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Phytochemical isolation and characterization of a potent food colorant from *Garcinia mangostana* peel

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ABSTRACT; Mangosteen (*Garcinia mangostana* L.) is an evergreen tropical tree belonging to Clusiaceae family, cultivated mainly as a source of highly palatable fruit. The fruit is dark purple or reddish with white juicy pulp Mangosteen which is also known as 'Queen of fruits". The fruit rind which is consists of many phytochemicals like xanthonens, benzophenols, flavonoids, and anthocyanin because of which pericarp having wide range of medicinal properties like in treatment of skin infection and wounds, amoebic dysentery in ayurveda it is used against inflammation and diarrhea, cholera and dysentery. The xanthonens derivatives of Mangosteen have pharmacological activities like anti-diabetic, antioxidants and anti-inflammatory properties. Because of this wide range of properties, the peel of fruit is concentrated for the color extraction. The extraction of color from Mangosteen peel involved several steps like collecting the peel of the fruit sun drying powdering this gives a crude extract which is used for aqueous extract where for extraction of color, water is used as solvent. Various parameters, including extraction time, hot plate temperature, RPM of hot plate, were optimized to maximize the extraction efficiency and color intensity. The colored product of aqueous extract is characterized using methods such as paper chromatography, gas chromatography-mass spectroscopy and Raman spectroscopy The RF value of aqueous extract when run on paper chromatography using mobile phase, petroleum ether, acetone, water in ratio of 3:1:1 respectively was found to be 0.56 which concludes the presence of xanthophyll pigments. For characterizing the compounds present in mangosteen aqueous extract and crude extract, Raman spectroscopy and Gas Chromatography-Mass Spectrometry (GC-MS) are powerful techniques. Raman Helps in identifying specific functional groups and molecular interactions present in the extracts. Gas Chromatography-Mass Spectrometry (GC-MS) identifies volatile and semi volatile organic compounds by using ethyl alcohol as the solvent which shows the presence of multiple compounds.

Keywords: *Garcinia mangostana L.*, GC-MS, Food colorants, xanthonens.

I. INTRODUCTION

Mangosteen *(Garcinia mangostana L.)* is an evergreen tropical tree belonging to the Clusiaceae family that grows in Southeast Asia, and is cultivated mainly as a source of its highly palatable fruit. The main phytochemicals present in the species are isoprenylated xanthones, a class of secondary metabolites with multiple reports of biological effects, such as antioxidant, pro-apoptotic, anti-proliferative, antinociceptive, anti-inflammatory, neuroprotective, hypoglycemic and anti-obesity. [1]

Figure.1 *Garcinia mangostana* fruit showing pericarp and pulp.

Mangosteen (*Garcinia mangostana Linn.*) (GML) is a tropical tree from India, Myanmar, Malaysia, Philippines, Sri Lanka, and Thailand

Mangosteen is composed of 17% of outer pericarp, 48% of inner pericarp, 31% of flesh and 4% of cap. Most of anthocyanin was found in outer pericarp (179.49) while most of total phenolic was found in inner pericarp (3,404) mg Gallic acid equivalent (GAE)/100 g).[2] The Mangosteen-fruit is dark purple or reddish, with white, soft and juicy

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edible pulp with a slightly acid and sweet flavor and a pleasant aroma. Mangosteen is known as “the queen of fruits.

Furthermore, mangosteen contains bioactive compounds such as xanthones, terpenes, anthocyanins, tannins, phenols, and some vitamins10. The nutritional value of mangosteen per 100 g includes 80.9 g of water, 0.5 g of protein, 18.4 g of carbohydrates, 1.7 g of fibre, 9 mg of calcium, 14 mg of phosphorus, 0.5 mg of iron, 2 mg of vitamin C, 0.09 mg of vitamin B1 (thiamine), 0.06 mg of vitamin B2 (riboflavin), and 0.1 mg of vitamin B5 (niacin), The main xanthone derivative is α-mangostin, this compound has a variety of pharmacological activities such as antidiabetic, antioxidants, and anti-inflammatory [3].

Food colorants play an important role in food industry altering or conferring colors to food to increase the customer attractiveness and sensory acceptability. Food colorants have been used since ancient times to increase the aesthetic value of foods and the level of demand by consumers. In addition, food colorants are widely used for many basic reasons such as revitalizing or intensifying the natural colour of food and making it permanent, as well as preserving aroma and light-sensitive vitamins, as the consumer associatescolour with food quality [4].

Natural food colors consist of pigments such as anthocyanins, carotenoids, chlorophyll etc. that are extracted from mainly plants and micro-organisms. The demand for food products with natural colourings agents has increased since consumption of synthetic colourings are believed to cause allergies, food intolerance, hyperactivity, irritability and sleep disorders in children [5].

