S, Fuloria S, Subramaniyan V, Meenakshi DU, Bajaj S, Mendiratta A, Islam, M, Tiwari R, Dhamija K. An air-cooling device with smart antimicrobial features. South Africa, 2021; 2021/4650.
18. Malviya R, Sundram S, Awasthi R, Mishra S, Jindal S, Srivastava SP, Raj K, Kumar V, Singh B, Balusam B, Dhanaraj RK, Fuloria NK. Acacia Chundra

Gum Stabilized Highly Faced Nanoparticles for Controlled Drug Delivery. Australia, 2021; 2021103637.
19. Azad AK, Srikumar C, Fuloria NK, Fuloria S, Poovi G, Malviya R, Meenakshi DU, Mendiratta A, Patel TD, Seng WY, Sharma PK, Subramaniyan V, Sundram S, Uddin H, Vanteddu VG, Yadav DZK. Composition of a transdermal film for protiene and peptide-based therapeutic drug delivery in a non-invasive way. Germany, 2021; DE202021105304U1.
20. Malviya R, Sharma PK, Md. AA, Sundra S, Kishore N, Vanteddu VG, Verma S, Fuloria NK, Fuloria S, Verma S, Singh PK, Sharma PK, Awasthi R, Subramaniyan V, Kaur A, Khatoon R. Chronotherapeutic dosage form for the effective treatment of disease. Australia, 2021; 2021107459.
21. Malviya R, Fuloria NK, Fuloria S, Subramaniyan V, Wu YS, Chakravarthi S. Glass separator for nanoparticles. Indian patent, India, 2021; 337830-001.
22. Malviya R, Fuloria NK, Fuloria S, Subramanian V, Meenakshi DU, Sundram S, Kishore N, Dipakbhai TP, Vanteddu VG, Khan SA, Kurra P. Neem (Azadirachita indica) Gum Based in Situ Gelling System for Targeted Delivery of Simvastatin into Stomach. Australia, 2021; 2021103679.
23. Malviya R, Fuloria NK, Fuloria S, Subramaniyan V, Dahiya R, Chakravarthi S, Karikalan B, Hari KD, Kumarasamy V, Palanisamy SM. An air-cooling device with smart antimicrobial features and its working mechanism. Australia, 2021; 2021103679.
24. Malviya R, Sundram S, Fuloria NK, Fuloria S, MP Singh, Subramaniyan V, Tiwari N, Unnikrishnan MD, Srivastava SP, Chauhan V, Mishra S. Method and Process to Develop Herbal Shampoo against Pediculus Humanus Capitis De Geer (Head Louse). Australia, 2021; 2021104305.
25. Akhlaq M, Azad AK, Fuloria S, Meenakshi DU, Raza S, Safdar M, Nawaz A, Subramaniyan V, Sekar M, Sathasivam KV, Wu YS, Miret MM, Fuloria NK. Fabrication of Tizanidine Loaded Patches Using Flaxseed Oil and Coriander Oil as a Penetration Enhancer for Transdermal Delivery. Polymers. 2021; 13(23):4217. https://doi.org/10.3390/polym13234217
26. Yap KM, Sekar M, Fuloria S, Wu YS, Gan SH, Rani NNIM, Subramaniyan V, Kokare C, Lum PT, Begum MY, Mani S, Meenakshi DU, Sathasivam K, Fuloria NK. Drug Delivery of Natural Products Through Nanocarriers for Effective Breast Cancer Therapy: A Comprehensive Review of Literature. International Journal of Nanomedicine. 2021; 16:7891. https://doi.org/10.2147/IJN.S328135
27. Khan TA, Azad AK, Fuloria S, Nawaz A, Subramaniyan V, Akhlaq M, Safdar M, Sathasivam KV, Sekar M, Porwal O, Meenakshi DU, Malviya R, Miret MM, Mendiratta A, Fuloria NK. Chitosan-Coated 5-Fluorouracil Incorporated Emulsions as Transdermal Drug Delivery Matrices. Polymers. 2021; 13(19):3345. https://doi.org/10.3390/polym13193345
