A Review on Pharmacological Activities of Prenylated Xanthone

By

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Declaration

It is hereby declared that

1. The thesis submitted is my/our own original work while completing degree at Brac University.
2. The thesis does not contain material previously published or written by a third party, except where this is appropriately cited through full and accurate referencing.
3. The thesis does not contain material which has been accepted, or submitted, for any other degree or diploma at a university or other institution.
4. I/We have acknowledged all main sources of help.

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Approval

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Ethics Statement

This project does not involve any clinical trial or human participants.

Abstract

In today's society, an increasing number of people are looking for herbal medicines for their primary healthcare needs. The rising interest in natural product markets as well as traditional medical practices is a direct reflection of the growing demands for complementary and alternative treatment. Due to their long history of safe and successful usage, not to mention their low price and availability, herbal medicines are rapidly gaining popularity. In addition, herbal medicine relies on the fact that herbs have several impacts on the body. The compound known as xanthone is a great example of this type of substance that contains a wide range of biological activities for example anti-inflammatory, anti-bacterial, cytotoxic, as well as chemotherapeutic properties. Moreover, this review paper aims to encourage researchers about medicinal plants and helps by offering essential groundwork required for future research and the invention of new medicines.

Keywords: Prenylated Xanthone, Conventional Treatment, Alternative Medicine.

Dedication

Dedicated to my faculty members, family and friends

Acknowledgement

I would like to start by thanking Almighty Allah for giving me strength throughout this project, Sania Ashrafi, Lecturer, School of Pharmacy, Brac University, for being a constant guide and so supportive, kind, and motivating. I am thankful to everyone on the faculty at the School of Pharmacy for all the help, support, and guidance they gave me throughout this journey. I would also like to use this chance to thank my family, friends and seniors for all the help they have given me.

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List of Acronym

CAM Complementary and Alternative Medicine

HIV Human immunodeficiency virus

AIDS Acquired Immunodeficiency Syndrome

IC Inhibitory Concentration

Chapter 1

Introduction

1.1 Overview

The quest for cures for human illness by way of natural means has existed since prehistoric times (Biljana Bauer Petrovska, 2012). From the beginning of time, plants, plant parts, and phytochemicals have been used to combat and cure numerous health conditions. About 25% of medications given globally are plant-based, and 121 active chemicals are used (Sahoo et al., 2010). Notably there has been a rapid rise in involvement as well as use of herbal drugs in regions having access to modern treatment. In both conventional and modern medicine, plant-based substances are often regarded by the general public as safe and well-tolerated However mankind and their quest for medicines in nature have a long history together. As per records from ancient Babylon, people have been using plants as medicines for 60,000 years (Msomi & Simelane, 2018). About 5000 years ago, herbal treatment was documented in Egypt and China and 2500 years ago, in Asia Minor and Greece. In Addition, the world's earliest book on herbs nearly 2000 years ago, The Divine Farmer's Classic of Herbalism was documented in China that contains many herbal pharmacopeias as well as different monographs on specific herbs. Further, ancient Hindu physicians and saints originated the healthcare system known as Ayurveda, which has been practiced in India for more than 5000 years. And about 1500 different plants and 10,000 different formulas are mentioned in detail in its materia medica (Msomi & Simelane, 2018). Due to their lower risk of side effects when particularly in comparison to modern medications, patients and healthcare professionals have come to acknowledge the superior therapeutic benefits of herbal medicines. They have shown to be reliable throughout time owing to the fact that they are safe, effective, culturally acceptable, and have fewer adverse effects. Herbal medicines are also referenced in ancient documents for treating age- related ailments including dementia, osteoporosis, diabetic wounds,

immunological and liver diseases and so on for which there is either no effective contemporary treatment or just palliative care is possible. Moreover, these drugs will boost the economies of those who generate them as they are prepared from renewable raw materials using ecofriendly procedures(Kamboj, 2000).