The epicarp of mangosteen has been used in medicine and pharmacology to treat diseases like antidiabetic, antimicrobial, anticarcinogenic, appetite suppressant, and others due to the presence of metabolites such as anthocyanins, xanthones, terpenoids, flavonoids, lactones [6]

Mangosteen peel is an ingredient of plant origin that was developed for the production of natural dyes in Malaysia and Indonesia because this material contains a lot of anthocyanin compounds which produces a red color, and tannin which produces a brown color [7].

Anthocyanins have been used in traditional medicine and for colouring food since ancient times. The therapeutic effects of anthocyanins are mainly attributed to their antioxidant activities [8]-. Anthocyanins have demonstrated several other health benefits such as antibacterial, Antiproliferative, hypoglycemicetc.[9]. The stability of anthocyanins is influenced by factors such as chemical structure, pH, temperature, light, presence of oxygen, solvent, the presence of co-pigments, metal ions, and enzymes [10].

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Part	Total Phenolic content (mg GAE/100g)	Anthocyanin content (mg Cyn-3-Glu/100g)	EC_{50} (µG/mL)
Outer Pericarp	2,930.49±318.10[b]	179.49±10.80	4.73±0.55
Inner Pericarp	3,404.49±321.92	19.71±22.98	1.35±0.13

Table.1 Total phenolic and anthocyanin content in outer and inner pericarp

Phytochemical screening, based on ethnomedicinal data, is considered as an effective approach for the discovery of new therapeutic agents. The major bioactive secondary metabolites of mangosteen are xanthone derivatives. [3]
Xanthones are the major bioactive component found in mangosteen. At least over 68 xanthones derivatives isolated from mangosteen fruit were reported[11].

Number	Compound Name	Type	Plant Part
1	α-Mangostin	Xanthones	Pericarp, whole fruit, stem, arils, and seed
2	β-Mangostin	Xanthones	Pericarp, whole fruit, stem
3	γ-Mangostin	Xanthones	Pericarp, whole fruit
4	1,3,6,7-Tetrahydroxy xanthone	Xanthones	Pericarp
5	1,3,6,7-Tetrahydroxy-2,8-(3-methyl-2-butenyl) xanthone P1	Xanthones	Pericarp
6	1,6-Dihydroxy-2-(2-hydroxy-3-methylbut-3-enyl)-3,7-dimethoxy-8-(3-methylbut-2-enyl)-xanthone	Xanthones	Pericarp
7	1,6-Dihydroxy-3-methoxy-2-(3-methyl-2-buthenyl)-xanthone	Xanthones	Pericarp
8	1,7-Dihydroxy-2-(3-methylbut-2-enyl)-3-methoxy-xanthone	Xanthones	Pericarp
9	1,7-dihydroxy-2-isopentyl-3-methoxy xanthone	Xanthones	Pericarp
10	1-Isomangostin	Xanthones	Pericarp
11	1-Isomangostin hydrate	Xanthones	Pericarp
12	2-(γ,γ-Dimethylallyl)-1,7-dihydroxy-3-methoxyxanthone	Xanthones	Pericarp
13	3-Isomangostin	Xanthones	Pericarp
14	3-Isomangostin hydrate	Xanthones	Pericarp
15	8-Deoxygartanin	Xanthones	Pericarp, whole fruit
16	8-Hydroxycudraxanthone	Xanthones	Pericarp
17	BR-Xanthone A	Xanthones	Pericarp
18	BR-Xanthone B	Xanthones	Pericarp
19	Cudraxanthone	Xanthones	Pericarp
20	Garcimangosone B	Xanthones	Pericarp

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21	Garcimangosone C	Xanthones	Pericarp
22	Garcinone B	Xanthones	Pericarp, whole fruit
23	Garcinone D	Xanthones	Pericarp, whole fruit, stem
24	Garcinone E	Xanthones	Pericarp, whole fruit, stem
25	Gartanin	Xanthones	Pericarp, whole fruit, stem
26	Mangostanin	Xanthones	Pericarp
27	Mangostenone A	Xanthones	Pericarp
28	Mangostenone B	Xanthones	Pericarp
29	Mangostinone	Xanthones	Pericarp, whole fruit
30	Smeathxanthone A	Xanthones	Pericarp
31	Tovophyllin A	Xanthones	Pericarp
32	Tovophyllin B	Xanthones	Pericarp
33	Toxyloxanthone A (trapezifolixanthone)	Xanthones	Pericarp
34	1,7-dihydroxyxanthone	Xanthones	Pericarp
35	Euxanthone	Xanthones	Pericarp
36	Caloxanthone A	Xanthones	Pericarp
37	Macluraxanthone	Xanthones	Pericarp
38	Mangostingone [7-methoxy-2-(3- isoprenyl)-8-(3-methyl-2-oxo-3-buthenyl)-1,3,6-trihydroxyxanthone	Xanthones	Pericarp
39	Garcimangosone D	Benzophenones	Pericarp
40	Maclurin	Benzophenones	Pericarp
41	Kolanone	Benzophenones	Pericarp
42	Epicatehin	Flavonoids	Pericarp
43	Chrysanthemin	Anthocyanins	Pericarp
44	Cyanidin-3-O-sophoroside	Anthocyanins	Pericarp

Table.2 Phytochemical composition of Mangosteen Pericarp [3].

