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ORA- Analytical study

Analytical Phytochemical Fingerprinting of *Durva Taila* (Cynodon dactylon (L.) Pers.) Using Gas Chromatography–Mass Spectrometry (GC–MS): Insights into Potential Wound-Healing Bioactive Constituents

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ABSTRACT:

Background: *Durva Taila* is a formulation which is described in classics for the management of wounds, bleeding, and inflammation. It is being used till now for the treatment of various diseases. As per the classics, sesame oil has to be used in the preparation of *Durva* Taila but in the present analytical study coconut oil is used as base because it has *Madhura rasa and sheeta virya* which could have better effects in wound healing. As this formulation lacks a systematic analysis of its chemical composition so by using modern analysis methods, we can provide its true potential in wound care and attain the greater acceptance of this Ayurvedic formulation. **Materials & Methods:** A 100ml sample of *Durva Taila* was prepared, with slight change choosing coconut oil as base instead of Sesame oil, following classical *Ayurvedic* procedures. Under standard protocols, GC-MS analysis was carried out to recognize volatile and semi-volatile phytoconstituents present in the formulation. **Results & Discussion:** The GC-MS analysis revealed a complex mixture of compounds including fatty acid esters, hydrocarbons, aldehydes & phytosterols derivatives. Total 26 key bioactive molecules at different retention time were identified which included 2-Heptanone,2-decenal,(E)-, Glycidyl palmitoleate, Dodecanoic acid (lauric acid), Pentadecanoic acid**,** δ-dodecalactone, 9-Octadecenamide, (Z)-, Pinoresinol, dimethyl ether (also known as (+)-eudesmin), etc. which are well established for their anti-inflammatory, anti-nociceptive/analgesic, anti-microbial, anti-oxidant, tissue repairment and regenerative properties. The presence of these multiple bioactive phytoconstituents suggests a cumulative synergistic mechanism underlying the therapeutic effects of *Durva Taila*. **Conclusion:** The isolation and identification of these bioactive compounds provides strong scientific evidence supporting the use of *Durva Taila* in wound healing and inflammation- analgesia management. This further encourages pharmacological and clinical studies in vivo and human trials to validate its potency and delve into potential integration to modern therapeutics.

KEYWORDS: Analgesic, Anti-inflammatory, Antimicrobial, *Cynodon dactylon* (L.) Pers., Durva Taila, GC–MS, Wound, Wound Healing

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1. INTRODUCTION

Every individual suffers with a *Vrana* (Wound) in their lifespan due to various factors. These wounds not only leave a scar after healing but also put a psychosocial impact on the patient when they tend to go towards chronicity. The chronic or complex wounds make a lot of burden on healthcare system and individuals as they don't heal easily. A systematic review and meta-analysis study found pooled prevalence of wounds to be 2.21 per 1000 global population, where majority of them were leg ulcers with an estimated prevalence of 1.51 per 1000 population. [1] In the early 21st century, the prevalence of wounds in the Indian population was 15.03 per 1000, among which acute & chronic wounds constituted 10.55 and 4.48 per 1000, respectively, where the most common site for both chronic and acute wounds was the lower extremity. [2] In an Indian community-based survey, the overall prevalence of chronic wounds was reported to be 1.89/1000, which is higher in rural areas (2.64/1000) than in urban areas (1.57/1000) in that males were found to be more prone with 68.42% than females 31.58%. [3] This puts a major burden on the Indian Healthcare system. It is predicted that the wound care cost will increase to $2.68 billion in India by the year 2027. [4] As the wound healing involves 4 stages, which starts from stage of hemostasis and progresses to stage of remodeling leading to scar formation by formed collagen tissue. In wound care the good initial care prevents infection, reduces pain, scarring, and accelerates healing, which reduces unnecessary usage of antimicrobial drugs. These chronic or complex wounds contribute heavily to morbidity, health care expenses and reduced QoL. So, to overcome this dreadful burden among the population, *Ayurveda* helps to bridges this issue with a variety of internal as well as external medicines. Now it is essential to emphasize on cross-disciplinary approach and to understand the utility of how these *Ayurvedic* medicines work in view of therapeutic efficacy to streamline them with conventional medicine practice. Wound management as per *Ayurveda* is a super-specialty which has innumerable treatment options like herbo-mineral formulations, local therapies that aids in better healing of various conditions and stages falling under wounds. Among these treatment options, *Durva Taila*, is classical medicated oil which is widely used by *Ayurvedic* clinicians for various types of wound management. [5] *Durva Taila* is a *Taila* (oil) based polyherbal formulation mentioned in *Caraka Samhita* which is indicated in *Vrana* (wound). It comprises *Durva* (*Cynodon dactylon* (L.) Pers.) juice, coconut oil and *Daruharidra* (*Berberis aristata*) bark powder as *Kalka Dravya* (herbal paste).[6] The rationale for using the coconut oil base instead of sesame oil base was that as per the classics as it has *madhura rasa, madhura vipaka and vata-pitta shamaka,*[7] which are attributed to the increase of granulation, [8] whereas sesame oil has predominance of pungent taste, hot potency and *vata-kapha* pacifying properties which is known to have scarifying property due to predominance of pungent taste. [9],[10] As per classical text, Acharya *Charaka mentioned Durva in Varnya Mahakashaya* (drugs used for remodeling of wound & scars), [11] *Acharya Sushruta* recognizes it as hemostatic in internal bleeding disorders, [12] *Kaidev Nighantu* in *Visrapa* (Shingles), *Daha* (inflammation), *Kustha* (skin disorders), *Jwara* (pyrexia), *Trishna* (excessive thirst); [13] *Bhavaprakash in Virsarpa & Vrana.* [14] Based upon these classical insights, *Durva Taila* [6] is valued for external application in *Sadyo vrana* (fresh wound), [15] aiding wound healing, pain relief and helps in maintaining hemostasis. Hence, to understand the therapeutic efficacy of *Durva Taila* in the treatment of wounds, the recognition along with analysis of its chemical composition and active molecules, through GC-MS helps in bridging the role to establish evidence for its wound healing activity, making it stand along the contemporary medicine.

2. MATERIALS AND METHODS

Sources of Raw Material

All the ingredients for the preparation of *Durva Taila* (DT) were procured from GMP certified KLE Ayurveda Pharmacy, Khasbag, Belagavi, Karnataka and DT was prepared in the Department of Shalya Tantra, KAHER's Shri B.M.K. Ayurveda Mahavidyalaya, Belagavi, following the classical method. Table 1 shows the proportions and ingredients used for making DT.

Authentication and Analysis of Drugs

All the raw drugs authentication and analysis were done in regard to the Institutional and National Ethical Guidelines in Central Research Facility (AYUSH approved ASU Drug Testing Laboratory) of KAHER's Shri BMK Ayurveda Mahavidyalaya, Shahapur, Belagavi, Karnataka- 590003. (Under voucher numbers – CRF/Auth/255/26-27, CRF/RM/263/2026-27, CRF/Auth/602/2025-2026, CRF/RM/504/2025-26, CRF/FG/109/2026-27). The specified micro-organisms test, microbial limit test and heavy metal testing of the DT was carried out in quality control GMP certified unit of Arogya Pharmaceuticals manufacturers of ayurvedic medicines, Belagavi, Karnataka.

Preparation of *Durva Taila*

Durva Taila was prepared as per the general method of preparation of *taila* from the classical reference of the authentic text, at GMP certified KLE Ayurveda Pharmacy at Khasbag, Belagavi. Standard operating measures were adopted during the preparation of the formulation of the *taila* as mentioned in table 1.

Table 1: Composition of *Durva Taila*

S.No.	Name of item	Latin Name	Amount
1.	*Durva (Swarasa)*	*Cynodon dactylon*	1 part
2.	*Daruharidra (Twaka Kalka)*	*Berberis aristata*	4 parts
3.	Coconut (Oil)	*Cocus nucifera*	16 parts

Gas chromatography-Mass spectrometry

Procedure: The sample for the conduction of GC-MS was prepared by diluting 1ml of DT with 9ml of Acetone. The prepared DT sample was sent to Amrith Pvt. Lab: Nisargam Pvt. Ltd., Shivamogga, Karnataka, for the GC-MS triplicates analysis. The phytochemical study was carried out at KAHER's Shri B.M.K. Ayurveda Mahavidyalaya, Belagavi.