28. Malviya R, Sundram S, Fuloria S, Subramaniyan V, Sathasivam KV, Azad AK, Sekar M, Kumar DH, Chakravarthi S, Porwal O, Meenakshi DU, Fuloria NK. Evaluation and Characterization of Tamarind Gum Polysaccharide: The Biopolymer. Polymers. 2021; 13(18):3023. https://doi.org/10.3390/polym13183023
29. Malviya R, Tyagi A, Fuloria S, Subramaniyan V, Sathasivam K, Sundram S, Karupiah S, Chakravarthi S, Meenakshi DU, Gupta N, Sekar M, Sudhakar K, Fuloria NK. Fabrication and Characterization of Chitosan—Tamarind Seed

Polysaccharide Composite Film for Transdermal Delivery of Protein/Peptide. Polymers. 2021; 13(9):1531. https://doi.org/10.3390/polym13091531
30. Sharma VK, Sharma PP, Mazumder B, Bhatnagar A, Subramaniyan V, Fuloria S, Fuloria NK. Mucoadhesive microspheres of glutaraldehyde crosslinked mucilage of Isabgol husk for sustained release of gliclazide. Journal of Biomaterial Science: Polymer Edition. 2021; 1420. https://doi.org/10.1080/09205063.2021.1925389
31. Malviya R, Raj S, Fuloria S, Subramaniyan V, Sathasivam K, Kumari U, Unnikrishnan Meenakshi D, Porwal O, Hari Kumar D, Singh A, Chakravarthi S, Kumar Fuloria NK. Evaluation of Antitumor Efficacy of Chitosan-Tamarind Gum Polysaccharide Polyelectrolyte Complex Stabilized Nanoparticles of Simvastatin. International Journal of Nanomedicine. 2021; 16: 2533. https://doi.org/10.2147/IJN.S300991
32. Malviya R, Jha S, Fuloria NK, Subramaniyan V, Chakravarthi S, Sathasivam K, Kumari U, Meenakshi DU, Porwal O, Sharma A, Kumar DH, Fuloria S. Determination of Temperature-Dependent Coefficients of Viscosity and Surface Tension of Tamarind Seeds (Tamarindus indica L.) Polymer. Polymers. 2021; 13(4):610. https://doi.org/10.3390/polym13040610
33. Chinni SV, Gopinath SCB, Anbu P, Fuloria NK, Fuloria S, Mariappan P, Krusnamurthy K, Veeranjaneya Reddy L, Ramachawolran G, Sreeramanan S, Samuggam S. Characterization and Antibacterial Response of Silver Nanoparticles Biosynthesized Using an Ethanolic Extract of Coccinia indica Leaves. Crystals. 2021; 11(2):97. https://doi.org/10.3390/cryst11020097
34. Fuloria NK, Ko MY, Rui CS, Hang CZ, Karupiah S, Paliwal N, Kumari U, Gupta K, Sathasivam K, Fuloria S. Green synthesis and evaluation of dimocarpus longan leaves extract based chitosan nanoparticles against periodontitis triggering bacteria. Asian Journal of Chemistry. 2020; 32(7): 1660. https://doi.org/10.14233/ajchem.2020.22649
35. Fuloria NK, Fuloria S, Chia KY, Karupiah S, Sathasivam K. Response of green synthesized drug blended silver nanoparticles against periodontal disease triggering pathogenic microbiota. Journal of Applied Biology & Biotechnology. 2019; 7(4): 46. https://doi.org/10.7324/JABB.2019.70408
36. Hang CZ, Fuloria NK, Hong OJ, Kim CB, Ting BYS, Ru CS, Ko MY, Fuloria S. Biosynthesis of DLLAE blended silver nanoparticles and their response against periodontitis triggering bacteria. International Journal of Research in Pharmaceutical Sciences. 2020; 11(2): 1849.