Mangosteen extracts, products, and isolated compounds were shown to increase antioxidant levels through in vivo studies by either increasing antioxidant enzymes (such as SOD, CAT, GPx and GSH) or by decreasing oxidative stress markers (such as MDA level). Mangosteen showed a positive effect in alleviating disease-related parameters in type II diabetes models, cardiovascular models, neurological disorder models, stress-induced models, and liver and kidney injury models. These results signified that mangosteen could be a promising adjuvant drug or supplement to oxidant-related diseases. However, in clinical trials, although mangosteen intervention significantly increased plasma antioxidant capacity. [12].

In recent years, polyphenols attracted the attention of many researchers for its physiological functionality. Due to the presence of abundant hydroxyl (–OH) groups in their structure phenolics have been reported to show antioxidant potential which is imputed by metal ion chelation and free radical scavenging mechanism. This antioxidative action combats oxidative damages in the body which is a chief cause for diseases such as diabetes, cardiovascular diseases, hypertension, gastrointestinal disorders, neurodegenerative diseases, and cancer. Hence, naturally available herbs are being exploited for these health benefits. The different species of the genus Garcinia are among those herbs widely used for its health benefits as they are rich in phytochemicals [23].

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Raman spectroscopic techniques are a group of chemical fingerprint detection methods based on molecular vibrational spectroscopy. They are compatible with aqueous solutions and are time saving, non-destructive, and highly informative [13][14].

The importance of the use of Raman spectroscopy for the rapid identification and characterization of phytochemicals present in plants were investigated. Raman spectroscopy offers significant advantages for the analysis of complex chemical compounds because it does not require laborious sample preparation and it is a non-destructive method [15].

GC-MS is an important technique that has been adapted to evaluate different phytoconstituents present in various plant extracts with their structures. This technique has superior separation potency that leads to produce a high accuracy and precision of chemical fingerprint. Moreover, quantitative data along with the coupled mass spectral database can be given by GC-MS that is of tremendous value for achieving the correlation between bioactive compounds and their applications in pharmacology [16].

II. MATERIALS AND METHODOLOGY

SAMPLE COLLECTION AND IDENIFICATION

Fresh ripen fruit was collected by a local market. Washed with tap water, then the fruit peel was collected and shade drying until peel become dried and the fruit was identified by Prof. Rudrappa (Botanist) as *Garcinia mangostana* and moved to further processing[19].

PREPERATION OF AQUOUS EXTRACT

Dried peel was finely powdered by using pestle and mortar. 25g of the crude powder was taken in a 500ml beaker, to that 250ml of distilled water was added. Mix thoroughly by using glass rod. Keep it in water bath at 100º C for 20 minutes by covering the mouth of the beaker. As soon as heating, the beaker was transferred to hot plate. A magnetic bead was put into the beaker. The hotplate was run for 2 hours at the temperature maintaining at about 40º C and the rpm of the hotplate was adjusted to

The content was allowed to settle for a few minutes. After the separation of upper clear and colored solution, it was separated by lower residue. The upper solution is taken in a clean petri plate and it is dried using oven for 1 hour at 150º C. The dryness of the extract is tested by scratching the extract using a spatula. The powdered is collected by scraping. Finally, the aqueous extract was filled in Eppendorf's tube [20].

TOTAL PHENOLIC CONTENT

Folin-Ciocalteau reagent (FCR) method was used to determine the content of total phenolics in extracts [17]. In a clean test tube, 0.5ml (10mg/mL) of extract was mixed with 0.5ml of FC reagent (1:1) along with 2ml of sodium carbonate (7%) and left for 30 minutes incubation at room temperature. The optical density was read at 765nm in UV-Vis spectrophotometer (eppendorf- Bio Spectrometer basic/6135). A standard curve was plotted using different concentrations of Gallic acid (standard, 0-1000 µg/ml) and the total phenolic content of extracts was expressed as µg Gallic acid equivalents (GAE) [18].

DPPH radical scavenging activity: 5g of the sample was homogenized with 20ml of methanol (80% v/v) in a pestle and mortar. To 0.2ml of extract, 0.3 ml of acetate buffer and 2.5 ml of DPPH solution were added. The reduction in colour was measured spectrophotometrically at 517nm. The absorbance of DPPH solution without sample was also measured. The difference in the absorbance of DPPH solution with and without sample was calculated. The decrease in absorbance with sample addition was used for calculation of anti-oxidant activity. The standard curve was prepared with different concentrations of ascorbic acid (20-100 µg/ml) and results were expressed as ascorbic acid equivalent antioxidant capacity (AEAC) [26].