Instrument: For precise Quantitative & Qualitative analysis a widely used instrument Shimadzu GCMS-QP-2010SE was used due to its high sensitivity, accuracy and reliability.

Carrier gas: Helium

Procedure: 1ml of DT was diluted with 9ml of Acetone, and the mixture was thoroughly inspected and homogenized to ensure uniformity before extraction. As per setting parameters, the injection temperature was set at 280°C for the chromatographic run, and the Column oven temperature was kept at 80^0C. The 1µL of the resultant extract was injected with a 10.0 split ratio, at a linear velocity of 36.1cm/sec, a column flow of 0.96 mL/min & linear velocity flow control mode ran at 61.9kPa of pressure. The overall flow rate was 13.6mL/min. The purge flow rate was maintained at 3.0mL/min. Moreover, the splitter hold, carrier gas saver and high-pressure injection features were kept off. The column temperature was programmed first at temperature of 80^0 C for four minutes. After it was raised to 150^0 C at a rate of 15^0 C/min for the next five minutes. It was raised then to 280^0C at the 15^0 C/min rate, which was maintained for three minutes. The temperature of the ion source was set at 220 °C with an interface temperature of 280 °C & Solvent cut time was 2.80 minutes. With zero thresholds and a detector gain of 1.24 kV + 0.20 kV, detection based on the tuning result was set through detector gain mode. The analysis of the MS started at three minutes and ended at thirty-eight minutes. With an event time of 0.30 sec, the acquisition mode was confronted to scan. With a mass range covered by the 1666 scan speed was 35 to 500 m/z, and the GC-MS system was used as the

sample unit. The components of the spectrum were compared with the spectrum database components stored in the GC-MS NIST (National Institute of Standards and Technology – Mass spectral Database 2008) library.

3. RESULTS

Table 2: Organoleptic Characters of *Durva Taila*

S. no.	Particulars	Results
1.	Form	Taila
2.	Colour	Dark Green
3.	Odour	Slightly Aromatic

Table 3: Physico-Chemical Standards

S. No.	Particulars	Results
1.	Moisture Content	0.277%
2.	Refractive Index at 27.8 ^{0}C	1.453
3.	Specific Gravity at 26 ^{0}C	0.9189
4.	Saponification Value	279.258
5.	Iodine Value	70.696
6.	Acid Value	3.896
7.	Rancidity	Negative

Table 4: (a)Tests for specified Micro-organisms (Qualitative)

S. No.	Bacteria	Limits	Results
1.	*Escherichia coli*	Absent/100ml	Absent
2.	*Staphylococcus aureus*	Absent/100ml	Absent
3.	*Pseudomonas aeruginosa*	Absent/100ml	Absent
4.	*Salmonella abony*	Absent/100ml	Absent
(b) Microbial limit test (Quantitative)			
1.	Total Bacterial Count	30-300 cfu/ml	No growth
2.	Total Fungal Count	10-100 cfu/ml	No growth
*cfu = colony forming units			

Table 5: Tests for Heavy Metals

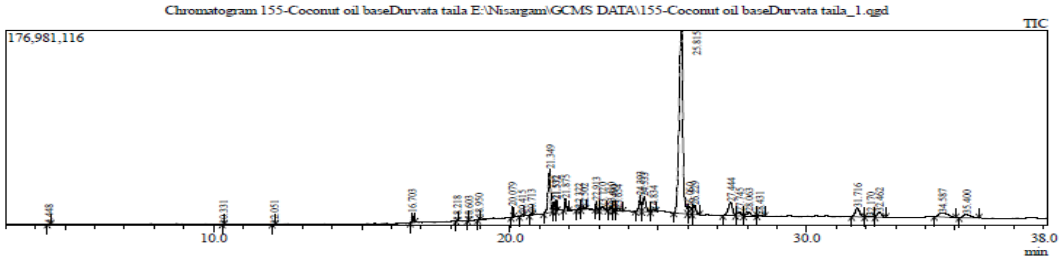
S. No.	Parameter	Results	Permissible limits (API)
1.	Lead (Pb)	Less than 0.1ppm	10ppm
2.	Arsenic (As)	Less than 0.1ppm	3ppm
3.	Cadmium (Cd)	Less than 0.1ppm	0.3ppm
4.	Mercury (Hg)	Less than 0.1ppm	1ppm

*ppm = parts per million

GC-MS Profile of *Durva Taila*

The GC-MS analysis of the medicated *Durva Taila* sample prepared in coconut oil base revealed a complex profile comprising of multiple bioactive fatty acids, glycidyl esters, alcohols & phytochemicals derivatives with 36 major peaks, depicted in Figure 1 representing diverse class of fatty acids esters, hydrocarbons, alcohols and lactones which contribute to the therapeutic effect, anti-inflammatory & wound healing potential of the formulation. Based on area % covered by the components of the triplicates of the sample-Taila (1,2& 3), Mean value, Standard deviation and RSD%, were calculated. The highest occurring major constituents are- 9-Octadecenoic acid (Z)-oxiranylmethyl ester (55.47%), comprising more than half of the total composition, Glycidyl (Z)-9-Heptadecenoate (8.73%), cis-9-Hexadecenal (4,.58%), cis-13-Docosenoyl chloride (3.42%), Guineensine (3.38%), Glycidyl palmitoleate (Ret. Time- 31.713, 3.03%). The other major constituents, enlisted in Table 6, detected were- Glycidyl palmitate (Ret. time- 18.218, 0.05%; 20.079,0.55%; 21.572,0.66 %; 21.875,1.55%; 22.913,0.54 %; 26.229,2.05% and 32.462,1.70 %), Glycidyl palmitoleate (Ret. Time- 22.502,0.30%; 24.393,2.28%; 27.745,1.18% and 31.716,2.96%), Glycidyl(Z)-9-heptadecenoate (Ret. Time- 21.349,8.31% & 21.532,1.65%), Dodecanoic acid (Ret. Time- 16.703,0.79%), Pentadecanoic

acid (Ret. Time- 18.950,0.21%), .delta.-Dodecalactone (Ret. Time- 18.603,0.03%), 2-Heptanone (Ret. Time- 4.448,0.06%),2-Decenal, (E)- (Ret. Time- 10.331,0.02%), Pinoresinol, dimethyl ether (Ret. Time- 26.060,1.71%), etc. The minor components may be in small quantities but may contribute to synergistic or biological activity. This profile showed a predominance of glycidyl esters (viz, glycidyl palmitate, palmitoleate, heptadecenoate) known for their rejuvenating skin barrier function, reduction in oxidative stress and promotive of collagen deposition. Apart these, presence of Dodecanoic acid (Lauric acid) and pentadecanoic acid adds a bacteriostatic & anti-fungal component. The detection of Pinoresinol derivatives act as antioxidant synergy. The volatile compounds like-delta-Dodecalactone acts as strong antifungal & inhibit bacterial growth reducing biofilm formation, 2-Heptanone acts like local anaesthetic & anti-microbial, 2-Decenal(E)- shows anti-microbial/antibiofilm/ membrane-disrupting activity. The pharmacological properties all of these bioactive compounds are mentioned in Table 7.



