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Evaluation of bioactive phytoconstituents in *Cocos nucifera* sprout using GC–MS and FT-IR spectroscopy

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Abstract
The present investigation was carried out to characterize its bioactive compounds present in methanol extract of *C.nucifera* fresh and dried sprouts using Gas Chromatography – Mass Spectrum (GC-MS). The results of the GC-MS analysis provide different peaks determining the presence of 58 and 41 bioactive compounds in the methanolic extract of dried and fresh *C.nucifera* sprouts respectively. The major phytocompounds 2,3-Bis[(4-hydroxy-3-methoxyphenyl)methyl]butane-1,4-diol tetramethyl ether (24.14%) and niranthin (14.44%) in dried sprout extract and Lup-20(29)-en-3-ol,acetate,(3β)- (31.52%) and α-Amyrin (17.7%) in fresh sprout extract and minor compounds were also present in both the dried and fresh *C.nucifera* sprout extracts. In FT-IR analysis of dried *C.nucifera* sprout extracts revealed that the presence of various groups such as alcohols, phenols,, carboxylic acids, amides, esters, aldehydes, ketones, alkanes and ethers. From the results, it could be confirmed that fresh and dried *C.nucifera* sprouts contains various bioactive compounds have various biological activities.

Keywords: *C.nucifera*, phytocompounds, GC-MS, FT-IR, bioactive compounds

Introduction

Medicinal plants have been widely recognized as important sources of therapeutic agents and pharmaceutical compounds. They contain diverse bioactive phytoconstituents that contribute to disease prevention and treatment with comparatively fewer side effects than synthetic drugs. It has been reported that nearly 80% of the global population depends on medicinal plants for primary healthcare needs (Sagbo *et al*., 2020) [1].

Cocos nucifera (L.), belonging to the family Arecaceae, often referred to as the "Tree of Life" because almost all parts of the plant are useful to humans. It is widely cultivated in tropical regions and produces fruits throughout the year. Extensive research has demonstrated that different parts of *C. nucifera* exhibit anti-inflammatory, antioxidant, antibacterial, antifungal, cardioprotective, hepatoprotective, and nephroprotective activities (Lima *et al*., 2015) [2]. These pharmacological properties vary depending on the phytochemical composition of each plant part.

Among the various components of the coconut fruit, the coconut haustorium, also known as the coconut sprout or coconut apple, has recently gained scientific attention due to its nutritional, functional, and physicochemical properties. During germination, the embryo develops into a soft, spongy structure called the haustorium, which absorbs nutrients from both the coconut water (liquid endosperm) and the solid kernel (endosperm). Approximately 20–24 weeks, the haustorium expands and eventually fills the internal cavity of the coconut shell (Smita *et al*., 2019) [3].

Bioactive compounds present in coconut haustorium have been reported to exhibit cytoprotective, anti-ulcer, antitumor, and cardioprotective effects. Secondary metabolites such as flavonoids and cardiac glycosides are known for their therapeutic potential in managing cardiovascular diseases and oxidative stress–related disorders (Wierzbicka & Czeczot, 2012) [4]. Molecular docking studies have further indicated that certain triterpenoids, including squalene, may show affinity toward ulcer-causing bacteria such as *Helicobacter pylori*, supporting its traditional use in gastrointestinal disorders (Valli & Gowrie, 2017) [5].

However, phytochemical composition may vary due to geographical location, environmental conditions, genetic factors, and harvest stage. Therefore, scientific identification and characterization of bioactive constituents are essential for standardization and validation of medicinal potential. Advanced analytical techniques such as Gas Chromatography–Mass Spectrometry (GC–MS) and Fourier Transform Infrared Spectroscopy (FTIR) are widely employed in phytochemical analysis.

Gas Chromatography–Mass Spectrometry (GC–MS) is a powerful analytical technique used for the separation, identification, and characterization of volatile and semi-volatile compounds present in plant extracts (Sarian *et al*., 2017) [6]. GC–MS is extensively applied in phytochemical studies to detect fatty acids, terpenoids, phenolics, sterols, and other secondary metabolites responsible for biological activities (Hossain *et al*., 2013) [7]. It also plays a crucial role in herbal drug standardization by generating chemical fingerprints of medicinal plants (Ludwiczuk *et al*., 2017) [8]. In studies involving *C. nucifera*, GC–MS analysis has identified bioactive compounds such as triterpenoids and squalene associated with antimicrobial and anti-ulcer activities (Valli & Gowrie, 2017) [5].