37. Fuloria S, Subramaniyan V, Karupiah S, Kumari U, Sathasivam K, Meenakshi DU, Wu YS, Sekar M, Chitranshi N, Malviya R, Sudhakar K, Bajaj S, Fuloria NK. Comprehensive Review of Methodology to Detect Reactive Oxygen Species (ROS) in Mammalian Species and Establish Its Relationship with Antioxidants and Cancer. Antioxidants. 2021; 10(1):128. https://doi.org/10.3390/antiox10010128
38. Fuloria S, Subramaniyan V, Karupiah S, Kumari U, Sathasivam K, Meenakshi DU, Wu YS, Guad RM, Udupa K, Fuloria NK. A Comprehensive Review on Source, Types, Effects, Nanotechnology, Detection, and Therapeutic Management of Reactive Carbonyl Species Associated with Various Chronic Diseases. Antioxidants. 2020; 9(11):1075. https://doi.org/10.3390/antiox9111075
39. Bajaj S, Fuloria S, Subramaniyan V, Meenakshi DU, Wakode S, Kaur A, Bansal H, Manchanda S, Kumar S, Fuloria NK. Chemical Characterization

and Anti-Inflammatory Activity of Phytoconstituents from Swertia alata. Plants. 2021; 10(6):1109. https://doi.org/10.3390/plants10061109
40. Jaju SB, Indurwade NH, Sakarkar DM, Fuloria NK, Ali M. Linoleic acid isolated from Alpinia galangal. Nigerian Journal of Natural Products and Medicine. 2009; 12, 310-31.
41. Gauniya A, Fuloria S, Tripathi P, Fuloria N, Pahwa S, Basu SP. Role of aromatic plants in national economy. Pharmaceutical reviews. 2008; 6(1).
42. Jaju SB, Indurwade NH, Sakarkar DM, Fuloria NK, Ali M, Basu SP. Isolation of β-sitosterol diglucosyl caprate from Alpinia galanga. Pharmacognosy Research. 2010; 2(4): 264.
43. Sharma P, Bajaj S, Fuloria S, Porwal O, Subramaniyan V, Ozdemir M, Meenakshi DU, Kishore N, Fuloria NK. Ethnomedicinal And Pharmacological Uses of Curcuma Caesia. NVEO – Natural Volatiles & Essential Oils. 2021; 8(1), 14902.
44. Ting LJ, Nanthinisri , Fuloria S, Subramaniyan V, Sharma PK, Meenakshi DU, Chinnasamy V ,Palanisamy SM, Fuloria NK. Response Of Various Extracts Of Manilkarazapota (L) Seeds Against Periodontitis Triggering Microbiota. NVEO – Natural Volatiles & Essential Oils. 2021: 8(1): 13047.
45. Zuraini NZA, Sekar M, Wu YS, Gan SH, Bonam SR, Rani NNIM, Begum MY, Lum PT, Subramaniyan V, Fuloria NK, Fuloria S. Promising Nutritional Fruits against Cardiovascular Diseases: An Overview of Experimental Evidence and Understanding Their Mechanisms of Action. Vascular Health and Risk Management. 2021; 17: 739. https://doi.org/10.2147/VHRM.S328096
46. Watroly MN, Sekar M, Fuloria S, Gan SH, Jeyabalan S, Wu YS, Subramaniyan V, Sathasivam K, Ravi S, Rani NNIM, Lum PT, Vaijanathappa J, Meenakshi DU, Mani S, Fuloria NK. Chemistry, Biosynthesis, Physicochemical and Biological Properties of Rubiadin: A Promising Natural Anthraquinone for New Drug Discovery and Development. Drug Design, Development and Therapy. 2021; 15: 4527. https://doi.org/10.2147/DDDT.S338548
47. Sahoo A, Fuloria S, Swain SS, Panda SK, Sekar M, Subramaniyan V, Panda M, Jena AK, Sathasivam KV, Fuloria NK. Potential of Marine Terpenoids against SARS-CoV-2: An In Silico Drug Development Approach. Biomedicines. 2021; 9(11):1505. https://doi.org/10.3390/biomedicines9111505
48. Ze PS, Yu CX, Jo LS, Subramaniyan V, Sharma PK, Meenakshi DU, Chinnasamy V, Palanisamy SM, Kishore N, Rajasekaran S, Adinarayana S, Yadav DK, Parihar L, Kushwaha SP, Muthuramu T, Fuloria S, Fuloria NK. In-vitro antimicrobial activity of Cymbopogon citratus Stem extracts. Journal of Cardiovascular Disease Research. 2021: 12(5): 1121.