Peak Report TIC

Peak#	R.Time	Area	Area%	Height	CAS#	Name
1	4.448	1587250	0.06	529397	110-43-0	2-Heptanone
2	10.331	530495	0.02	220168	3913-81-3	2-Decenal, (E)-
3	12.051	1038010	0.04	314127	3564-95-2	(1Alpha,3beta,4beta)-p-menthane-3,8-diol
4	16.703	21703755	0.79	8416044	143-7-7	Dodecanoic acid
5	18.218	1282199	0.05	749222	7501-44-2	Glycidyl palmitate
6	18.603	871807	0.03	550488	713-95-1	.delta.-Dodecalactone
7	18.950	5798277	0.21	2366664	1002-84-2	Pentadecanoic acid
8	20.079	15078751	0.55	9495181	7501-44-2	Glycidyl palmitate
9	20.415	9341562	0.34	1897294	7225-68-5	Dodecane, 1-cyclopentyl-4-(3-cyclopentylprop
10	20.713	6338608	0.23	1546970	143-28-2	9-Octadecen-1-ol, (Z)-
11	21.349	228770016	8.31	39200803	0-0-0	Glycidyl (Z)-9-Heptadecenoate
12	21.532	45390555	1.65	10264181	0-0-0	Glycidyl (Z)-9-Heptadecenoate
13	21.572	18122818	0.66	10061627	7501-44-2	Glycidyl palmitate
14	21.875	42605664	1.55	10551428	7501-44-2	Glycidyl palmitate
15	22.322	6788182	0.25	1537695	6064-90-0	Heneicosanoic acid, methyl ester
16	22.502	8399086	0.30	1499425	213738-77-3	Glycidyl palmitoleate
17	22.913	14950144	0.54	7670390	7501-44-2	Glycidyl palmitate
18	23.120	18569120	0.67	2760715	0-0-0	4-Trifluoromethylbenzoic acid, hexadecyl este
19	23.410	16181165	0.59	3369599	301-2-0	9-Octadecenamide, (Z)-
20	23.490	5141818	0.19	1591574	2938-55-8	1,5,9-Cyclododecanetriol
21	23.654	17995497	0.65	2363197	0-0-0	1b,5,5,6a-Tetramethyl-octahydro-1-oxa-cyclop
22	24.393	62684916	2.28	14214320	213738-77-3	Glycidyl palmitoleate
23	24.533	93829959	3.41	13769382	7459-29-2	cis-13-Docosenoyl chloride
24	24.834	7078469	0.26	1188058	3015-65-4	N,N-Dimethyltetradecanamide
25	25.815	1527252988	55.45	123316438	5431-33-4	9-Octadecenoic acid (Z)-, oxiranylmethyl ester
26	26.060	46971274	1.71	6411021	29106-36-3	Pinoresinol, dimethyl ether
27	26.229	56358241	2.05	8310267	7501-44-2	Glycidyl palmitate
28	27.444	120722024	4.38	12270368	56219-4-6	cis-9-Hexadecenal
29	27.745	32587304	1.18	3372933	213738-77-3	Glycidyl palmitoleate
30	28.063	35169105	1.28	3925646	0-0-0	Octanoic acid, 4-tridecyl ester
31	28.431	5346727	0.19	678837	56630-51-4	9-Octadecenamide, n-butyl-
32	31.716	81421031	2.96	8008268	213738-77-3	Glycidyl palmitoleate
33	32.170	12869626	0.47	997274	0-0-0	1-Decanoyl-3-dodecanoylglycerol
34	32.462	46683615	1.70	4634269	7501-44-2	Glycidyl palmitate
35	34.587	84568923	3.07	3731810	55038-30-7	Guineensine
36	35.400	54130561	1.97	3035552	70928-49-3	1-Bromo-3-(2-bromoethyl)-nonane
		2754159542	100.00	324820632		

Figure 1: Gas Chromatography- Mass Spectrometry chromatogram of acetone extract of *Durva Taila*.

Table 6: Enlisted Phytocomponents detected in the acetone-extracted *Durva Taila* using GC-MS

Peak#	Retention Time	Area	Mean Area%	Std. Deviation	RSD%	Height	CAS#	Name
1	4.448	1587250	0.06	-	-	529397	110-43-0	2-Heptanone
2	10.331	530495	0.02	-	-	220168	3913-81-3	2-Decenal, (E)-
3	12.051	1038010	0.04	-	-	314127	3564-95-2	(1Alpha,3beta,4beta)-p-menthane-3,8-diol
4	16.703	21703755	0.80	0.13	16.33	8416044	143-7-7	Dodecanoic acid
	18.218	1282199	0.05	0.00	0.00	749222		

	20.079	15078751	0.66	0.11	15.98	9495181		
	21.572	18122818	0.71	0.06	9.10	10061627		
	21.875	42605664	1.66	0.32	19.53	10551428		
	22.913	14950144	0.65	0.10	15.15	7670390		
5	26.229	56358241	2.16	0.30	13.72	8310267	7501-44-2	Glycidyl palmitate
	32.462	46683615	1.78	0.09	4.80	4634269		
6	18.603	871807	0.04	0.01	20.20	550488	713-95-1	.delta.-Dodecalactone
7	18.950	5798277	0.23	0.02	6.74	2366664	1002-84-2	Pentadecanoic acid
8	20.415	9341562	0.35	0.08	21.57	1897294	7225-68-5	Dodecane, 1-cyclopentyl-4-(3-cyclopentylpropyl)-
9	20.713	6338608	0.24	0.05	19.09	1546970	143-28-2	9-Octadecen-1-ol, (Z)-
10	21.349	228770016	8.73	0.39	4.46	39200803	0-0-0	Glycidyl (Z)-9-Heptadecenoate
	21.532	45390555	1.19	0.40	33.21	10264181		
11	22.322	6788182	0.23	0.09	39.85	1537695	6064-90-0	Heneicosanoic acid, methyl ester
12	22.502	8399086	0.34	0.06	18.45	1499425		
	24.393	62684916	2.16	0.17	8.07	14214320		
	27.745	32587304	0.85	0.28	33.17	3372933	213738-77-3	Glycidyl palmitoleate
	31.716	81421031	3.03	0.23	7.51	8008268		
13	23.120	18569120	0.58	0.08	13.68	2760715	0-0-0	4-Trifluoromethylbenzoic acid, hexadecyl ester
14	23.410	16181165	0.44	0.15	32.71	3369599	301-2-0	9-Octadecenamide, (Z)-
15	23.490	5141818	0.21	0.04	16.44	1591574	2938-55-8	1,5,9-Cyclododecanetriol
16	23.654	17995497	0.49	0.16	31.42	2363197	0-0-0	1b,5,5,6a-Tetramethyl-octahydro-1-oxa-cyclopropa[a]inden-6-one
17	24.533	93829959	3.42	0.38	10.97	13769382	7459-29-2	cis-13-Docosenoyl chloride
18	24.834	7078469	0.33	0.07	21.21	1188058	3015-65-4	N,N-Dimethyltetradecanamide
19	25.815	1527252988	55.47	2.88	5.18	123316438	5431-33-4	9-Octadecenoic acid (Z)-, oxiranylmethyl ester
20	26.060	46971274	1.01	0.61	60.31	6411021	29106-36-3	Pinoresinol, dimethyl ether
21	27.444	120722024	4.58	0.41	9.04	12270368	56219-4-6	cis-9-Hexadecenal
22	28.063	35169105	0.97	0.27	28.07	3925646	0-0-0	Octanoic acid, 4-tridecyl ester
23	28.431	5346727	0.20	0.04	20.48	678837	56630-51-4	9-Octadecenamide, n-butyl-
24	32.170	12869626	0.28	0.18	64.29	997274	0-0-0	1-Decanoyl-3-dodecanoylglycerol
25	34.587	84568923	3.38	0.27	8.05	3731810	55038-30-7	Guineensine
26	35.400	54130561	1.82	0.44	24.25	3035552 324820632	70928-49-3	1-Bromo-3-(2-bromoethyl)-nonane

4. DISCUSSION

Physico-Chemical Parameters:

The extracted *taila* is dark green in colour and slightly aromatic (Table 2), which indicates the proper extraction and preservation of the phytoconstituents during its preparation. As mentioned in Table 3, the very low moisture content (0.277%) suggests minimal risk of hydrolytic degradation and improved shelf stability, since water can interfere with volatile compound detection. The refractive index (1.453 at 27.8 ^{0}C) falls within the range for vegetable oils and fatty acid esters, indicating the presence of unsaturated fatty acids, good purity & homogeneity of the sample. The specific gravity (0.9189 at 26 ^{0}C) confirms the absence of heavy impurities and the typical density of fatty acid-rich extracts. The saponification value (279.258) relatively high value, indicating predominance of low molecular weight fatty acids and high content of fatty esters, which shows the sample is enriched in volatile or semi-volatile components. The iodine value (70.696) indicates moderate unsaturation which implies the presence of mono and possibly polyunsaturated fatty acids and balanced oxidative stability. The acid value (3.896) indicates the presence of free fatty acids due to mild hydrolysis, suggesting the sample is still within acceptable quality limits. The negative rancidity test confirms the absence of oxidative spoilage and stability of the unsaturated component. As mentioned in Table 4(a), all tested pathogens- *E. coli, S. aureus, P. aeruginosa, S. abony* are absent within specified limits indicating high microbial purity, hygienic quality, and safe for pharmaceutical purposes, and supports the integrity of the GC-MS results as microbial contamination can alter chemical composition. As mentioned in Table 4(b), the absence of both bacterial and fungal growth indicates high microbiological purity, resistance to bacterial contamination & absence of yeast & molds, and compliance with standard quality limits, confirming its pharmaceutical utility and cosmetic application. As mentioned in Table 5, all tested toxic heavy metals (Lead, Arsenic, Cadmium, Mercury <0.1ppm) are well within the permissible limits prescribed by API, confirming the safety & purity of the sample as the above normal permissible limit of lead may develop neurotoxicity, organ damage, arsenic may develop carcinogenicity, skin & systemic toxicity, cadmium may develop renal toxicity & bioaccumulation in system and mercury may develop nervous system and renal issues.