Fourier Transform Infrared Spectroscopy (FTIR) is a rapid and non-destructive analytical technique used to identify functional groups present in plant extracts (Abbasi *et al*., 2012) [9]. FTIR works by measuring the absorption of infrared radiation by specific chemical bonds, thereby providing information about molecular structure and chemical composition (Bribi, 2018) [10]. It is widely used in phytochemical screening to detect functional groups such as hydroxyl (–OH), carbonyl (C=O), amine (–NH), and aromatic groups characteristic of various bioactive

compounds (Sood *et al*., 2012) [11]. FTIR complements GC–MS analysis by confirming the presence of chemical classes and supporting structural elucidation of phytoconstituents (Yang *et al*., 2020) [12]. The combined application of GC–MS and FTIR provides comprehensive qualitative characterization and strengthens pharmacological validation (Ghazali *et al*., 2014) [13].

Therefore, the present study aims to analyze the bioactive compounds present in *Cocos nucifera* sprouts using GC–MS and FTIR techniques and to evaluate their potential antioxidant, anti-inflammatory, enzyme inhibitory, and antibacterial activities. Scientific validation of these properties may support the utilization of coconut sprouts as an economical, natural, and health-promoting dietary source with promising therapeutic applications.

Materials and Methods

Sample Collection

Mature sprouts of *Cocos nucifera* (L.) were collected from nearby agricultural fields and thoroughly cleaned to remove adhering soil and other foreign materials, followed by authentication using standard botanical identification procedures. A portion of the freshly collected sprouts was immediately processed for extraction, while the remaining portion was subjected to oven drying for the preparation of dried samples. The cleaned sprouts were cut into uniform pieces and dried in a hot air oven maintained at 50–55 °C until a constant weight was obtained. After drying, the samples were cooled to room temperature, ground into a fine powder using a mechanical grinder, and stored in airtight containers for further analysis. Oven drying was adopted to reduce moisture content, inhibit microbial growth, and preserve phytochemical constituents (Trease & Evans, 2009) [14].

Qualitative Phytochemical Screening

Preparation of Extracts

About 10 g each of the fresh sample and oven-dried sprout were separately extracted with 100 mL of methanol through maceration for 48 hours at room temperature with occasional shaking. The mixtures were then filtered using Whatman No. 1 filter paper and subsequently concentrated. The filtrates were preserved at 4 °C until further use for qualitative phytochemical analysis.

Quantitative Phytochemical Screening

The major phytochemical constituents were determined quantitatively in fresh and oven-dried *C. nucifera* sprout extracts by spectrophotometric techniques. Total phenolic content by the Folin–Ciocalteu method and the results expressed as mg gallic acid equivalents (GAE) per gram of extract, whereas total flavonoid content was measured by the aluminium chloride colorimetric assay and reported as mg quercetin equivalents (QE) per gram of extract. Total tannins by the Folin–Denis method, and saponin content by gravimetric analysis. Alkaloids were quantified through the acid–base precipitation method, while total terpenoids were determined using a phosphovanillin-based colorimetric assay. All experiments were conducted in triplicate, and the results were presented as mean ± standard deviation in accordance with standard procedures (Harborne, 1998 [15]; Singleton *et al*., 1999[16]; Trease & Evans, 2009 [14]).

Gas chromatography-mass spectrometry (GC-MS) profiling

Approximately 20 mg of the extract of both fresh and dried coconut sprouts was dissolved in GC-grade methanol (Sigma-Aldrich) in a 2 mL vial, vortexed, and sonicated to ensure complete dissolution. The sample was treated with primary–secondary amine (PSA), filtered through a syringe filter, and the clear supernatant was collected for GC–MS analysis. GC–MS analysis was performed using a Shimadzu GC-2010 Plus gas chromatograph coupled with a GCMS-QP-2020 mass spectrometer equipped with an auto-sampler. Separation was achieved on an SH-Rxi-5MS Sil capillary column (30 m × 0.25 mm × 0.25 µm) using helium as the carrier gas at a flow rate of 1.70 mL/min. The oven temperature was programmed from 80 °C to 280 °C at a rate of 7 °C/min. The injector and ion source temperatures were maintained at 230 °C and 220 °C, respectively, and 0.40 µL of sample was injected in splitless mode. Mass spectra were recorded in the range of 50–500 m/z under electron ionization at 70 eV. Compounds were identified by comparison with NIST spectral libraries, and results were expressed as relative percentage peak areas.