1.2 Herbal Drug

Herbal drugs are the use of plant materials, either separately or in combination, as active ingredients. This includes herbs, herbal materials, herbal preparations, and completed herbal products.Herbal drugs may be divided into three categories depending on the composition of the active metabolites. The first category includes substances utilized in rawest form. The second category of herbal drugs consists of the active components that have been separated out from plant extracts. As these molecules are isolated from any impurities, making them more potent in terms of their pharmacological effects. Lastly, the third category of herbal drugs has animal acute and chronic toxicity data (Sahoo et al., 2010). In addition, excipients, such as dilutions, solvents, as well as preservatives, are added to herbal drugs, comprising active ingredients, parts of the plant or plant materials in a refined or unrefined condition. The fragrance, taste, as well as color of the plant are enhanced by these active constituents, while shielding the plant from harm and illness. These are also referred to as phytochemicals including saponins, flavonoids, glycosides, tannins, alkaloids, and terpenoids. Over the time, phytochemicals have been shown to promote human health such as sedatives and stomachic herbal treatments comprising fragrant plant species with medicinal essential oils that are antimicrobial, stomach-soothing, as well as antispasmodic (Msomi & Simelane, 2018).

1.2 Conventional Treatment

Conventional method of treatment that has gained widespread acceptance as well as routinely used by medical specialists. In addition, use of conventional treatment is also well recognized among people in order to protect themselves from illness, help in the diagnosis, and treat existing problems (Wilson, 2022). Common examples of conventional treatments include pharmaceutical drugs, physical therapy, radiation therapy, and surgical procedures etc. Remarkable progress is being made in contemporary medicine at such a rapid pace. To prove their safety and efficacy, specialists have also tested conventional treatments including chemotherapy and radiation therapy. In addition to that the mortality rates from cancer, heart disease, and stroke have declined owing to conventional treatment. Notably heart disease deaths have dropped by 60% since 1970 and HIV/AIDS deaths have reduced by 75% 1995 (Ostermeyer, 2021). However, there are certain downsides to conventional treatments including the fact that the occurrence of adverse effects has been discovered to be much greater (Msomi & Simelane, 2018).

1.3 Necessity of Complementary and Alternative Medicine (CAM)

The medication that is used in conjunction with or as an alternative to conventional medicines is referred to as complementary and alternative medicine (CAM) which can be explained as a diagnosis, treatment, and prevention that supports conventional medicine by meeting a need not fulfilled by orthodoxy or broadening the conceptual frameworks of medicine. All complementary and alternative medicine (CAM) typically emphasizes natural ingredients, thus believing that it is safer, gentler, or more suited to the needs of the human body compared to conventional treatment. Furthermore, 20% of people in the UK reported using complementary

and alternative medicine in the past year, according to a recent telephone study (Ernst, 2000). People are turning to complementary and alternative medicine in greater numbers because it is not only more affordable, but also more familiar (Wilson, 2022).

1.4 Example of Marketed Herbal Drug

Table 1 lists the top 10 best-selling herbal drugs on the market.

Table 1: List of marketed herbal drug (Kamboj, 2000).

Name of the Drug	**Botanical Name**
Echinacea	*Echinacea species*
Garlic	*Allium sativum*
Ginko	*Ginko biloba*
Ginseng	*Panax species*
Goldenseal	*Hydrastis canadensis*
Aloe gel	*Aloe barbadensis*
Saw palmeto	*Serenoa repens*
Cranberry	*Vaccinium macrocarpon*
Ephedra	*Ephedra species*
Eleuthero	*Eleutherococcus senticosus*

1.5 Drawbacks of Conventional Treatment

The use of conventional treatments comes with both advantages and disadvantages. The number of reports of adverse effects associated with conventional medications was discovered to be significantly higher than the number of complaints associated with herbal medications. When receiving conventional treatment, patients have the possibility of experiencing major detrimental effects, including drug interactions, poisoning, and death if they take the incorrect dosage. Further the expenses are different for each treatment option, however some may be more cost-effective than conventional methods (Wilson, 2022).

Chapter 2

Objective

The objective of this review paper is to evaluate the therapeutic value of xanthone in the treatment of a broad range of ailments. In this review, we've attempted to outline potential xanthone compounds along with the sources, extractions method, biological activity against various cell line and their mechanism of action.