***Durva Taila* GC-MS Analysis:**

Durva Taila is a well-known *Ayurvedic* formulation for the management of wounds and conditions related to it, but as we used coconut oil instead of sesame oil, it lacks validation in terms of evidence-based scientific medicinal benefits. This study may pioneer in reporting its hidden potential benefit in wound care and its related conditions. The GC-MS chromatograph (Figure 1) demonstrates a predominance of variety of various bioactive compounds and minor peaks corresponding to synthetic and halogenated derivatives representing analytical artifacts. As the comparative study of coconut oil and sesame oil has shown more anti-inflammatory, anti-bacterial, anti-oxidant properties, affecting the healing cascade by releasing various growth factors (platelet-derived growth factor, transforming growth factor-α & β, connective tissue activating protein, connective tissue growth factor, and fibroblast growth factor) in coconut oil.[16] As mentioned in Table 6, A total of 26 compounds were identified, which are known to exhibit various properties (in Table 7), like 2-Heptanone is a Volatile organic compound (VOC), which has antimicrobial; insect repellent properties and show potential for developing a local anesthetic. [17,18] 2-Decenal, (E)- an aldehyde/VOC, shows strong antimicrobial capabilities against *Proteus vulgaris, Enterococcus faecalis, Bacillus subtilis, E. coli & Staphylococcus aureus* and antioxidant scavenging effect on DPPH, antibiofilm, membrane-disrupting activity in-vitro for the protection against biodeterioration caused by fungi as well as against

aflatoxin contamination. It's a moderate skin sensitizer with no evidence of phototoxicity or photo allergenicity. [19,20] Dodecanoic acid also known as Lauric acid is a saturated fatty acid which is known for its translational evidence as it has broad spectrum antimicrobial activity causing membrane lysis by increasing cellular permeability; maintains neural health by maintaining cellular redox balance and mitochondrial health; reduce secondary diabetic complication by inducing inhibition of the aldose reductase enzyme and Dpp-IV and act as potent cellular antioxidant by reducing lipopolysaccharide-induced reactive species (ROS) & proinflammatory cytokines production. It also possesses Anti-TB activity, maintains insulin-glucose homeostasis, and has anti-biofilm activity against various microbes in topical development. [21-23]. Glycidyl palmitate (also known as palmitic acid glycidyl ester), a derivative of Glycidyl Esters (GE), although it lacks evidence-based clinical data due to an intermediate exposure marker glycidol risk but studies showed that GE has good cosmetic emollient properties for collagen formation and wound healing. [24] delta.-Dodecalactone is primarily a flavor compound used in food and perfumes, produced naturally by microbes and plants shows strong antifungal activity against multiple Aspergillus and Penicillin species and act as antimicrobial by eradicating biofilm over wounds, so can be used as a bio-preservative in food, topical products which may aid as wound dressing adjuncts. [25,26] Pentadecanoic acid a derivative of saturated fatty acid is known for its broad activities exhibiting anti-inflammatory activity which showed progressive reduction in wound healing and enhance wound closure/contraction and anticancer activity suggestive of its efficacy on chronic wounds to reduce chances of wound undergoing local or systemic malignant changes. [27-30]. Dodecane, 1-cyclopentyl-4-(3-cyclopentylpropyl)- volatile long chain hydrocarbon present in GC-MS of medicinal plants has antioxidant, antibacterial & antitumor activities. [31] 9-Octadecen-1-ol, (Z), (also known as Oleyl alcohol) unsaturated fatty alcohol found in natural waxes, which is widely used as topical excipient with clinical importance in terms of chemical transdermal permeation/penetration enhancer, emollient/vehicle & a component of liposomes/nanocarriers in Lipid bilayer modification may help in penetration of other chemical compounds into the cells enhancing the growth of healthy granulation tissue, also it has antitumor activity. [32-34] Heneicosanoic acid, methyl ester (also known as methyl heneicosanoate) is a long chain fatty acid methyl ester (FAME)present in extracted food/plant seed oils possesses dose -dependent antioxidant, anti-inflammatory activities and is active against tested bacteria, fungi, which suggests its broad-spectrum antimicrobial activity. [35] Unlike other GE's, Glycidyl palmitoleate has been explored for its clinical utility where it has biological activity that can influence lowering of blood sugar where this substance was bonded to the catalytic sites of alpha-glucosidase by hydrogen bonds and hydrophobic interactions in mahogany seed study, results showing effects on blocking alpha-glucosidase activity lighting to the potential drug candidate for diabetes and hypertension treatment with no toxicity to respiratory, reproductive system, non-nephrotoxic, no skin sensitization and non-carcinogenic property. [36] 4-Trifluoromethylbenzoic acid, hexadecyl ester - a synthetic fluorinated ester used in analytical chemistry & industry, one among 18 corresponding derivative esters of 4-(trifluoromethyl) benzoic acid evaluated as potential antimycotic agent with promising anti-fungal properties towards eight fungal strains in an in-vitro study. [37] 9-Octadecenamide, (Z)- (also known as oleamide) is a well-studied fatty-acid amide which acts as a positive Neuromodulator and Cannabinergic effect providing plausible mechanisms for its pain & inflammation alleviating activity. Oleamide also shows Anti-inflammatory & antibacterial effects. [38-40] 1,5,9-Cyclododecanetriol, a cyclic polyol, is a rare cyclic alcohol derivative of plant secondary metabolites, with no sufficient data acknowledged in-vivo or in-vitro.