Fourier transform infrared spectroscopy (FT-IR) analysis

For FT-IR analysis, a Shimadzu IR Affinity-1 Spectrum FT-IR system (Shimadzu, Japan) equipped with a DLATGS detector was used. The instrument operated at a mirror speed of 2.8 mm/sec over a scanning range of 4000–400 cm^{-1} with a resolution of 4 cm^{-1}. Methanolic extract of fresh coconut sprouts were prepared and concentrated using a flash evaporator. The dried extracts were blended with potassium bromide (KBr) using a mortar and pestle and compressed into thin pellets. The infrared spectra were recorded using the KBr pellet method within the range of 4000–500 cm^{-1}.

Results and Discussion

Phytochemical analysis

Quantitative analysis revealed that phenolics (2.73 ± 0.6 mg/g in fresh; 2.85 ± 0.8 mg/g in dried) and flavonoids (1.98 ± 0.8 mg/g in fresh; 2.10 ± 0.9 mg/g in dried) were the predominant phytochemicals, with phenolics exhibiting the highest levels, indicating significant antioxidant potential (Pandey & Rizvi, 2009) [17]. Alkaloids and glycosides were present in moderate amounts, suggesting potential antimicrobial and cardioprotective activities (Harborne, 1998) [15]. Tannins, saponins, and terpenoids occurred in lower concentrations but remain functionally important (Francis *et al*., 2002) [19], while steroids were detected only in trace amounts (Okwu, 2004) [20]. The comparatively higher phytochemical content in dried sprout flour indicates that controlled drying may enhance phytochemical retention and supports its potential use as a functional and nutraceutical ingredient (Sultana *et al*., 2012 [21]; Shahidi & Ambigaipalan, 2015 [18]).

Gas chromatography-mass spectrometry analysis (GC-MS)

GC–MS analysis of the methanolic extracts revealed a diverse array of bioactive compounds, with notable differences between fresh and dried sprouts. The GC-MS chromatogram of methanolic extract of dried and fresh *C.nucifera* sprout was given in figure 2 and 3. The dried sprout extract showed 58 compounds, whereas the fresh extract exhibited 41 compounds, indicating enhanced phytochemical concentration after drying. The major phytocomponents identified by GC–MS in dried and fresh *C.nucifera* Sprout methanolic extract was given in table 1 and 2.

In the dried *C.nucifera* sprout extract, the major constituents identified were 2,3-Bis[(4-hydroxy-3-methoxyphenyl)methyl]butane-1,4-diol tetramethyl ether (24.14%), Niranthin (14.44%), Hypophyllanthin (14.05% and 10.84%), and β-Asarone (12.40%) based on peak area percentage. The high peak area of the phenolic derivative (24.14%) indicates significant antioxidant potential and hepatoprotective activities due to the presence of hydroxyl-substituted aromatic rings capable of hydrogen donation and free radical scavenging. The substantial proportion of lignan derivatives such as Niranthin and Hypophyllanthin (collectively above 39%) suggests notable hepatoprotective, anti-inflammatory, and antioxidant activities, primarily through inhibition of lipid peroxidation and modulation of oxidative stress pathways. The compound predominantly found in dried sprout is β-Asarone (12.40%) which contributes antimicrobial and neuroprotective properties. Additionally, the detection of fatty acids such as n-hexadecanoic acid and 9,12-octadecadienoic acid supports anti-inflammatory and hypocholesterolemic potential.

Table 1: Phytocompounds present in Methanolic Extract of dried *C.nucifera* Sprout by GC–MS Analysis