49. Yap KM, Sekar M, Seow LJ, Gan SH, Bonam SR, Mat Rani NNI, Lum PT, Subramaniyan V, Wu YS, Fuloria NK, Fuloria S. Mangifera indica (Mango): A Promising Medicinal Plant for Breast Cancer Therapy and Understanding Its Potential Mechanisms of Action. Breast Cancer: Targets and Therapy. 2021; 13:471.
50. Yap KM, Sekar M, Wu YS, Gan SH, Rani NNIM, Seow LL, Subramaniyan V, Fuloria NK, Fuloria S, Lum PT. Hesperidin and its Aglycone Hesperedin in Breast Cancer Therapy: A Review of Recent Developments and Future

Prospects. Saudi Journal of Biological Sciences. 2021; 28: 6730. https://doi.org/10.1016/j.sjbs.2021.07.046
51. Sathasivam KV, Haris MRHM, Fuloria S, Fuloria NK, Malviya R, Subramaniyan V. Chemical Modification of Banana Trunk Fibers for the Production of Green Composites. Polymers. 2021; 13(12):1943. https://doi.org/10.3390/polym13121943
52. Sharma PK, Fuloria S, Ali M, Singh A, Kushwaha SP, Sharma VK, Subramanyan V, Fuloria NK. Isolation of new phytometabolites from Alpinia galanga Wild rhizomes. Pakistan Journal of Pharmaceutical Sciences, 2021; 34(4): 1397. https://doi.org/10.36721/PJPS.2021.34.4.REG.1397-1401.1
53. Sharma PK, Fuloria S, Alam S, Sri MV, Singh A, Sharma VK, Kumar N, Subramaniyan V, Fuloria NK. Chemical composition and antimicrobial activity of oleoresin of Capsicum annuum fruits. Mindanao Journal of Science and Technology. 2021; 19(1), 29. https://mjst.ustp.edu.ph/index.php/mjst/article/view/789
54. Dahiya R, Dahiya S, Shrivastava J, Fuloria NK, Gautam H, Mourya R, Fuloria S. Natural cyclic polypeptides as vital phytochemical constituents from seeds of selected medicinal plants. Archiv der Pharmazie, 2021; 354:2. https://doi.org/10.1002/ardp.202000446
55. Velu V, Swagata B, Radhakrishnan V, Gupta G, Chellapan DK, Fuloria NK, Fuloria S, Mehta M, Dua K, Malipeddi H. Identification of phytoconstituents of Tragia involucrata leaf extracts and evaluate their correlation with anti-inflammatory & antioxidant properties. Anti-Inflammatory & Anti-Allergy Agents in Medicinal Chemistry. 2021 ;20,. https://doi.org/10.2174/1871523020666210126144506
56. Fuloria NK, Fuloria S, Sharma VK, Ali M, Singh A, Sharma PK. Isolation of new diterpene from methanolic extract of Capsicum annuum Linn. Fruits. Pharmacognosy Magazine. 2020; 16: 72. https://doi.org/10.4103/pm.pm_250_20
57. Kayarohanam S, Subramaniyan V, Janakiraman AK, Kumar SM. Antioxidant, antidiabetic, and antihyperlipidemic activities of dolichandrone atrovirens in albino Wistar rats. Research Journal of Pharmacy and Technology. Research J. Pharm. and Tech. 2019; 12(7): 3511-3516.
58. Subramaniyan V, Jegasothy R. Update on ethanol induced oxidative stress in liver toxicity and the effects of pregnancy. Indian Journal of Public Health. 2019; 10(8):1800- 1804.
59. Chinnasamy V, Subramaniyan V, Chandiran S, Kayarohanam S, Kanniyan DC, Velaga VS, Muhammad S. Antiarthritic Activity of Achyranthes Aspera on Formaldehyde-Induced Arthritis in Rats.2 019; 7(17):2709-2714.
60. Subramaniyan V, Kayarohanam S, Kumarasamy V. Impact of herbal drugs and its clinical application. Impact of herbal drugs and its clinical application. Int. J. Res. Pharm. Sci. 2019; 10 (2): 1340-1345.
61. Vetriselvan S, Summaiya S, Anupam B, Gobinath M, Sarath C. Potential action of Rumex vesicarius [L.] against potassium dichromate and gentamicin induced nephrotoxicity in experimental rats. Pakistan Journal of Pharmaceutical Sciences 2018.31(2): 509-516.