Calculation

$$\text{DPPH} = \frac{\text{OD 517} \times \text{Std.value} \times \text{Total volume} \times 100}{\text{Assay value} \times \text{Wt.of the sample (g)} \times 1000}$$

$$\% \text{ inhibition} = \frac{(AC - AS)}{(AC)} \times 100$$

Where,
AC = Absorbance of control
AS = Absorbance of sample

CHARACTERIZATION OF THE AQUEOUS EXTRACT

Characterization of aqueous extract, which helps to detect the pigments present in the sample by using Chromatographic and GCMS methods.

Chromatography

The separation of plant pigments by paper chromatography is an analysis of pigment molecules of given plant based on absorption and capillarity.

Whatman filter paper was taken and a thin line was drawn above 2cm from the bottom by using pencil and scale Then the filter paper was cut to

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make conical edge from the line drawn towards margin end by using scissors to cut Whatman filter paper. Spot 'A' and 'B' were marked on the line. The crude extract and the aqueous extract were mixed separately with acetone and spotted on 'A' and 'B' at the same time.

Mobile phase was added to a clean chromatographic column. Mobile phase is the combination of solvents petroleum ether, acetone and water in the ratio 3:1:1 respectively. Bend the strip of paper from the top. Then, using a pushpin attach the paper to the bottom of the cork. Adjust the length of the paper. The absorbent paper should not touch the surface of the measuring cylinder. After that, allow the solvent to move up the absorbent paper. When the solvent front has stopped moving, remove the paper. Allow it to dry for a while until the colours completely elute from the paper. At last, mark the front edge travelled by each pigment. Calculated Rf values for each pigment. Rf stands for retardation or retention factor. Rf value was calculated by knowing the distance analyte travelled by the distance solvent travelled. The yellow band represents xanthophyll pigment.

Raman Spectra

All optical components in a Raman spectrometer show small contributions to the final spectrum of routine samples. Two Raman spectra of the optical background were collected under similar conditions as the routine samples with the difference that no samples are in focus. Before subtraction from the Raman spectra of routine samples, Raman spectra of optical background were dark corrected, averaged out and shifted towards the reference axes as will be discussed further on.

Gas Chromatography Mass Spectrometry

The powdered material of both crude extract and aqueous extract were stocked in an airtight glass container. A total a pinch of samples was used to perform GC-MS using different solvents by following the method used by Durga Mahalakshmi et al., 2014[23].

III. RESULTS AND DISCUSSION

Figure.2 Dried Mangosteen peels

Figure.3 Crude extract

SELECTION AND IDENTIFICATION

Fresh ripen fruit was collected and it is identified as *Garcinia mangostana* and shade dried until peel becomes completely dried as shown in Figure.1and Figure.2 displays powered dried peel.

Duraisamy Gomathi, Manokaran Kalaiselvi, Ganesan Ravikumar, Kanakasabapathi Devaki, Chandrasekar Uma (2013) reported that "GC-MS analysis of bioactive compounds from the whole plant ethanolic extract of *Evolvulus alsinoides (L.) L.*

Evolvulus alsinoides (L.) L. used for the investigation was obtained from Coimbatore District, Tamilnadu, India. The plant was authenticated by Dr. P. Satyanarayana, Botanical Survey of India, Tamil Nadu Agricultural University (TNAU) Campus, Coimbatore. The voucher number is BSI/SRC/5/23/2011-12/Tech.-514. Fresh whole plant material of *Evolvulus alsinoideswas* washed under running tap water, air dried and powdered in electric blender [19].

PREPARATION OF AQUEOUS EXTRACT

As seen in **Figure.3** It shows the transition from crude extract to aqueous extract involved using water as solvent, initially heating was done in hot water bath and then transferred to hot plate with magnetic bead upper solution was taken and dried it was the aqueous extract which is further proceed to characterization.

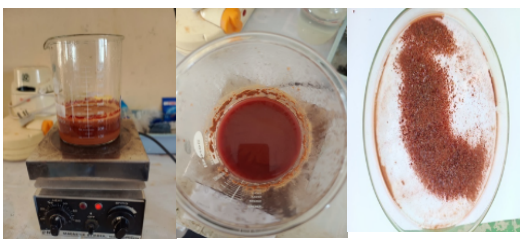

Figure.4 Preparation of aqueous extract

Rony Mia, Md. Minhajul Islam, Taosif Ahmed, Md. Azhar Waqar, (2022) reported "Natural dye extracted from *Triadica Sebifera* in aqueous medium for sustainable dyeing and functionalizing of viscose fabric".