1b,5,5,6a-Tetramethyl-octahydro-1-oxa-cyclopropa[a]inden-6-one is a volatile oxygenated terpenoid-type compound found in essential oils of *Citrus aurantifolia* possesses insecticidal activities which may help keep insects away from wound, preventing insects mediated supra added infections. [41] cis-13-Docosenoyl chloride (also known as Erucoyl chloride), a fatty acid chloride, is derivative of Erucic (cis-13-docosenoic) acid, in various studies exhibits in-vitro bactericidal effect against *Borrelia burgdorferi and B. garinii* with potential antiviral activity by suppressing viral polymerase & down regulated NF-κB, p38 MAPK pathways reducing ISGF3 activity, inflammatory responses and influenza hence will help to keep the wound devoid of any infection and making wound conditions sterile. It also significantly demonstrated strong antioxidant activity in liposome oxidation assay by inhibiting COX-I/II; does enzyme inhibition of thrombin and neutrophil elastase, molecular docking evidence in cytokine modulation supporting its mechanistic role in inflammatory modulation, indicating direct anti-inflammatory potential in healthy granulation tissue. It also possesses cognitive enhancement in mice model exhibiting neuroprotective activity, triggering healthy sensation around the healed margins of skin tissue, enhanced antioxidant defense by acting as a broad carrier potential for other drugs, especially in tumor growth related conditions. [42] N,N-Dimethyltetradecanamide (also known as Dimethyl myristamide) is a derivative of fatty amide commonly found in plant secondary metabolites. Though its direct biological activity is not well documented, but related plant derived amides are well known to possess biological activities like Anti-tumor, Anti-helminthic, anti-spasmodic, Anti-fungal insecticidal, herbicidal, diuretic, anti-viral, antiseptic, anti-inflammatory, analgesic, wound healing, antifeedant, antibacterial properties. [43,44] Pinoresinol, dimethyl ether (also known as (+)-eudesmin) is a plant origin demethylated lignan identified as potential anti-anaphylactoid component inhibiting β hexosaminidase & histamine release assays on mast cells, inhibits platelet aggregation, exert cytotoxic/antiproliferative activity in breast & other cancer cell lines relevant for translational oncology interest. It also demonstrates antioxidant and anti-inflammatory properties in cyclic-AMP phosphodiesterase assays, fostering anti-platelet aggregation, vasodilatation, increased neo-angiogenesis to the healing tissue and reducing the local erythematous changes by countering the histaminic process in clinical conditions. [45-48] cis-9-Hexadecenal is a naturally occurring long-chain aldehyde that appears in plant extracts, insect pheromone blends and essential oils exhibiting antifungal, anti-melanogenic, antioxidant, anti-inflammatory, antimicrobial activities, non-cytotoxic in various in-vitro studies conducted on marine sponge *Cliona celata*, lung epithelial cell line, inhibition of A. fumigatus biofilm & cytotoxicity respectively. [49-51] Octanoic acid, 4-tridecyl ester (also known as Tridecyl octanoate) is an aliphatic fatty acid ester where its activity is noted as a whole extract or fraction, not as the isolated pure ester, reported as one of the volatile or FAMEs in plant and algal extracts exhibiting antimicrobial, antioxidant, strong preservative potential, surfactant, disinfectant, foaming agents. [52,53] 9-Octadecenamide, n-butyl- (also known as Butyl oleamide) is a fatty amide synthetic analogue of oleamide or derivative of 9-octadecenamide acts as insecticidal, anti-inflammatory, antibacterial, dermatological, dietary & neuroprotective potential while some study said that methanolic extract of *Cinnamomum zeylanicum* acts as antifungal against Aspergillus Niger, Asp. Terreus, Asp. Flavus, Asp. fumigatus and antibacterial against five clinical pathogens viz. Klebsiella pneumoniae, Pseudomonas aeruginosa, E. coli, Staphylococcus aureus & proteus mirabilis. [54-56] 1-Decanoyl-3-dodecanoylglycerol is a diacylglycerol (DAG) species derivative creating a synergistic effect that significantly prevents Hypertriglyceridemia by inhibiting dysregulated DAG pools implicated in hepatic and muscular

insulin resistance, fatty liver physiology or other metabolic disturbances. Potential target for developing treatments for obesity and metabolic syndrome by regulating lipid and metabolic homeostasis secondary messenger which indicates its utility in the diabetic-like conditions presenting with non-healing or chronic wounds. [57, 58] Guineensine is an alkylamide natural *N-isobutylamide* found in Piper having Cannabimimetic effect, antiepileptic, analgesic & anti-inflammatory lead. [59, 60] 1-Bromo-3-(2-bromoethyl)-nonane is halogenated alkane synthetic reagent, not a natural bioactive and its clinical uses are yet to be explored, as these halogenated compounds may be due to possible contamination occurring due to solvent, laboratory handling or environmental exposure. Thus, *Durva Taila* contains numerous bioactive constituents (Table 7) with proven anti-inflammatory, analgesic, antioxidant, antimicrobial, antifungal, properties which help to promotes collagen formation, cessation of blood purge on wounds and thence promoting repairment and rejuvenation of wound tissue by promoting healthy healing of the variety of wounds, related conditions and associated pain management.

Table 7: Pharmacological activity of compounds found in *Durva Taila*

Serial No.	Compound	Pharmacological Activity	Chemical Formula
1	2-Heptanone	Local anaesthetic, anti-microbial	$C_7H_{14}O$
2	2-Decenal, (E)-	Strong Antimicrobial, anti-biofilm activity, membrane-disrupting activity, protection against biodeterioration caused by fungi as well as aflatoxin contamination, strong antioxidant & scavenging effect on DPPH, no genotoxic or clastogenic effect or phytoallergenicity	$C_{10}H_{18}O$
3	(1Alpha,3beta,4beta)-p-menthane-3,8-diol	PMD stereoisomer show no dermal sensitization, non-toxic, non-immunotoxic, no immune suppression esp, on 10 antibody response on RBCs	$C_{10}H_{20}O_2$
4	Dodecanoic acid (Lauric acid)	Antimicrobial, Anti-diabetic, Anti-inflammatory, Anti-neuroinflammatory, Anti-Alzheimer's, potent cellular antioxidant, reduces lipopolysaccharide-induced reactive species (ROS) & Proinflammatory cytokine production, hypolipidemic, anti-hyperglycemic & maintains insulin-glucose homeostasis, Anti-biofilm activity as topical antimicrobial development	$C_{12}H_{24}O_2$
5	Glycidyl palmitate	Lacks data on toxicity in-vivo & in-vitro study, formation of intermediate but GE acts as good emollient, exposure marker in food contamination	$C_{19}H_{36}O_3$
6	.delta.-Dodecalactone	Strong anti-fungal activity, potential biopreservative in food & topical products, antibacterial & reduces biofilm formation	$C_{12}H_{22}O_2$
7	Pentadecanoic acid	Antioxidant, antimicrobial, multiple system and organ longevity enhancing candidate compound viz. anti-inflammatory, antifibrotic, anticancer, anti-cholesterolic, improved insulin sensitivity& β-cells function, mitochondrial repairment, non-cytotoxic	$C_{15}H_{30}O_2$
8	Dodecane, 1-cyclopentyl-4-(3-cyclopentylpropyl)-	Volatile long chain hydrocarbon still not acquainted as pure compound but present in GC-MS of medicinal plants showing anti-oxidant, antibacterial & antitumor activities	$C_{25}H_{48}$
9	9-Octadecen-1-ol, (Z)- (Oleyl alcohol)	Lipid bilayer modifier, Transdermal permeation enhancer, antitumor activity	$C_{18}H_{36}O$
10	Glycidyl (Z)-9-Heptadecenoate	No evidence of therapeutic/clinical use, processing contaminant formed on high	$C_{20}H_{36}O_3$

		temperature	
11	Heneicosanoic acid, methyl ester	Antimicrobial, antioxidant, anti-inflammatory	$C_{22}H_{44}O_2$
12	Glycidyl palmitoleate	Antimicrobial, blocks alphaglucosidase activity so anti-diabetic, anti-hypertensive, non-nephrotoxic, non-carcinogenic, no toxic respiratory and reproductive activities, therapeutic potential to augment neuron level by manipulation of eCB signaling pathway.	$C_{19}H_{34}O_3$
13	4-Trifluoromethylbenzoic acid, hexadecyl ester	Potential antimycotic agent with promising anti-fungal properties	$C_{23}H_{35}O_2F_3$
14	9-Octadecenamide, (Z)- (aka oleamide)	Endogeneous Neuromodulation of serotonergic & GABAergic neurotransmission promoting Hypnotic effect, Cannabinergic , Anti-inflammatory, antibacterial, antifibrotic	$C_{18}H_{35}NO$
15	1,5,9-Cyclododecanetriol	No clinical in-vitro or in-vivo data known	$C_{12}H_{24}O_3$
16	1b,5,5,6a-Tetramethyl-octahydro-1-oxa-cyclopropa[a]inden-6-one	Insecticidal activities	$C_{13}H_{20}O_2$
17	cis-13-Docosenoyl chloride [Aka Erucoyl chloride , derivative of Erucic acid]	Antibacterial, Anti-viral, Anti-inflammatory, anti-cancerous, Anti- Parkinson's, Neuroprotective, Broad carrier potential for other drugs, Anti-malarial	$C_{22}H_{41}ClO$
18	N,N-Dimethyltetradecanamide (aka Dimethyl myristamide)	Derivative of fatty amide chemical found in plant 20 metaboliteswith biological Anti-tumor, Anti-helminthic, anti-spasmodic, Anti-fungal insecticidal, herbicidal, diuretic, anti-viral, antiseptic, anti-inflammatory, analgesic, wound healing, antifeedant, antibacterial properties	$C_{16}H_{35}N$
19	9-Octadecenoic acid (Z)-, oxiranylmethyl ester (aka Glycidyl oleate)	Food processing contaminant, not known yet for therapeutic utility	$C_{21}H_{38}O_3$
20	Pinoresinol, dimethyl ether [aka (+)-eudesmin]	Anti-inflammatory, Antioxidant, Anti- anaphylactoid, Anti-tumor, Anti-platelet, & potential metabolic effects	$C_{22}H_{26}O_6$
21	cis-9-Hexadecenal	Anti-fungal, Anti-melanogenic, Anti-inflammatory, Antioxidant, Antimicrobial, Non-cytotoxic	$C_{16}H_{30}O$
22	Octanoic acid, 4-tridecyl ester (aka Tridecyl octanoate)	Activity of pure compound not known yet but derivatives of aliphatic fatty-acid ester act as antimicrobial, antioxidant, preservative efficacy, potential applications as surfactants, disinfectants, foaming agents	$C_{21}H_{42}O_2$
23	9-Octadecenamide, n-butyl- (aka Butyl oleamide)	Derivative of 9-octadecenamide acts as insecticidal, anti-inflammatory, antibacterial; dermatological, dietary & neuroprotective potential	$C_{22}H_{43}NO$
24	1-Decanoyl-3-dodecanoylglycerol	Diacylglycerol Species (DAG) derivative creating synergistic effect that significantly prevents Hypertriglyceridemia. Potential target for developing treatments for obesity and metabolic syndrome by regulating lipid and metabolic homeostasis secondary messenger	$C_{25}H_{48}O_5$
25	Guineensine	Natural N-isobutylamide found in Piper having Cannabimimetic effect, antiepileptic, analgesic & anti-inflammatory lead	$C_{24}H_{33}NO_3$
26	1-Bromo-3-(2-bromoethyl)-nonane	Not known yet	$C_{11}H_{22}Br_2$