S. No.	Retention time (min)	Peak Area %	Name of the Compound	Molecular formula	Molecular weight (G/Mol)
1.	3.153	0.06	1,2,3-Propanetriol	$C_3H_8O_3$	92
2.	18.160	0.05	2,4-Di-tert-butylphenol	$C_{14}H_{22}O$	206
3.	18.314	0.09	(2R,3R,6S)-6-Isopropyl-3-methyl-2-(prop-1-en-2-yl)-3-vinylcyclohexanone	$C_{15}H_{24}O$	220
4.	19.871	0.17	Isoelemicin, Z-	$C_{12}H_{16}O_3$	208
5.	20.477	0.10	Diethyl Phthalate	$C_{12}H_{14}O_4$	222
6.	21.049	0.12	Dehydroxy-isocalamendiol	$C_{15}H_{24}O$	220
7.	21.174	12.40	β-Asarone	$C_{12}H_{16}O_3$	208
8.	22.640	0.12	β-Asarone	$C_{12}H_{16}O_3$	208
9.	23.266	0.11	Benzene,1-methyl-4-(1,2,2-trimethylcyclopentyl)-	$C_{15}H_{22}$	202
10.	23.970	0.10	1-(2,4,5-Trimethoxyphenyl)propan-2-one	$C_{12}H_{16}O_4$	224
11.	24.304	0.03	Isosorbide Dinitrate	$C_{15}H_{26}O_2$	238
12.	24.547	0.28	Tetradecanoic acid	$C_{14}H_{28}O_2$	228
13.	24.620	0.05	Loliolide	$C_{11}H_{16}O_3$	196
14.	26.114	0.11	Neophytadiene	$C_{20}H_{38}$	278
15.	26.628	0.06	Ent-Norsecurinine	$C_{12}H_{13}NO_2$	203
16.	27.713	0.05	Hexadecanoic acid, methyl ester	$C_{17}H_{34}O_2$	270
17.	28.182	1.24	Dibutyl phthalate	$C_{16}H_{22}O_4$	278
18.	28.333	2.28	n-Hexadecanoic acid	$C_{16}H_{32}O_2$	256
19.	28.501	0.13	Phthalic acid, butyl 2-pentyl ester	$C_{17}H_{24}O_4$	292
20.	29.787	0.05	Phthalic acid, butyl 3-methylbutyl ester	$C_{17}H_{24}O_4$	292
21.	29.969	0.05	Phthalic acid, butyl undecyl ester	$C_{23}H_{36}O_4$	376
22.	30.068	0.04	Phthalic acid, pentyl 2-pentyl ester	$C_{18}H_{26}O_4$	306
23.	30.492	0.05	n-Propyl 9,12-octadecadienoate	$C_{21}H_{38}O_2$	322
24.	30.607	0.23	9-Octadecenoic acid (Z)-, methyl ester	$C_{19}H_{36}O_2$	296
25.	30.772	0.09	Squalene	$C_{20}H_{40}O$	296
26.	31.105	1.53	9,12-Octadecadienoic acid (Z,Z)-	$C_{18}H_{32}O_2$	280
27.	31.203	3.93	Dichloroacetic acid, tridec-2-ynyl ester	$C_{15}H_{24}Cl_2O_2$	306
28.	31.564	0.79	Octadecanoic acid	$C_{18}H_{36}O_2$	284
29.	31.763	0.07	1H-pyrrole-2,5-dione,1-(2-furanylmethyl)-	$C_9H_7NO_3$	177
30.	32.968	24.14	2,3-Bis[(4-hydroxy-3-methoxyphenyl)methyl]butane-1,4-diol tetramethyl ether	$C_{24}H_{34}O_6$	418
31.	33.573	0.10	1-Butyl-2-(8-methylnonyl)phthalate	$C_{22}H_{34}O_4$	362
32.	33.780	0.12	2-((3,5,5-Trimethylhexyloxy)carbonyl)benzoic acid	$C_{17}H_{24}O_4$	292
33.	33.943	3.76	2,3-Naphthalenedimethanol derivative	$C_{24}H_{32}O_6$	416
34.	34.298	0.11	Phthalic acid, 3-methylbutylnonadecyl ester	$C_{32}H_{54}O_4$	502
35.	34.553	0.38	12D-Methyldibenzo pentaleno indene triamine	$C_{23}H_{21}N_3$	339
36.	34.883	0.29	Phthalic acid, 4-methylhept-3-yl pentyl ester	$C_{21}H_{32}O_4$	348
37.	35.035	0.29	Phthalic acid, butyldec-2-yl ester	$C_{22}H_{34}O_4$	362
38.	35.205	0.14	Didecan-2-yl phthalate	$C_{28}H_{46}O_4$	446
39.	35.620	0.04	4-Hydroxy-7-methoxyflavan	$C_{16}H_{16}O_3$	256
40.	35.700	0.12	Phthalic acid, decyl neopentyl ester	$C_{23}H_{36}O_4$	376
41.	35.860	0.05	Di-5-nonyl phthalate	$C_{26}H_{42}O_4$	418
42.	35.959	0.29	Diethylene glycol dibenzoate	$C_{18}H_{18}O_5$	314
43.	36.320	14.05	Hypophyllanthin	$C_{24}H_{30}O_7$	430
44.	36.737	0.76	Bis(2-ethylhexyl) phthalate	$C_{24}H_{38}O_4$	390
45.	37.194	0.15	Didecan-2-yl phthalate	$C_{28}H_{46}O_4$	446
46.	37.374	1.02	4'-O-Methylglabridin	$C_{21}H_{22}O_4$	338
47.	37.633	0.04	Acridin-9-yl-(4-methoxy-phenyl)-amine	$C_{20}H_{16}N_2O$	300
48.	37.712	0.05	Columbin	$C_{20}H_{22}O_6$	358
49.	38.124	0.40	1,2-Benzenedicarboxylic acid, dinonyl ester	$C_{26}H_{42}O_4$	418
50.	38.216	0.41	3,4-Bis(1,3-benzodioxol-5-ylmethyl)oxolan-2-one	$C_{20}H_{18}O_6$	354
51.	38.482	10.84	Hypophyllanthin	$C_{24}H_{30}O_7$	430
52.	38.605	14.44	Niranthin	$C_{24}H_{32}O_7$	432
53.	38.880	1.34	2-(2-Methylpropenyl)benzothiazole	$C_{11}H_{11}N$	189