The tallow tree barks were prepared by grinding using a grinder machine for 1 min. After

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extracting the sample from the grinder chamber and placing it in a poly bag, approximately 1000 g of tallow tree bark powder were prepared and weighed using a digital balance meter. The sample was then prepared for use in the extraction procedure. In order to get the dyes from the bark of the tallow trees, a water extraction was done. First, the power of the tallow tree bark was taken and made into a flux. Then, a different amount of powder and water were taken. There are a lot of different single-factor conditions that were looked at in this case, like the M: L Ratio (1:20, 1:40, 1:60, 1:80, 1:100, and 1:120). Then, at different temperatures, like (50 °C, 60 °C, 70 °C, 80 °C, 90 °C, 100 °C), the pH was 3,5,7,9,11,13, and time were 30 min, 50min, 70 min, 90 min and 110 min, and 130 min. Here, NaOH and CH3COOH were used to keep the water pH level stable. After prepared the solution, it was cold and then filtered through filter paper to get rid of a big particle from the water [20].

TOTAL PHENOLIC CONTENT OF EXTRACTS OF *Garcinia mangostana*

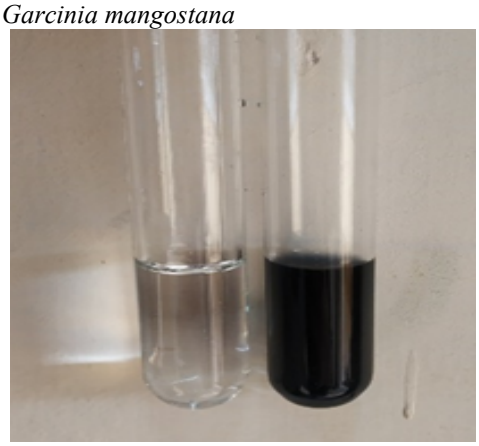

Figure.5 Test tube showing presence of phenolic content.

The Citrus fruits contain abundant amount of phenolic compounds and it show strong antioxidant properties through the dehydrogenation of hydroxyl groups. Table 3 shows the content of total phenolics in *Garcinia mangostana* peel extracts (as estimated by FCR method). Total phenolic content, as estimated in terms of µg GAE/mg extract, was high in ethanolic extract of *Garcinia mangostana* peel followed by methanolic extract.

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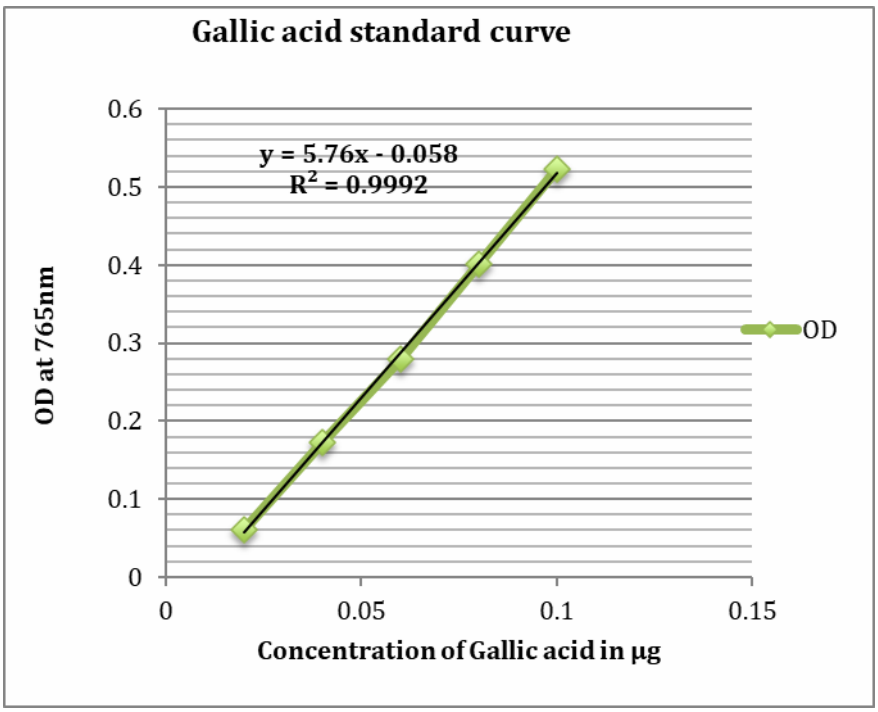

Graph 1: Gallic acid standard curve

Extract	**Total phenolic content (µg GAE/mg)**
Ethanolic	2.87
Methanolic	2.59

Table.3. Total phenolic content (µg GAE/mg) of extracts of *Garcinia mangostana* peel

Sadef Y, Javed T, Javed R, Mahmood A, Alwahibi MS, Elshikh MS, Abdel Gawwa MR, Alhaji JH, Rasheed RA (2022) reported the details in 'Nutritional status, antioxidant activity and total phenolic content of different fruits and vegetable's peels'. lowing the Folin-Ciocalteu (FC) method with slight modifications as described by Srinivas et al. [30]. Briefly, 0.5 ml of 10% Folin reagent was added to 0.1 ml of prepared extract. The mixture was then swirled and allowed to stand for about 6 minutes, followed by the addition of 1 ml of 7.5% Na2CO3 followed by thorough mixing. The resulting solutions could then stand for 2 hours at room temperature. After incubation, the absorbance was measured at 765 nm by using UV/Vis Shimadzu–Japan spectrophotometer. The calibration curve was obtained using gallic acid as standard with concentrations ranging from 100 to 1000 mg/ml. The results of TPC were expressed as gallic acid equivalent (GAE) per gram of dry sample concerning the gallic acid standard curve (R2 = 0.900) [21]