Limitations:

The activities of few compounds identified in the GC-MS have no published data available. Present GC-MS analysis gives only thermally stable volatile compounds but they may not represent the complete profile of the plant. Complementary technique like NMR is recommended for comprehensive characterization.

5. CONCLUSION

The GC-MS analysis of *Durva Taila* formulated in coconut oil base revealed various bioactive compounds, including fatty acids & esters, glycidyl esters, volatile compounds, terpenoids/ essential oil components, fatty amides/signaling lipids, polyol/lactones, lignans, alkyl amides, halogenated and fluorinated agents and they support enhanced skin barrier repair, antioxidant property promoting collagen synthesis, while the presence of fatty acids proves to be potent antimicrobial and antifungal. It may be assumed that the bioactive volatile constituents identified in Durva Taila could contribute to its potential therapeutic effects through local anesthetic, antimicrobial, neuro-modulatory, anti-inflammatory, and wound-healing mechanisms. These phytoconstituents may support tissue regeneration and facilitate progression of the wound-healing process; however, further experimental and clinical studies are required to validate these proposed effects.

Abbreviations:

Ret. Time: Retention Time, GC-MS: Gas Chromatography combined with Mass Spectrometry, VOC: Volatile organic compound

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REFERENCES:

1. Martinengo L, Olsson M, Bajpai R, Soljak M, Upton Z, Schmidtchen A, Car J, Järbrink K. Prevalence of chronic wounds in the general population: systematic review and meta-analysis of observational studies. Annals of Epidemiology [Internet]. 2019 Jan;29:8-15. Available from: https://doi.org/10.1016/j.annepidem.2018.10.005
2. Gupta N, Gupta SK, Shukla VK, Singh SP. An Indian community-based epidemiological study of wounds. Journal of Wound Care [Internet]. 2004 Sep;13(8):323-5. Available from: https://doi.org/10.12968/jowc.2004.13.8.26657
3. Sharma A, Srivastava V, Shankar R, Yadav AK, Ansari MA, Gupta SK. Epidemiological Profile of Chronic Wounds in an Indian Population: A Community-Based Cross-Sectional Observational Study. Cureus [Internet]. 2024 Sep;16(9):1-19 Available from: https://doi.org/10.7759/cureus.68684
4. Sen CK. Human Wound and Its Burden: Updated 2020 Compendium of Estimates. Advances in Wound Care [Internet]. 2021 May;10(5):281-92. Available from: https://doi.org/10.1089/wound.2021.0026
5. Khanna V, Bhardwaj A, Raina A, Khajuria A, Sharma A. Role of Durvadi Taila in the Management of Sadhyo Vrana | Ayushdhara [Internet]. 2017 Dec;4(4):1292-1296. Available from: https://ayushdhara.in/index.php/ayushdhara/article/view/315

6. Gangasahaya Pandey (editor). Commentary: Kashinath Shastri Vidyotini on Charaka Samhita by Agnivesha, Part II, Chikitsasthana, chapter 25, Verse no. 93, Reprint edition, Varanasi; Chaukhambha Bharati Academy; 2018;711
7. Ambikadutta Shastri (editor). Commentary: Ayurveda Tattva Sandipika on Susruta Samhita of Maharsi Susruta, Part I, Sutrasthana, chapter 46, verse no. 120, 14th edition, Varanasi; Chaukhambha Sanskrit Sansthan;2003;179
8. Gangasahaya Pandey (editor). Commentary: Kashinath Shastri Vidyotini on Charaka Samhita by Agnivesha, Part I, Sutrasthana, Chapter 26, verse no. 42-1, Reprint edition, Varanasi; Chaukhambha Bharati Academy; 2018;503-04.
9. Ambikadutta Shastri (editor). Commentary: Ayurveda Tattva Sandipika on Susruta Samhita of Maharsi Susruta, Sutrasthana, chapter 46, verse no. 112, 14th edition, Varanasi; Chaukhambha Sanskrit Sansthan;2003;178
10. Gangasahaya Pandey (editor). Commentary: Kashinath Shastri Vidyotini on Charaka Samhita by Agnivesha, Part I, Sutrasthana, chapter 26, verse no. 42-4, Reprint edition, Varanasi; Chaukhambha Bharati Academy; 2018;506.
11. Gangasahaya Pandey (editor). Commentary: Kashinath Shastri Vidyotini on Charaka Samhita by Agnivesha, Part II, Chikitsasthana, chapter 04, Verse no. 8-8, Reprint edition, Varanasi; Chaukhambha Bharati Academy; 2018;78
12. Keval Krishna Thakral (editor). Commentary: Shri Dalhanacharya evum Shri Gayadas Virachita Vistrut Hindi Vyakhaya on Susruta Samhita of Maharsi Susruta, Part-III, Uttarasthana, chapter 45, verse no. 20, reprint edition, Varanasi; Chaukhambha Orientalia;2023;411
13. P.V. Sharma & Guru Prasad Sharma (editor & translator). Commentary: Kaiyadeva Nighantu, Pathyapathyavibodhaka, Oshadhi varga- Verse, Second Edition, Varanasi, Chaukhambha Orientalia, 2009;1232-33
14. G.S. Pandey (editor). Commentary: K.C Chunekar on Bhavaprakash Nighantu (Indian Materia Medica) of Shri Bhavamishra, Guduchyadi varga -Verse, Tenth edition, Varanasi; Chaukhambha Bharati Academy;1995;174
15. Ambikadutta Shastri (editor). Commentary: Ayurveda Tattva Sandipika on Susruta Samhita of Maharsi Susruta, Part I, Chikitsasthana, chapter 02, verse no. 91, Reprint edition, Varanasi; Chaukhambha Sanskrit Sansthan;2016;26
16. Mostafa, D., Alarawi, R., AlHowitiy, S., AlKathiri, N., Alhussain, R., Almohammadi, R., & Alhussain, R. (2022). The effectiveness of microneedling technique using coconut and sesame oils on the severity of gingival inflammation and plaque accumulation: A randomized clinical trial. *Clinical and Experimental Dental Research*.2022 June;8:1249–1258. Available from: https://doi.org/10.1002/cre2.618
17. Papachristoforou A, Kagiava A, Papaefthimiou C, Termentzi A, Fokialakis N, Skaltsounis AL, Watkins M, Arnold G, Theophilidis G. The Bite of the Honeybee: 2-Heptanone Secreted from Honeybee Mandibles during a Bite Acts as a Local Anaesthetic in Insects and Mammals. PLoS ONE [Internet]. 2012 Oct;7(10):e47432. Available from: https://doi.org/10.1371/journal.pone.0047432
18. Saccà ML, Bianchi G, Lo Scalzo R. Biosynthesis of 2-Heptanone, a Volatile Organic Compound with a Protective Role against Honey Bee Pathogens, by Hive Associated Bacteria. Microorganisms [Internet]. 2021 Oct;9(11):1-13. Available from: https://doi.org/10.3390/microorganisms9112218
19. Kačániová M, Galovičová L, Ivanišová E, Vukovic NL, Štefániková J, Valková V, Borotová P, Žiarovská J, Terentjeva M, Felšöciová S, Tvrdá E. Antioxidant, Antimicrobial and Antibiofilm Activity of Coriander (Coriandrum sativum L.) Essential Oil for Its Application in Foods. Foods [Internet]. 2020 Mar;9(3):282. Available from: https://doi.org/10.3390/foods9030282
20. Wu X, Wei F, Ding F, Yang N, Niu J, Ran Y, Tian M. Phytochemical analysis, antioxidant, antimicrobial, and anti-enzymatic properties of Alpinia coriandriodora (sweet ginger) rhizome. Frontiers in Plant Science [Internet]. 2023 Oct;14:1-14. Available from: https://doi.org/10.3389/fpls.2023.1284931
21. M A, I MA, Ramalingam K, Shanmugam R. Biomedical Applications of Lauric Acid: A Narrative Review. Cureus [Internet]. 2024 Jun;16(6):1-10. Available from: https://doi.org/10.7759/cureus.62770
22. Nirmal CR, Rajadas SE, Balasubramanian M, Magdaline D, Chilamakuru NB, Dinesh R, Radhakrishnan A, Paraman R, Mondal R, Dusthackeer VN. Dodecanoic acid & palmitic acid disarms rifampicin resistance by putatively targeting mycobacterial efflux pump Rv1218c. Indian Journal of Medical Research [Internet]. 2023 Feb-Mar;157(2&3):192-203. Available from: https://doi.org/10.4103/ijmr.ijmr_1610_22
23. Pan S, Zou Z, Zhou X, Wei J, Liu H, Su Z, Liao G, Huang G, Huang Z, Xu Y, Lu M, Gu R. Therapeutic impacts of GNE-477-loaded H_2O_2 stimulus-responsive dodecanoic acid-phenylborate ester-dextran polymeric micelles on osteosarcoma. International Journal of Molecular Medicine [Internet]. 2024 Jun;54(2):1-13. Available from: https://doi.org/10.3892/ijmm.2024.5393
24. Yabani DS, Ofosu IW, Ankar-Brewoo GM, Lutterodt HE. Exposure to Dietary Glycidyl and 3-MCPD Fatty Acid Esters and Associated Burden of Cancer in Selected Asian and European Countries: A Review and Data Synthesis. Environmental Health Insights [Internet]. 2024 Jan10; 18:1-17. Available from: https://doi.org/10.1177/11786302241277628
25. Chaturvedi S, Singh T, Fatima H, Maurya AC, Dutta T, Khare SK. Lactones as promising biofilm inhibitors: disrupting bacterial communication for