Chapter 3

Method & Methodology

This review paper was written by conducting a comprehensive study of existing literature from 2005 to current time. Article was chosen based on relevant as well as recent research paper. Additionally, the information was compiled from a range of reliable sources, including books, journals, official papers, publications, peer-reviewed media, and internet academic databases. To improve the quality of the review paper, fundamental and supplementary material were gathered from a variety of books. Some of the terms that have been used in order to access the data: prenylated xanthone, herbal medicine, natural products, conventional treatment, alternative therapy etc. The following is a list of search engine that were used to find articles for this paper

- Google Scholar
- PubMed
- Springer Link
- Nature
- Science Direct
- ResearchGate

Chapter 4

Review

4.1 Xanthone

Xanthones are considered to be a family of oxygenated heterocycles which are usually available as secondary metabolites in many different plants, fungal, lichen, and bacteria from a wide variety of families and genera. Additionally, a significant amount of xanthones may be found in the Gentianaceae, Polygalaceae, and Clusiaceae families (Huang et al., 2021). They have several beneficial biological effects, including antioxidant, monoamine oxidase inhibitor, anti-hypertensive, hepatoprotective, anti-fungal, and anti-cancer properties. Different biological activity can be shown depending on the tricyclic scaffold and the type and location of the substituents attached to it. Scientists have long been interested in isolating and synthesizing xanthones or their analogs due to their unique structural framework and therapeutic relevance. Moreover, synthesis and the isolation of xanthones (Figure 1) from natural resources are the two primary ways to obtain xanthones (Panda et al., 2013).

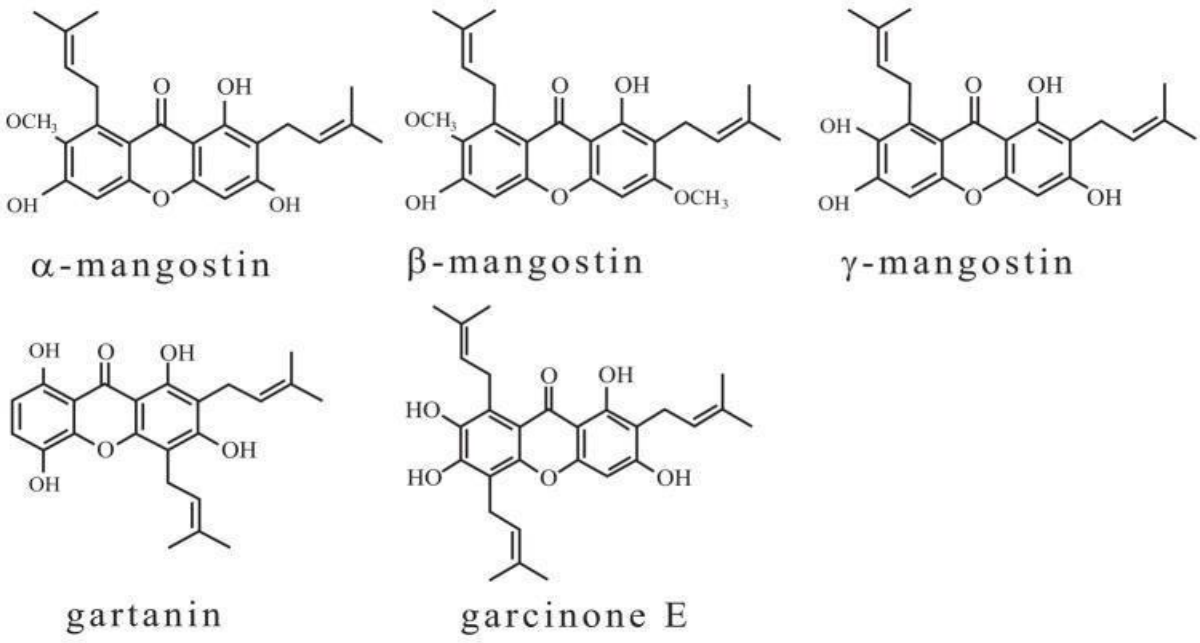

Figure 1: Chemical structure of different xanthones (Shan et al., 2011)