62. Subramaniyan V, Velmurugan P. Anti-arthritic activity of aqueous extract of Achyranthes aspera. Asian Journal of Pharmaceutical and Clinical Research. 2017; 10(10):372-375.

63. Venkateshan S, Subramaniyan V, Cinnasamy V, Chndiran S. Antioxidant and Antihyperlipidemic activity of Hemidesmus indicus in rats fed with high fat diet. Avicenna Journal of Phytomedicine. 2016; 6(5):516-525.
64. Vetriselvan S, Anil Middha: Potential action of Andrographis paniculata against Chronic Ethanol Consumption Induced Liver Toxicity in Experimental Rats. European Journal of Medicinal Plants. 2016; 12(2): 1-9.
65. Vetriselvan S, Subasini U, Velmurugan C, Muthuramu T, Shankar Jothi, Revathy: Anti- inflammatory activity of Cucumis sativus seed in carrageenan and xylene induced edema model using albino wistar rats. International Journal of Biopharmaceutics. 2013; 4(1): 34- 37.
66. Vetriselvan S, Eugine Felix A, Magendran R, PrabakaranT, Shankar Jothi, Revathi Davan: "The Phytochemical Screening And the Anti-Ulcer Activity of Methanolic Extract of Ixora coccinea Linn Leaf. Journal of Pharmacy Research. 2012; 5(6):3074-3077.
67. Vetriselvan S, Rusliza Basir, Subasini U, Velmurugan C: "Woung Healing activity of ethanolic polyherbal extract in wistar rats" International Journal of Research in Pharmaceutical and Nano Sciences. 2012; 1(1):19-26. 2693-2700.
68. Vetriselvan S, Subasini U, Rajamanickam C, Thirumurugu S. Hepatoprotective activity of Andrographis paniculata in ethanol induced hepatotoxicity in albino wistar rats. International Journal of Comprehensive Pharmacy. 2011; 1: 1-4.
69. Subasini U, Thenmozhi S, Sathyamurthy D, Vetriselvan S, Victor Rajamanickam G, Dubey GP. Pharmacognostic and phytochemical investigations of Dioscorea bulbifera L. Int.J. of Pharm. & Life Sci. 2013; 4(5): 2693.
70. Gayathiri S, Vetriselvan S, Shankar Jothi IS, Hemah Devi SK, Yaashini A. Hepatoprotective activity of aqueous extract of Hippophae rhamnoides L. in carbon tetrachloride induced hepatotoxicity in albino wistar rats. International Journal of Biological and Pharmaceutical Research. 2012; 3(4): 531-537.
71. Jothi S, Vetriselvan S, Gayathiri S, Ishwin S, Shereenjeet G, Devi CH, Yaashini A. Comparative evaluation of antiinflammatory activity of extract of Curcuma longa and standard drug in carrageenan induced paw edema model using albino Wister rats. International Journal of Biological and Pharmaceutical Research. 2012; 3(4): 538-544.
72. Singh I, Vetriselvan S, Shankar J, Gayathiri S, Hemah C, Shereenjeet G, Yaashini A. Hepatoprotective activity of aqueous extract of curcuma longa in ethanol induced hepatotoxicity in albino wistar rats. International Journal of Phytopharmacology. 2012; 3(3): 1-8.
73. Kaur S, Vetriselvan S, Hemah C, Gayathiri S, Yaashini A, Singh I, Shankar J. Hepatoprotective activity of aqueous extract of Picrorhiza kurroa in carbon tetrachloride (ccl4) induced hepatotoxicity in albino wistar rats. International Journal of Pharmacy and Therapeutics. 2012; 3(2): 207- 214.
74. Annamalai Y, Jothi S, Singh I, Kaur S, Devi H, Vetriselvan S. Hepatoprotective activity of Bacopa monnieri extract in Ethanol induced Hepatotoxicity in Albino Rats" International Journal of Pharmacy and Therapeutics. 2012; 3 (3): 259-266.
75. HemahDevi SJ. Wound healing activity of terminaliaarjunain albino wistar rats. International Journal of Phytopharmacology. 2012; 3(3): 234-240.