54.	38.974	1.44	2(3H)-Furanone derivative	$C_{21}H_{22}O_6$	370
55.	39.135	0.16	β-Sitosterol acetate	$C_{31}H_{52}O_2$	456
56.	39.331	0.46	1,2-Benzenedicarboxylic acid, diisononyl ester	$C_{26}H_{42}O_4$	418
57.	39.523	0.13	Glabridin	$C_{20}H_{20}O_4$	324
58.	39.922	0.09	Tetrahydro-2-(3,3,3-trifluoropropyl)furan	$C_7H_{11}F_3O$	168

In contrast, the fresh *C.nucifera* sprout extract was predominantly characterized by triterpenoids, particularly Lup-20(29)-en-3-ol acetate (31.52%) and α-Amyrin (17.79%, 10.17%, and 1.60%), with a combined α-amyrin contribution exceeding 29%. The highest peak area observed for Lup-20(29)-en-3-ol acetate (31.52%) indicates strong triterpenoid dominance in the fresh sample. Triterpenoids such as α-amyrin are well recognized for their anti-inflammatory and hepatoprotective effects, mediated through cyclooxygenase (COX) inhibition, suppression of pro-inflammatory cytokines, and enhancement of endogenous antioxidant defense systems. B-Asarone (9.67%) was also detected in moderate proportion, contributing additional antimicrobial activity. The presence of phenolic compounds and fatty acids further strengthens the antioxidant and cardioprotective potential of the fresh extract.

Table 2: Phytocompounds present in Methanolic Extract of fresh *C.nucifera* Sprout by GC–MS Analysis