4.2 Prenylated Xanthone

Prenylated xanthones are only found in plants belonging to the family Guttiferae, hence their distribution is also limited to those plants. Additionally, 173 of the 285 prenylated xanthones that were investigated were found to be novel compounds. The “3-methylbut-2-enyl or isoprenyl group”, which is observed frequently, was the key C5 unit of the substituents in isoemericellin. Whereas, “3-hydroxy-3-methylbutyl” (as in nigrolineaxanthone P) and “1,1-dimethylprop-2-enyl” (as in globuxanthone) were significantly less prominent (Negi et al., 2013b). Figure 2 demonstrates the structure of 5-O-methyl celebi xanthone which is an example of Prenylated Xanthone.

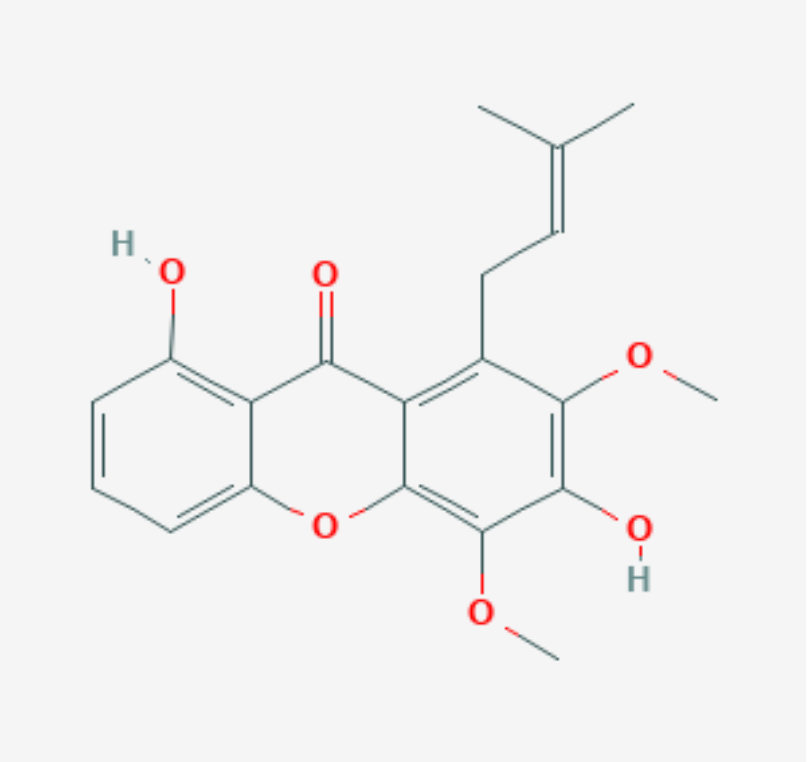

Figure 2: Structure of 5-O-methyl celebi xanthone (PubChem, n.d.)