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ANTIOXIDANT ACTIVITY

Sample	DPPH % inhibition
Crude extract	69.4
Aqueous extract	58.26

Table.4. Percentage inhibition of DPPH in Crude and Aqueous extract

Table 4 reveals the percentage inhibition of DPPH in crude and aqueous extract. The antioxidant activity of *Garcinia mangostana* was evaluated by using DPPH assay which measures the ability of peel extracts to reduces the DPPH is a stable free radical accepts an electron or hydrogen radical to become a stable diamagnetic molecule. The reduction capability of DPPH radical is determined by the decrease in absorbance at 517nm induced by antioxidants to yellow coloured diphenyl picrylhydrazine, among the crude and aqueous extract the crude extract shows the high level of antioxidant activity by DPPH inhibition percentage of 69.4% and aqueous extract show 58.26%, so the crude extract of *Garcinia mangostana* has stronger ability to neutralize free radicle compared to aqueous extract.

Nurhayati Rahayu; Setiyo Gunawan; Hakun Wirawasista Aparamarta (2023) reported the detailes of Extraction of bioactive compound from mangosteen peel (*Garcinia mangostana L.*) using ternary system solvent.

This study aims to determine the effect of the ternary system solvent on the antioxidant activity of mangosteen peel extract. In this study, mangosteen peel extraction was done by a simple Liquid-liquid Extraction (LLE) method using a choice of ternary system solvent by heating and shaking. The solvents used are 96% ethanol, isopropyl alcohol, and ethyl acetate, which are added with hexane and H2O mixture and will form two solvent layers. Extraction was performed at operating temperature conditions of 40°C, a solid to solvent ratio was 1:20 (w/v), and the extraction time was 1 hour. The soluble solids content was determined by the gravimetric and the antioxidant abilities tested using the DPPH method (1,1-diphenyl-2-picrihidazil). The results showed the best antioxidant results in the solvent mixture isopropyl alcohol: Hexane: H2O 1:1:1 upper fraction, with extract yield values of 17.52% and %DPPH inhibition of 60.42 for 20 µg/ml extract. In comparison, the α-mangostin standard has a DPPH inhibition value of 24.737% for a concentration of 20 µg/ml [22].

CHROMATOGRAPHY

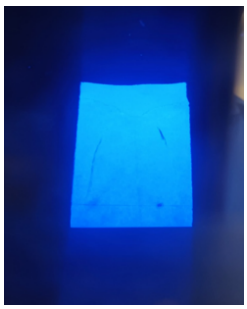

Figure.5 Paper Chromatogram observed under UV light

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Rf value was calculated by knowing the distance analyte travelled by the distance solvent travelled. The yellow band represents xanthophyll pigment.
Rf value= Distance xanthophyll travelled / Distance solvent travelled = 5.6/10 = 0.56.

RAMAN SPECTRA

Crude extract

Raman spectra as illustrated in figure 6 gives the prominent peak at wave number 1143 cm^{-1}, 1338 cm^{-1}, 1318 ,1339 cm^{-1}, 1606 cm^{-1} , 1665cm^{-1} , 1611cm^{-1}

The 1143cm^{-1} peaks can be attributed to vibrational modes of CH2 twisting.

1338cm^{-1} for polynucleotide chain 1318cm^{-1} and 1339cm^{-1} for CH2 twist and bend (Nucleic acid and Protein, Lipids)

1606cm^{-1} and 1669cm^{-1} for aromatic amino acids 1611cm^{-1} for Tryptophan.

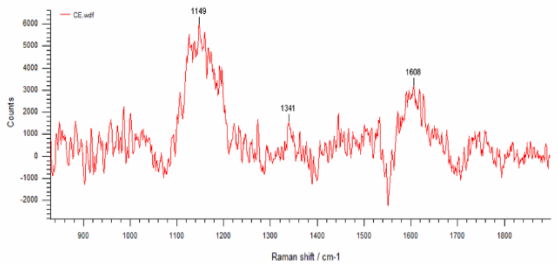

Figure.6 Spectra of crude extract

Crude extract -1

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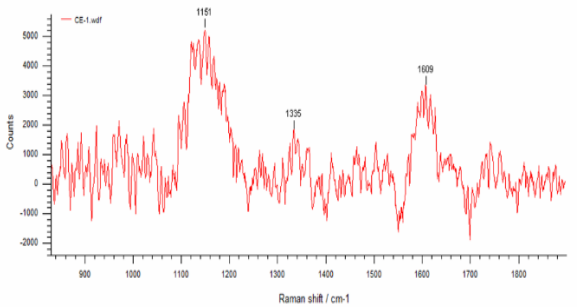

Figure.7 Spectra of crude extract-1

Raman spectra obtaining from **Figure.5** shows the prominent peak at wave number 1151 cm^{-1} 1176 cm^{-1} , 1318 cm^{-1} , 1338 cm^{-1} , 1359 cm^{-1} , 1336 cm^{-1}, 1605cm^{-1} , 1614 cm^{-1}. The 1151 cm^{-1} and 1176cm^{-1} peak can be attributed to vibrational modes of Protein and Carotenoids.