S.No.	Retention Time (min)	Peak Area %	Name of the Compound	Molecular Formula	Molecular weight (G/Mol)
1.	3.025	0.18	2-(methyl-D3)-cycloheptanone	$C_8H_{11}D_3O$	129
2.	3.164	0.47	1,2,3-Propanediol	$C_3H_8O_3$	92
3.	4.743	0.13	N-Methyl-N-[2-(methylamino)ethyl]cyclohexanamine	$C_{10}H_{22}N_2$	170
4.	6.325	0.12	4H-Pyran-4-one,2,3-dihydro-3,5-dihydroxy-6-methyl-	$C_6H_8O_4$	144
5.	7.676	1.14	Benzoic acid,2-hydroxy-,methyl ester	$C_8H_8O_3$	152
6.	8.363	0.16	2-Furancarboxaldehyde,5-(hydroxymethyl)-	$C_6H_6O_3$	126
7.	8.831	0.06	3-Acetoxy-3-hydroxypropionic acid,methyl ester	$C_6H_{10}O_5$	162
8.	9.819	0.06	β-Alanine,N-acryloyl-,isobutyl ester	$C_{10}H_{17}NO_3$	199
9.	13.116	0.33	1,2,3-Benzenetriol	$C_6H_6O_3$	126
10.	18.330	0.09	(2S,3S,6S)-6-Isopropyl-3-methyl-2-(prop-1-en-2-yl)-3-vinylcyclohexanone	$C_{15}H_{24}O$	220
11.	19.887	0.13	Benzene,1,2,3-trimethoxy-5-(1-propenyl)-,(E)-	$C_{12}H_{16}O_3$	208
12.	20.517	10.93	Diethyl phthalate	$C_{12}H_{14}O_4$	222
13.	21.183	9.67	β-Asarone	$C_{12}H_{16}O_3$	208
14.	21.542	0.25	Benzenepropanoic acid,4-hydroxy-	$C_9H_{10}O_3$	166
15.	22.650	0.14	β-Asarone	$C_{12}H_{16}O_3$	208
16.	23.975	0.11	(E)-4-(3-Hydroxyprop-1-en-1-yl)-2-methoxyphenol	$C_{10}H_{12}O_3$	180
17.	24.322	0.08	Isocalamenediol	$C_{15}H_{26}O_2$	238
18.	24.547	0.05	Tetradecanoic acid	$C_{14}H_{28}O_2$	228
19.	25.059	0.10	Oplopanonyl acetate	$C_{17}H_{28}O_3$	280
20.	26.125	0.09	Neophytadiene	$C_{20}H_{38}$	278
21.	26.723	0.06	Ent-Norsecurinine	$C_{12}H_{13}NO_2$	203
22.	27.477	1.55	Diphenyl sulfone	$C_{12}H_{10}O_2S$	218
23.	28.335	1.88	n-Hexadecanoic acid	$C_{16}H_{32}O_2$	256
24.	28.896	0.06	Hexadecanoic acid,ethyl ester	$C_{18}H_{36}O_2$	284
25.	30.781	0.06	2-Hexadecen-1-ol,3,7,11,15-tetramethyl- (Phytol)	$C_{20}H_{40}O$	296
26.	31.101	0.87	9,12-Octadecadienoic acid (Z,Z)-	$C_{18}H_{32}O_2$	280
27.	31.197	1.89	9(Z,Z)-6,9-Cis-3,4-epoxy-nonadecadiene	$C_{19}H_{34}O$	278
28.	31.567	0.41	Octadecanoic acid	$C_{18}H_{36}O_2$	284
29.	31.643	0.11	Ethyl (9Z,12Z)-9,12-octadecadienoate	$C_{20}H_{36}O_2$	308
30.	32.678	0.05	ent-Atisan-16α-ol	$C_{20}H_{34}O$	290
31.	34.285	0.06	2H-Pyran-2-one,tetrahydro-6-tridecyl-	$C_{18}H_{34}O_2$	282
32.	34.976	17.79	α-Amyrin	$C_{30}H_{50}O$	426
33.	35.040	10.17	α-Amyrin	$C_{30}H_{50}O$	426
34.	35.809	31.52	Lup-20(29)-en-3-ol,acetate,(3β)-	$C_{32}H_{52}O_2$	468
35.	36.485	0.62	Methylcommatea	$C_{32}H_{52}O_4$	500
36.	36.600	1.99	Acetic acid,(triphenylphosphoranylidene)-,methyl ester	$C_{21}H_{19}O_2P$	334
37.	36.752	2.42	Bis(2-ethylhexyl)phthalate	$C_{24}H_{38}O_4$	390
38.	37.335	0.99	(6aR,11aR)-9-Methoxy-6a,11a-dihydro-6H-[1]benzofuro[3,2-c]chromen-3-ol	$C_{16}H_{14}O_4$	270
39.	37.496	1.60	α-Amyrin	$C_{30}H_{50}O$	426
40.	38.076	1.26	Lup-20(29)-en-3-yl acetate	$C_{32}H_{52}O_2$	468
41.	39.874	0.37	Olean-12-en-3-ol,acetate,(3β)-	$C_{32}H_{52}O_2$	468

Comparatively, the dried sprout extract exhibited higher lignan and phenolic dominance, with major peak areas ranging from 10% to 24%, whereas the fresh sprout extract showed pronounced triterpenoid predominance, with peak areas reaching up to 31.52%. This compositional variation suggests that controlled drying may enhance the concentration and detectability of lignans and phenolic derivatives, while fresh sprouts retain higher levels of triterpenoids. Overall, both extracts demonstrate significant bioactive potential, with the dried sprout favoring antioxidant and hepatoprotective lignans, and the fresh sprout showing stronger triterpenoid-associated anti-inflammatory activity.

These observations are consistent with the findings of Parimalam *et al*. (2021) [22], who reported significant presence of phenolics, terpenoids, and fatty acids in coconut haustorium extracts through GC–MS analysis, emphasizing their therapeutic relevance. Similarly, Valli and Gowrie (2017) [5], documented the occurrence of bioactive phenolic and terpenoid compounds in coconut-derived materials, highlighting their antioxidant and antimicrobial activities.