Next-Gen therapies. Preparative biochemistry & biotechnology [Internet]. 2025 Aug:1-11. Available from: https://doi.org/10.1080/10826068.2025.2551375

26. Hashemi M, Ehsani A, Hosseini Jazani N, Aliakbarlu J, Mahmoudi M. PubMed [Internet]. Chemical composition and in vitro antibacterial activity of essential oil and methanol extract of Echinophora platyloba D.C against some of food-borne pathogenic bacteria - Veterinary Research Forum PubMed. 2013 Jun;4(2):123-127. Available from: https://pubmed.ncbi.nlm.nih.gov/25653784/
27. Venn-Watson S, Schork NJ. Pentadecanoic Acid (C15:0), an Essential Fatty Acid, Shares Clinically Relevant Cell-Based Activities with Leading Longevity-Enhancing Compounds. Nutrients [Internet]. 2023 Oct 30;15(21):4607. Available from: https://doi.org/10.3390/nu15214607
28. Robinson MK, Lee E, Ugalde-Nicalo PA, Skonieczny JW, Chun LF, Newton KP, Schwimmer JB. C15:0 Supplementation in Young Adults with Overweight and Obesity: A Randomized Controlled Trial. The Journal of Nutrition [Internet]. 2024 Jul;154(9):2763-2771. Available from: https://doi.org/10.1016/j.tjnut.2024.07.030
29. Venn-Watson S, Lumpkin R, Dennis EA. Efficacy of dietary odd-chain saturated fatty acid pentadecanoic acid parallels broad associated health benefits in humans: could it be essential? Scientific Reports [Internet]. 2020 May 18;10(1):8161. Available from: https://doi.org/10.1038/s41598-020-64960-y
30. Ratishkumar Patel M, Saddam A, Golaviya A, Ramdas Singh W, Sharma A, Kumawat S, Kumar D. GC-MS Analysis and Wound Healing Potential of Ficus racemosa L. Gum in Wistar Albino Rats. Acta Sci Vet Sci [Internet]. 2022 Dec;4(12):203-10. Available from: https://doi.org/10.31080/asvs.2022.04.0579
31. Swapna sonale R, Ramalakshmi K, Udaya Sankar K. Characterization of Neem (Azadirachta indica A. Juss) seed volatile compounds obtained by supercritical carbon dioxide process. J Food Sci Technol [Internet]. 2018 Feb;55(4):1444-54. Available from: https://doi.org/10.1007/s13197-018-3060-y
32. Karve T, Banga AK. Comparative evaluation of physical and chemical enhancement techniques for transdermal delivery of linagliptin. International Journal of Pharmaceutics [Internet]. 2024 Apr;654:123992. Available from: https://doi.org/10.1016/j.ijpharm.2024.123992
33. Orienti I, Zuccari G, Bergamante V, Fini A, Carosio R, Montaldo PG. Enhancement of Oleyl Alcohol Anti Tumor Activity through Complexation in Polyvinylalcohol Amphiphilic Derivatives. Drug Delivery [Internet]. 2007 Jan;14(4):209-17. Available from: https://doi.org/10.1080/10717540601036898
34. Ingólfsson HI, Andersen OS. Alcohol's Effects on Lipid Bilayer Properties. Biophysical Journal [Internet]. 2011 Aug;101(4):847-55. Available from: https://doi.org/10.1016/j.bpj.2011.07.013
35. Alqahtani FY, Aleanizy FS, Mahmoud AZ, Farshori NN, Alfaraj R, Al-sheddi ES, Alsarra IA. Chemical composition and antimicrobial, antioxidant, and anti-inflammatory activities of Lepidium sativum seed oil. Saudi Journal of Biological Sciences [Internet]. 2019 Jul;26(5):1089-92. Available from: https://doi.org/10.1016/j.sjbs.2018.05.007
36. Taiyeb M, Hartati H, Arwansyah A, Dahlia, Muis A, Mu'nisa A, Arif AR, Salleh LM. Self-Nanoemulsifying Drug Delivery System (SNEDDS) formulation and molecular docking of mahogany seed extract (Swietenia mahagoni) as anti-hyperglycemic. International Journal of Design & Nature and Ecodynamics[Internet]. 2025 Feb;20(2):373-381. Available from: https://doi.org/10.1016/j.imu.2024.101517
37. Krátký M, Vinšová J. Antifungal Activity of Salicylanilides and Their Esters with 4-(Trifluoromethyl) benzoic Acid. Molecules [Internet]. 2012 Aug;17(8):9426-42. Available from: https://doi.org/10.3390/molecules17089426
38. Boger DL, Henriksen SJ, Cravatt BF. Oleamide: An Endogenous Sleep-inducing Lipid and Prototypical Member of a New Class of Biological Signaling Molecules. Current Pharmaceutical Design [Internet]. 1998 Aug;4(4):303-14. Available from: https://doi.org/10.2174/1381612804042210101522 20
39. Mendelson W. The Hypnotic Actions of the Fatty Acid Amide, Oleamide. Neuropsychopharmacology [Internet]. 2001 Nov;25(5):S36—S39. Available from: https://doi.org/10.1016/s0893-133x(01)00341-4
40. Muzahid AA, Sharmin S, Hossain MS, Ahamed KU, Ahmed N, Yeasmin MS, Ahmed NU, Saha BK, Rana GM, Maitra B, Bhuiyan MN. Analysis of Bioactive Compounds Present in Different Crude Extracts of Benincasa Hispida and Cucurbita Moschata Seeds by Gas Chromatography-Mass Spectrometry. Heliyon [Internet]. 2022 Jan;9(1):1-9. Available from: https://doi.org/10.1016/j.heliyon.2022.e12702
41. Sarma R, Adhikari K, Mahanta S, Khanikor B. Insecticidal activities of Citrus aurantifolia essential oil against Aedes aegypti (Diptera: Culicidae). Toxicology Reports [Internet]. 2019 Oct;6:1091-1096. Available from: https://doi.org/10.1016/j.toxrep.2019.10.009
42. Galanty A, Grudzińska M, Paździora W, Paśko P. Erucic Acid—Both Sides of the Story: A Concise Review on Its Beneficial and Toxic Properties. Molecules [Internet]. 2023 Feb;28(4):1-11. Available from: https://doi.org/10.3390/molecules28041924
43. Kumar, V., Bhatt, V., Kumar, N. (2018). "Chapter 9 - amides from plants: Structures and biological importance," in *Studies in natural products chemistry*, vol. 56 . Ed. Atta ur, R. (Amsterdam Netherlands: Elsevier),