1338cm^{-1} for Polynucleotide chain 1318 cm^{-1} and 1359 cm^{-1} for CH2 twist and bend (nucleic acid, protein and lipids) 1336cm^{-1} for adenine. Polyphenol, 1605 cm^{-1} for aromatic amino acids. 1614 $cm^{-1}$for NH3+asymmetric bond.

Aqueous extract

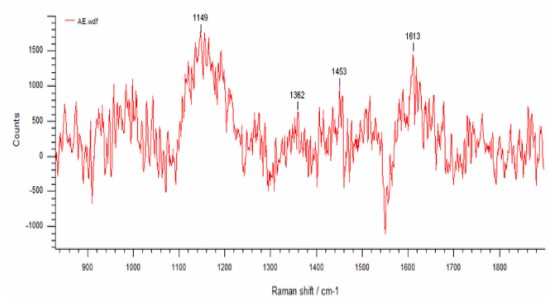

Figure.8 Spectra of aqueous extract

Raman spectra reveals in figure 8 were presents the prominent peaks at wave number at 1149 cm^{-1} , 1367 cm^{-1} , 1382 cm^{-1}, 1448 cm^{-1},1452 cm^{-1} ,1447 cm^{-1}.

The 1143 cm^{-1} peaks can be attributed to vibrational mode of CH2 twisting.1367cm^{-1} and 1382 cm^{-1} for CH3 symmetric stretching and co-symmetric stretching.

1448cm^{-1} for CH2 Scimoring.

1452cm^{-1} for CH2Strech deformation of methylene group (lipids).

1447cm^{-1} for C- 4 deformation, nucleic acid, protein, lipids.

1447$cm^{-1}$for lipids Proteins.

Aqueous extract – 1

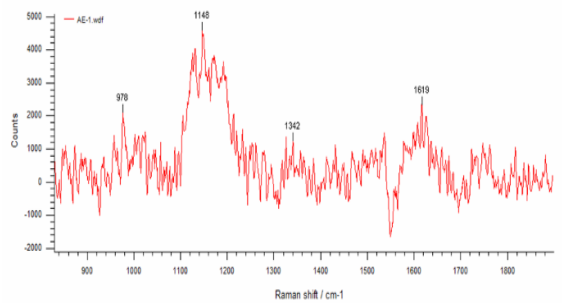

Figure.9 Spectra of aqueous extract-1

Raman spectra depicted in **Figure 7** were provides the prominent peak at wave number 986cm^{-1}, 957 cm^{-1}, 936 cm^{-1}, 1141 cm^{-1},1338 cm^{-1}, 1318 cm^{-1},1339cm^{-1},1336 cm^{-1},1614 cm^{-1} ,1611 cm^{-1} .

The 98 cm^{-1}, peaks attributed to vibration mode of C-C or (-o ribose)

937cm^{-1} for membrane protein 936cm^{-1} for skeletalmode of Polysaccharide.

1443cm^{-1} for CH2 twisting.

1338cm^{-1} for Polynucleotide chain. 1318 cm^{-1} and 1339cm^{-1} for CH _2 twist and bond (nucleic acid, protein, lipids) 1336cm^{-1} for adenine, Phenyl adenine CH deformation.

1614cm^{-1} for NH3 asymmetry bond.

1611cm^{-1} for Tryptophan.

GC – MS ANALYSIS

Crude extract EA

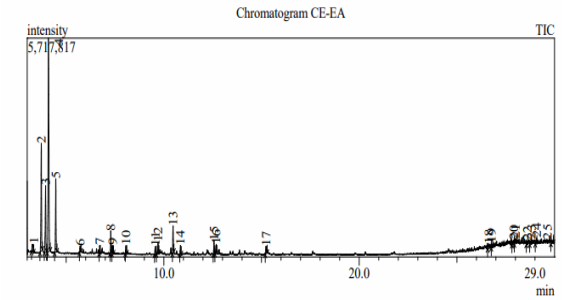

Figure.10 Chromatogram of crude extract

Figure 10 reveals GCMS chromatogram of a Mangosteen peel crude extract which was obtained by using ethyl alcohol as solvent. the chromatogram presents 4 peaks each peak signifies multiple compounds in extract.

Peak 2 corresponds to chemical compounds Chlorobenzene and phenyl chloride.

Peak 3 to Ethylbenzene, Ethylbenzol and Phenylethane.