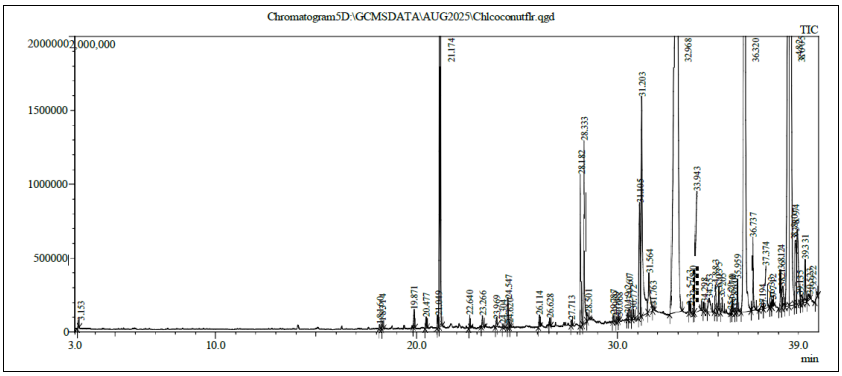

Fig 1: GC-MS Spectrum of methanolic extract of dried coconut sprout

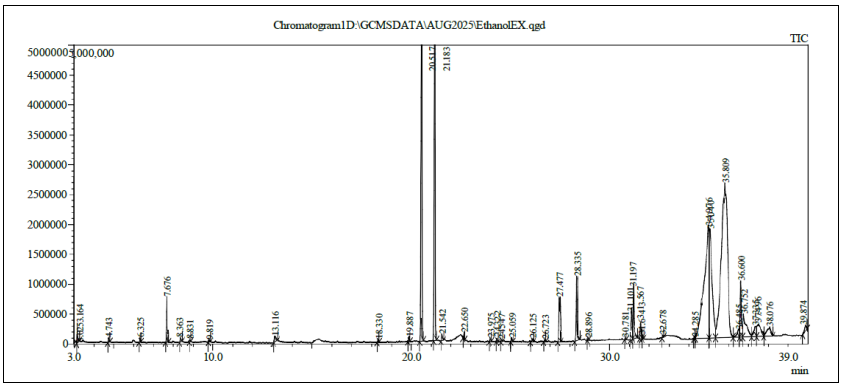

Fig 2: GC-MS Spectrum of methanolic extract of fresh coconut sprout

Fourier transform infrared spectrophotometer (FT-IR) analysis

FT-IR is a reliable and sensitive method used for identification of biomolecular composition of plant extracts. The crude extract of dried *C.nucifera* sprout was subjected to FT-IR analysis. The functional group of the components was separated based on its peak ratio. The FT-IR spectrum chromatogram profile of dried *C.nucifera* sprouts was illustrated in the table 3 and figure 3.

The FT-IR spectrum exhibited strong absorption bands with characteristic functional groups. The FT-IR spectra of dried *C.nucifera* sprouts showed the presence of various functional groups such as alcohols, phenols, carboxylic acids, amides, esters, aldehydes, ketones, alkanes and ethers. The results revealed that terpenoids were present due to the presence of C-H stretch of alkanes at 2137.13 and 2854.65 cm^{-1}. The presence of O-H stretch of alcohols and phenols shows the peaks at 3992.65 and 3734.19 cm^{-1}. High wave numbers correspond to higher energy vibrations such as O-H and C-H stretching. At the same time, the presence of C=O stretch of ketones showed at 1870.95, 1847.81, 1828.52 and 1743.65 cm^{-1} indicated the presence of saponins in par with Valli and Gowrie, 2017. Strong peaks such as ketones, aldehydes and esters fall into these ranges and produce strong absorption. Similarly, amines (N-H) stretching showed peak at 3425.58 and 3197.98 cm^{-1} and alcohols (C-O stretching) was noticed peak at 1257.59, 1145.72, 1103.28, 1053.13 and 925.83 cm^{-1} in the dried *C.nucifera* sprouts.