76. Fuloria S, Fuloria NK, Hong OJ, Kim CB, Ting BYS, Karupiah S, Paliwal N, Kumari U, Sathasivam K. Synthesis of SNPs of corn silk agrowaste and their bioactivities. Asian Journal of Chemistry. 2020; 32(6): 1497. https://doi.org/10.14233/ajchem.2020.22625
77. Bajaj S, Wakode S, Kaur A, Fuloria S, Fuloria NK. Anti-inflammatory & ulcerogenic activity of newer phytoisolates of S. alata C.B. Clarke. Natural Product Research, 2020. https://doi.org/10.1080/14786419.2020.1775224
78. Velu V, Fuloria N, Fuloria S and Malipeddi H. In Vitro and In Vivo Anti-Urolithiatic Activity of Terpenoid-Rich Ethyl Acetate Extract of Rhizomes of Curcuma Zedoaria. Studies on Ethno medicine. 2018;12(1,2): 31.
79. Vakiloddin S, Fuloria N, Fuloria S, Dhanaraj SA, Balaji K and Karupiah S. Evidences of hepatoprotective and antioxidant effect of Citrullus colocynthis fruits in paracetamol induced hepatotoxicity. Pakistan Journal of Pharmaceutical sciences; 2015; 28(3): 951.
80. Khan H, Rauf A, Fuloria S, Fuloria NK. Inhibition on Urease and Thermal Induced Protein Denaturation of commonly used Antiulcer Herbal Products. Study based on in-vitro assays. Pharmacognosy Journal. 2015; 7(3): 147. https://doi.org/10.5530/pj.2015.3.1
81. Jaju SB, Indurwade NH, Sakarkar DM, Ali M, Fuloria N. Antidiabetic & antiinflammatory studies of Alpinia galangal rhizome. Asian Journal of Chemistry. 2011; 23(3): 1230.
82. Jaju S, Pahwa S, Sangita K, Fuloria N. Pharmacognostical Studies & antibacterial activity of leaves of Murraya Koenigii", Pharmacognosy Journal. 2009; 1(3): 211.
83. Radha R, Kavimani S, Ravichandran V. Antitumour activity of methanolic extract of *Plumeria alba* L. leaves against Dalton lymphoma ascites in mice. International Journalof Health Research. 2008;1(2):79-85.
84. Choudhary M, Kumar V, Gupta P, Singh S. Investigation of antiarthritic potential of *Plumeria alba* L. leaves in acute and chronic models of arthritis. BioMed research international. 2014 1;2014.
85. Lawal OA, Ogunwande IA, Opoku AR. Constituents of essential oils from the leaf and flower of *Plumeria alba* grown in Nigeria. Natural Product Communications. 2014 ;9(11):1934578X1400901121.
86. Nor MM, Susanti D, Omar MN. Extraction And Phytochemical Screening FromDifferent Parts Of Franggipani (*Plumeria alba*).
87. Porwal O, Nee JLJ, Fuloria S, ozdemir M, Kala D, Answer ET, Fuloria NK. Response Of Hydroalcoholic Extract Of Plumeria alba Leaves Against Periodontal Disease Triggering Microbiota. NVEO – Natural Volatiles & Essential Oils. 2021: 8(1): 13047.
88. S Vetriselvan, J.Shankar, S.Gayathiri, S.Ishwin, C.Hemah Devi, A.Yaashini, G.Sheerenjet: Comparative evaluation of in vitro antibacterial and antioxidant activity using standard drug and polyherbal formulation. International Journal of Phytopharmacology. 2012; 3(2): 112-116.
89. S Jaju, AT Patil, NJ Durgakar, NK Fuloria. Phytochemical and antimicrobial activity of stem and leaves of Desmodium gangeticum linn. Hamdard medicus. 2009; 52(4), 131-135.
90. Nor MM, Zuberdi AM, Omar MN. Evaluation Of The Total Phenol Content And Antioxidant Potential Of Plant Extract (*Plumeria alba*).
91. Chattopadhyay A, Dixit B, Nijhawan P, Kamarudheen N, Rao B. Phytochemical screening, in vitro anti quorum sensing activity and

antioxidant activity of extracts of *Plumeria alba*, *Pisonia alba* and *Cynodon dactylon*. Journal of Applied PharmaceuticalScience. 2017 ;7(02):162-6.