4.3 Biological Activities

In this review, the biological activities of various prenylated xanthones derived from a variety of medicinal plant sources are analyzed and discussed. According to the findings of the study, a good number of these prenylated xanthones demonstrate cytotoxic and antimalarial activities.Celebixanthone, Cochinchinone A, mangostin, -mangostin, and Cochinchinone C, all of which were extracted from Cratoxylum cochinchinese, exhibit cytotoxic effects against NCI-H187 cells with IC50 values ranging from 0.65 to 5.2g/ml. Other compounds extracted from this plant, including -mangostin, also exhibit these effects. With a value of 0.65 g/ml for its IC50, cochinchinone A possesses the highest activity. Antimalarial activity has been demonstrated by 5-O-methylcelebixanthone, Celebixanthone,-mangostin, and Cochinchinone C against dihydroartemisinin, with IC50 values ranging from 2.6 to 7.2 g/ml. After testing the effects of bannaxanthones A-H, guttiferone E, xanthochymol, garcinone E, allanxanthone C, isojacareubin, garcinone C, and -mangostin from Garcinia xipshuanbannaensis on the growth of cancer cells, the researchers determined that bannaxanthones D, garcinone E, and -mang Afzeliixanthones A-B, 1,5-dihydroxyxanthone1, 7-dihydroxyxanthone, and 1,3,7-trihydroxy-2-(3-methylbut-2-enyl) xanthone, all derived from Garcinia afzelii, display a significant amount of antioxidant activity in comparison to BHA. The cytotoxic activity of caloxanthone O and caloxanthone P from Calophyllum inophyllum was investigated. Caloxanthone O was found to be active against the SGC-7901 cell line with an IC50 value of 22.4 g/mL, whereas caloxanthone P was found to be inactive (IC50 > 100 g/mL). It was discovered that several compounds derived from Calophyllum inophyllum, including caloxanthone Q, 2-deprenylrheediaxanthoneB, jacareubin, and 6-deoxyjacareubin, were ineffective against cancer cell lines. Caloxanthone N, gerontoxanthone C, and 2-hydroxyxanthone were extracted from Calophyllum inophyllum and tested for their cytotoxic activity. Caloxanthone N and gerontoxanthone C were found to be active against cancer cell lines, whereas 2-

hydroxyxanthone did not have any effect on the cancer cell lines. After testing the effects of 5-farnesyltoxyloxanthone B, -mangostin, rubraxanthone, and isocowanol derived from Garcinia merguensis on MCF-7 cells, it was determined that rubraxanthone from Garcinia merguensis had the highest level of activity against MCF-7 cells. In general, the article highlights the potential of prenylated xanthones as sources of natural compounds that have biological activities such as cytotoxic and antimalarial effects, in addition to antioxidant properties.

Table 2: Pharmacological Activities of Prenylated Xanthones

Compound	Source	Extrac-tion Procedure	Biological activity	Experimental detail	Result	Reference
α-Mangostenones C (New) Mangostenones D (New) Mangostenones E (New) Demethylcalabaxanthone Garcinone B 1,6-Dihydroxy-7-methoxy-8-(3-methylbut-2-enyl)6',6'-dimethyl pyrano (2',3':3,2) xanthone -Mangostin 8-Desoxygartanin Gartanin Garcinone E -mangostin Mangostinone -mangostin Mangostanol Mangostanin Garcinone D Garcinone C 11-Hydroxy-1-isomangostin	*Garcinia mangostana* (Clusiaceae)	EtOAc & MeOH	Cytotoxicity Bioassay	In vitro cytotoxic effects against KB, BC-1, and NCI-H187 cells	α-Mangostin exhibited the most potent effects against KB and BC-1 with IC50 values of 2.08 and 0.92 mg/ml against Standard ellipticine	(Suksamrarn et al., 2006),
5-O-methylcelebixanthone (New) Celebixanthone 1,3,7-trihydroxy-2,4-di(3-methylbut-2-enyl) xanthone	*Cratoxylum cochinchinese*	C.cochinchinense were extracted with hexane	Cytotoxic & Antimalarial bioassays	Cytotoxic Assay employed colorimetric method was done against NCI-H187 Cell	Celebixanthone, Cochinchinone A,- mangostin,- mangostin ,	(Laphookhieo et al., 2006).

Cochinchinone A -mangostin - mangostin Cochinchinone C		& methylene chloride		line & In-vitro Antimalarial activity against Plasmodium falciparum using the method of Trager and Jensen.	Cochinchinone C showed cytotoxic activity against NCI-H187 with IC50 value of 0.65 to 5.2g/ml . Cochinchinone A had the highest activity with IC50 value of 0.65 g/ml . 5-O-methylcelebixanthone, Celebixathone,-mangostin,Cochinchinone C exhibit antimalarial activity with IC50 value of of 3.2, 4.9, 7.2 and 2.6 g/ml against dihy-droartemisnin.	