2018; 56:287–333. Available from: https://doi.org/10.1016/B978-0-444-64058-1.00009-1

44. Farhan N, Rageh Al-Maleki A, Ataei S, Muhamad Sarih N, Yahya R. Synthesis, DFT study, theoretical and experimental spectroscopy of fatty amides based on extra-virgin olive oil and their antibacterial activity. Bioorganic Chemistry [Internet]. 2023 Jun;135:106511. Available from: https://doi.org/10.1016/j.bioorg.2023.106511
45. Lin Y, Xu J, Jia Q, Sun W, Fu J, Lv Y, Han S. Cell membrane chromatography coupled online with LC-MS to screen anti-anaphylactoid components from Magnolia biondii Pamp targeting on Mas-related G protein-coupled receptor X2. Journal of Separation Science [Internet]. 2020 May;43(13):2571-2578. Available from: https://doi.org/10.1002/jssc.202000014
46. Feng WS, He YH, Zheng XK, Dong BB, Zhang YL, Cao YG, Yang YY, Zhang JK. Lignans from flower buds of Magnolia biondii. Zhongguo Zhong Yao Za Zhi. 2018 Mar;43(5):970-976. Available from: https://doi.org/10.19540/j.cnki.cjcmm.2018.0028
47. Luelf UJ, Wassing A, Böhmer LM, Urlacher VB. Plasmid-free production of the plant lignan pinoresinol in growing Escherichia coli cells. Microbial Cell Factories [Internet]. 2024 Oct;23(1):1-12. Available from: https://doi.org/10.1186/s12934-024-02562-3
48. Šimat V, Skroza D, Tabanelli G, Čagalj M, Pasini F, Gómez-Caravaca AM, Fernández-Fernández C, Sterniša M, Smole Možina S, Ozogul Y, Generalić Mekinić I. Antioxidant and Antimicrobial Activity of Hydroethanolic Leaf Extracts from Six Mediterranean Olive Cultivars. Antioxidants [Internet]. 2022 Aug;11(9):1656. Available from: https://doi.org/10.3390/antiox11091656
49. Hoda S, Gupta L, Shankar J, Gupta AK, Vijayaraghavan P. cis-9-Hexadecenal, a Natural Compound Targeting Cell Wall Organization, Critical Growth Factor, and Virulence of Aspergillus fumigatus. ACS Omega [Internet]. 2020 Apr;5(17):10077-88. Available from: https://doi.org/10.1021/acsomega.0c00615
50. Alves J, Gaspar H, Silva J, Alves C, Martins A, Teodoro F, Susano P, Pinteus S, Pedrosa R. Unravelling the Anti-Inflammatory and Antioxidant Potential of the Marine Sponge Cliona celata from the Portuguese Coastline. Marine Drugs [Internet]. 2021 Nov;19(11):632. Available from: https://doi.org/10.3390/md19110632
51. Hoda S, Gupta L, Agarwal H, Raj G, Vermani M, Vijayaraghavan P. Inhibition of Aspergillus fumigatus Biofilm and Cytotoxicity Study of Natural Compound Cis-9-Hexadecenal. Journal of Pure and Applied Microbiology [Internet]. 2019 Jun;13(2):1207-16. Available from: https://doi.org/10.22207/jpam.13.2.61
52. Chaudhary J. Preservative Evaluation of Caprylic Acid Derivatives in Aluminium Hydroxide Gel – USP. Scientia Pharmaceutica [Internet]. 2008 Sep ;76(3):533-9. Available from: https://doi.org/10.3797/scipharm.0807-24
53. Kim JJ, Kim HK. Antioxidant and Antibacterial Activity of Caprylic Acid Vanillyl Ester Produced by Lipase-Mediated Transesterification. Journal of Microbiology and Biotechnology [Internet]. 2021 Feb;31(2): 317-326. Available from: https://doi.org/10.4014/jmb.2010.10018
54. Martić A, Čižmek L, Ul'yanovskii NV, Paradžik T, Perković L, Matijević G, Vujović T, Baković M, Babić S, Kosyakov DS, Trebše P, Čož-Rakovac R. Intra-Species Variations of Bioactive Compounds of Two Dictyota Species from the Adriatic Sea: Antioxidant, Antimicrobial, Dermatological, Dietary, and Neuroprotective Potential. Antioxidants [Internet]. 2023 Apr;12(4):857. Available from: https://doi.org/10.3390/antiox12040857
55. Hameed I, Altameme H, Mohammed G. Evaluation of Antifungal and Antibacterial Activity and Analysis of Bioactive Phytochemical Compounds of Cinnamomum Zeylanicum (Cinnamon Bark) using Gas Chromatography-Mass Spectrometry. Orient Journal of Chemistry [Internet]. 2016 Aug;32(4):1769-88. Available from: https://doi.org/10.13005/ojc/320406
56. M Sahi N. University of Babylon Private CDN [Internet]. Evaluation of insecticidal activity of bioactive compounds from Eucalyptus citriodora against Tribolium castaneum.; 2016 Aug;8(8): 1256-1270 Available from: https://cdnx.uobabylon.edu.iq/research/repository1_publication175112_12_1724.pdf
57. Khatun I, Clark RW, Vera NB, Kou K, Erion DM, Coskran T, Bobrowski WF, Okerberg C, Goodwin B. Characterization of a Novel Intestinal Glycerol-3-phosphate Acyltransferase Pathway and Its Role in Lipid Homeostasis. J Biol Chem [Internet]. 2015 Dec;291(6):2602-15. Available from: https://doi.org/10.1074/jbc.m115.683359
58. Kolczynska K, Loza-Valdes A, Hawro I, Sumara G. Diacylglycerol-evoked activation of PKC and PKD isoforms in regulation of glucose and lipid metabolism: a review. Lipids in Health Disease [Internet]. 2020 May;19(1):1-15. Available from: https://doi.org/10.1186/s12944-020-01286-8
59. Nicolussi S, Viveros-Paredes JM, Gachet MS, Rau M, Flores-Soto ME, Blunder M, Gertsch J. Guineensine is a novel inhibitor of endocannabinoid uptake showing cannabimimetic behavioral effects in BALB/c mice. Pharmacological Research [Internet]. 2014 Feb;80:52-65. Available from: https://doi.org/10.1016/j.phrs.2013.12.010
60. Reynoso-Moreno I, Najar-Guerrero I, Escareño N, Flores-Soto ME, Gertsch J, Viveros-Paredes JM. An Endocannabinoid Uptake Inhibitor from Black Pepper Exerts Pronounced Anti-Inflammatory Effects in Mice. Journal of Agricultural and Food Chemistry [Internet]. 2017 Oct;65(43):9435-42. Available from: https://doi.org/10.1021/acs.jafc.7b02979