92. Rahman H, Reddy VB, Ghosh S, Mistry SK, Pant G, Sibi G. Antioxidant, cytotoxic and hypolipidemic activities of *Plumeria alba* L. and *Plumeria rubra* L. American Journalof Life Sciences. 2014 17;2(6-1):11-5.
93. Balaji K, Ni LH, Rajindran B, Sikarwar MS, Fuloria NK, and Fuloria S. Determination of Total Phenolic, Flavonoid Content and Antioxidant Activity of Terminalia Chebula (Fruit). Research Journal of Pharmaceutical, Biological and Chemical Sciences. 2015; 6(2): 413.
94. Fuloria S, Fuloria NK, Sundram KM, Sathasivam K., Singh S, Gupta K, Jain A, Sridevi U, HImaja M, Shanker S. Synthesis & discerning of antibiotic potential of PCMX based novel azetidinones. Acta Poloniae Pharmaceutica: Drug Research. 2017; 76(6): 171.
95. Fuloria NK, Fuloria S, K Sathasivam, S. Karupiah. Synthesis and discerning of antimicrobial potential of novel oxadiazole derivatives of chloroxylenol moiety. Acta Poloniae Pharmaceutica: Drug Research. 2017; 74(6): 1125.
96. Rohane SH, Chauhan AJ, Fuloria NK, Fuloria S. Synthesis and invitro antimycobacterial potential of novel hydrazones of eugenol. Arabian Journal of Chemistry. 2020; 13(2): 4495. https://doi.org/10.1016/j.arabjc.2019.09.004
97. Fuloria NK, Singh V, Yar MS, and Ali M. Synthesis, characterization and antimicrobial evaluation of novel imines and thiazolidinones. Acta Poloniae Pharmaceutica-Drug Research. 2009; 66(2): 141.
98. Gupta R, Fuloria NK, and Fuloria S. Synthesis and antimicrobial profile of some newer 2-amino-thiazole derivatives. Turkish Journal of Pharmaceutical Sciences. 2013; 10(3): 425.
99. Fuloria NK, Singh V, Shaharyar M, Ali M. Synthesis and antimicrobial evaluation of newer oxadiazoles derived from phenylpropiono hydrazides. Molecules. 2009; 14(5): 1898. https://doi.org/10.3390/molecules14051898
100. A Husain, Varshney MM, Percha V, Fuloria NK. Synthesis, characterization and biological evaluations of some 5-(substituted amino alkyl)-2-{(1, 3- benzothiazole-2-yl)}-thiazolidine-4 one Mannich bases as potent antibacterial agent. Journal of Applied Pharmaceutical Science 201; 3(4): 135.
101. Fuloria NK, Singh V, Yar MS, and Ali M. Antimicrobial evaluation of imines and thiazolidinones derived from 3-phenyl propanehydrazide. Acta Poloniae Pharmaceutica-Drug Research. 2009; 66(4): 371.
102. Fuloria NK, Singh V, Yar MS, and Ali M. Synthesis, characterization and biological studies of novel imines and azetidinone derivatives of haloaryloxy moiety. Asian Journal of Chemistry. 2008; 20(6), 4891.
103. Suryasa, I. W., Rodríguez-Gámez, M., & Koldoris, T. (2022). Post-pandemic health and its sustainability: Educational situation. *International Journal of Health Sciences*, *6*(1), i-v. https://doi.org/10.53730/ijhs.v6n1.5949
104. Pahwa S, Fuloria NK, Kumar N, Singh V, Fuloria S. Diversified beauty of Saccharomyces boulardii. Pharmaceutical reviews. 2007, 5(6).
105. Jiea CK, Fuloria S, Subrimanyan V, Sathasivam K, Meenakshi DU, Kumar V, Chakravarthi S, Kumari U, Sekar M, Wu YS, Fuloria NK. Phytochemical screening and antioxidant activity of Cananga odorata extract. Research Journal of Pharmacy and Technology. 2022; 15(3), 1230.

106. Sa'ad MA, Kavitha R, Fuloria S, Fuloria NK, Ravichandran M, Lalitha P. Synthesis, Characterization and Biological Evaluation of Novel Benzamidine Derivatives: Newer Antibiotics for Periodontitis Treatment. Antibiotics. 2022, 11(2):207.