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Peak 4 to Orthoxylene, Benzene 1, 2 – Dimethyl, Ortho dimethyl Benzene. Orthoxylol, Orthomethyl toluene and 1,2 dimethyle benzene .
Peak 5 to O xylene, Benzene, 1,2 Dimethyl Orthodimethyl benzene, orthomethyl toluene, 1,2 dimethyl benzene.
Each peak contains multiple compounds they co – elute, means they travel together they have similar retention time and cannot be fully resolved.

Aqueous extract EA

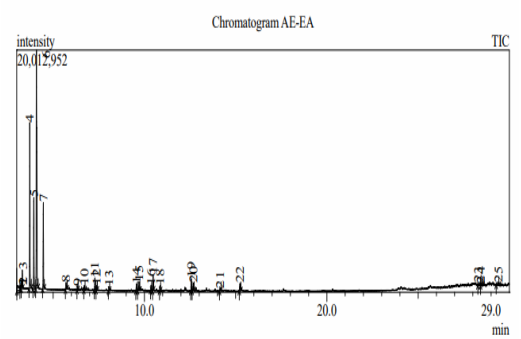

Figure.11 Chromatogram of aqueous extract.

GCMS chromatogram of aqueous extract of Mangosteen peel was obtained by ethyl alcohol as the solvent (figure 10) The chromatogram yield 3 eminent peaks each peak represents the varied chemical compound represent in the aqueous extract. Peak 4 corresponds to Chlorobenzene, Phenyl chloride, Benzene chloride. Peak 5 to Ethylbenzene,Ethyl benzol ,Pheneyk ethane , Aethylebenzol. Peak 6 to 0 – xylene, Benzene, 1-2 dimethyl, orthodimethyl benzene, orthomethyl toluene.

Prabhanna Banakar (2018) reported the details of "GC-MS Anaysis Of Bioactive Compounds from Ethanoilc Leaf Extract Of *Watheria Indica* Linn. And Their Pharmacoogical Activitis".

The GC - MS chromatogram of the ethanolic leaf extract of Waltheria indica Linn. showed 27 peaks indicating the presence of twenty-seven compounds (Fig. 1). The active principles with their peak, retention time (RT), area (%), height (%), molecular formula and molecular weight are presented in the Table 1. The tetradecane, hexadecane, squalene, 2,3-Dihydro-3,5-Dihydroxy-6-methyl-4H-pyran-4-one showed maximum per-centage. The 2-propenoic acid, 10- Heneicosene (c.t), Nonadecane, 3-Eicosene, (E)-, 1,1 Bicyclo propyl-2-octanoic acid, megastigmatrinone-4 showed a moderate percentage. The minimum percentage compounds are 1-docosanol, 3',5'-Di-methoxyacetophenone, 2-Hexadecen-1-Ol, 3,7,11, 15-Tetramethyl-, [R-[R*,R*-(E)]]-, Z,Z-8,10-Hexa-decadien-1-ol, phytol, tetracosane, 2-bromodecane, 5,5, Diethyl hepta-decane. The GC - MS identified compounds shows various pharmacological activities and are ascertained [23].

Md. Mahmudul Hasan,Md.Rezuan Al Mahmud, and Md. Gaziul Islam reported the details of "GC-MS Analysis of Bio-active Compounds in Ethanol Extract of *Putranjiva roxburghii* Wall. Fruit Peel"

The GC-MS analysis has revealed the existence of different phytochemical compounds in the ethanolic extract of PRFP. The major compounds in PRFP extract are Cyclohexanol, 5-methyl-2-(1-methylethenyl)- (4.56%), 6-Octen-1-ol, 3,7-dimethyl- (41.07%), Geraniol (2.45%), (1R,2S,5R)-2-(2-Hydroxy-2-propanyl)-5-methylcyclohexanol (14.09%), 2,6-Octadiene, 2,6-dimethyl- (7.04%), p-Menthane-3,8-diol, cis-1,3,trans-1,4- (3.39%), 2,6-Octadien- 1-ol, 3,7-dimethyl-, acetate (6.69%) and 13-Docosenamide, (Z)- (2.83%). A total of 25 compounds identified representing 99.98% of total ethanolic extract [24].

IV. CONCLUSION

Mangosteen *(Garcinia mangostana L.)* is also known as queen of fruits because it is one of the best tasting tropical fruit. The pericarp having properties like anti-inflammatory and anti-oxidant it is used to treat diarrhoea, Cholera, wounds and dysentery. Phytochemical composition of mangosteen pericarp shows presence of various bioactive compounds. Mangoteen peels is a low-cost agricultural waste in recent days the more peoples are concern towards health so natural dye is good alternative to synthetic dyes in this study pericarp used to produce natural dyes because it contains lot of anthocyanin compounds which produce red colour. Sample was collected and aqueous extract was prepared. characterization of both aqueous extract and crude extract was done by using chromatography, Raman, GCMS which represent the multiple peaks it indicates the presence of multiple compounds.

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