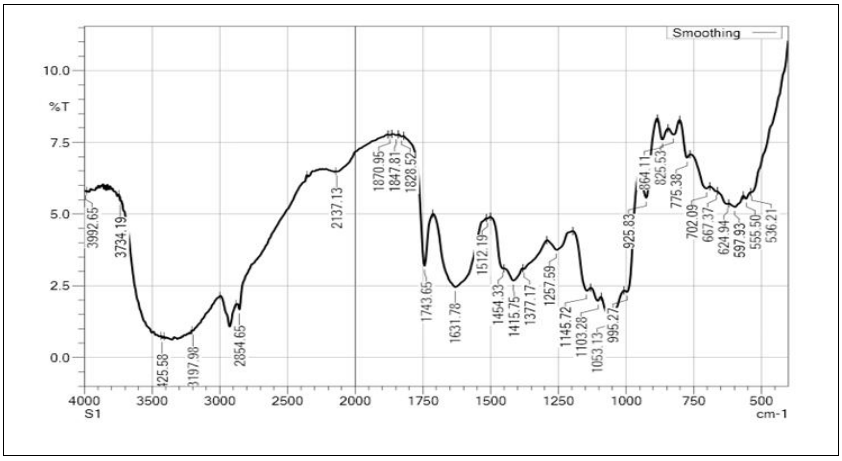

Fig 3: FTIR spectrum of dried *C.nucifera* sprout

The FTIR spectrum of dried *C.nucifera* sprout exhibited broad absorption bands at 3992.65 cm^{-1} and 3734.19 cm^{-1}, corresponding to O–H stretching vibrations. These broad peaks are characteristic of hydroxyl functional groups present in phenolic compounds and triterpenoids. The presence of O–H stretching in this region may be attributed to hydroxyl-containing phytoconstituents such as α-amyrin and other triterpenoid alcohols identified through GC–MS analysis.

Table 3: Significant Functional Groups Identified from the FT-IR Spectrum of dried *C.nucifera* sprout

S.No	Wavenumber (cm^{-1})	% Transmittance (Corr. Intensity)	Functional Group	Reference Compound	Intensity
1.	3992.65	0.03	O–H stretching	Free hydroxyl group (alcohols/phenols)	Weak
2.	3734.19	0.07	O–H stretching	Free alcohol / phenolic O–H	Weak
3.	3425.58	0.07	O–H stretching (broad)	Hydrogen bonded alcohols / phenols	Weak–Medium
4.	3197.98	0.06	N–H stretching	Secondary amines / amides	Weak
5.	2854.65	0.39	C–H stretching	Alkane	Medium
6.	1743.65	2.59	C=O stretching	Ester / α-lactone	Strong
7.	1631.78	2.50	C=C stretching	Alkene	Strong
8.	1512.19	0.04	N–O stretching	Nitro compound	Weak
9.	1454.33	0.15	C–H bending	Alkane	Weak–Medium
10.	1377.17	0.07	O–H bending	Alcohol / Phenol	Weak
11.	1257.59	0.45	C–N stretching	Amines	Medium
12.	1145.72	0.58	C–O stretching	Tertiary alcohol	Medium
13.	1103.28	0.24	C–O stretching	Secondary alcohol	Medium
14.	1053.13	0.79	S=O stretching	Sulfoxide	Medium

These findings are consistent with reports by Valli and Gowrie (2017) [5], who documented the presence of hydroxyl-containing phytochemicals in coconut-derived materials and associated them with antioxidant and antimicrobial properties. Similarly, Parimalam *et al*. (2021) [22] confirmed the occurrence of phenolics and triterpenoids in coconut haustorium extracts, highlighting their therapeutic relevance. The biological significance of hydroxyl-bearing phytoconstituents in antioxidant and antidiabetic mechanisms has also been widely supported in phytochemical literature (Shahidi & Ambigaipalan, 2015) [18].

Therefore, the O–H stretching peaks observed at 3992.65 cm^{-1} and 3734.19 cm^{-1} confirm the presence of hydroxyl-rich phytocompounds such as triterpenoids and phenolics, which contribute substantially to the antioxidant, anti-inflammatory and antibacterial potential of dried coconut sprout flour.

Conclusion

From the above results, it was observed that the dried and fresh *C.nucifera* sprout extract exhibited 58 compounds and 41 compounds. It can be inferred that *C.nucifera* sprouts are rich in a variety of bioactive compounds exhibiting distinct biological properties including antimicrobial, anti-inflammatory, cytotoxic potential, antioxidant and hepatoprotective activities. Among the identified compounds 2,3-Bis[(4-hydroxy-3 methoxyphenyl)methyl]butane-1,4-diol tetramethyl ether and Lup-20(29)-en-3-ol,acetate,(3β)- emerges as the most prevalent constituents constituting 24.14% and 31.52% of the total compounds detected in the dried and fresh *C.nucifera* sprouts respectively. The dried and fresh *C.nucifera* sprouts used as a traditional healer for various health issues which is backed by the presence of numerous bioactive compounds. Hence, it was concluded that GC-MS and FTIR estimation confirmed the presence of numerous bioactive compounds which strongly recommended for human ailments.

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