-mangostin 9-hydroxycalabaxanth- one mangostanol mangostenone F allanxanthone E -mangostin mangostingone garcinone D -mango-stin mangosenone G smeathxanthone A a new xanthone	*Garcinia mangostana* (Clusiaceae)	CHCl3 , EtOH, EtOH-H2O(1:1), H2O	-Glucosidase inhibition & antihyperglycemic assay	-Glucosidase was assayed according to standard procedures by following the hydrolysis of nitrophenyl glycosides. In vivo hyperglycemic assay performed on 1 ml of Streptozotocin injected Male Spcague–Dougly (SD) rats.	All of thecompounds tested displayed Significant -glucosidase inhibition with IC50 value of 1.5–58.8 M & -mango-stin exhibited the highest activity with IC50 value of 1.4 M & mixed inhibition. Using, a physiologically relevant substrate, maltose -mangostin,-mango-stin, gartanin, smeathxanthone A showed potent inhibition with the IC50 value of 53.3, 17.5, 37.5, and 35.3 M against deoxynojirimycin	(Ryu et al., 2011)
1,3,7-trihydroxy-2-(3-methyl-2-butenyl)-8-(3-hydroxy-3-methylbutyl)-xanthone (New)	*Garcinia mangostana* (Clusiaceae)	ethanol	Cytotoxicity Assay	In vitro cytotoxic activities CNE1, CNE2, SUNE1 and HONE1.	All compounds showed potent cytotoxic activities against hirsutanol A.	(Xu et al., 2014).

1,3,8-trihydroxy-2-(3-methyl-2-butenyl)-4-(3-hydroxy-3-methylbutanoyl)-xanthone (New) garcinone C garcinone D gartanin xanthone I -mangostin						
cudratricusxanthones J (New) cudratricusxanthones K (New) cudratricusxanthones L (New) cudratricusxanthones M (New) Isocudraxanthone K cudraxanthone C cudratricusxanthone A cudraxanthone L	*Cudrania tricuspidata*	MeOH	Assay of MAO Inhibitory Activity	MAO activity was measured fluorometrically on Mouse brain mitochondrial fraction using kynuramine as a substrate according to the method of Kraml	cudratricusxanthone A exhibited weak inhibitory activity, with IC50 values of 88.3 against Iproniazid	(Hwang et al., 2007)
Cudracuspixanthones A (NEW) Cudracuspixanthones B (NEW) Cudracuspixanthones C (NEW) Cudracuspixanthones D (NEW) 2,6-dihydroxyxanthone laxanthone-I isocudraniaxanthone A isocudraniaxanthone B 1,3,5-trihydroxy-4-prenylxanthone cudraxanthone H cudratricusxanthone K macluraxanthone B 2-deprenylrhee-diaxanthone B cudraxanthone M cudraxanthone A	*Cudrania tricuspidata*	MeOH	antiproliferative assay	antiproliferative activity was evaluated against HSC-T6 cells against	Cudracuspixanthones A showed moderate antiproliferative activity on HSC-T6 cells with IC50 values of 9.7 against Epigallocatechin-3-gallate	(Jo et al., 2014)

2,6-dihydroxyxanthone isogentisin alloathyriol laxanthone-I isocudraniaxanthone A isocudraniaxanthone B 1,3,5-trihydroxy-4-prenyl- xanthone cudraxanthone H cudratricusxan-thone K dulxanthone B macluraxanthone B cudracuspixanthone A cudratricusxan-thone A gerontoxanthone I maclura-xanthone C cudracuspixanthone E alvaxanthone isoalvaxanthone cudraxanthone L toxyloxanthone C 2-deprenylrheediaxanthone B 8-prenylxanthone cudraxanthone M cudratrixanthone H cudracuspixanthone B cudracuspi-xanthone C cudraxanthone B cudracus-pixanthone D cudraxanthone A cudracuspixanthone G	*Cudrania tricuspidata*	MeOH	Inhibitory activity	anti-inflammatory activities were evaluated by employing RAW 264.7 cells, a macro-phage cell line as an in vitro assay system.	Isogentisin, isocudraniaxanthone A,isocudraniaxanthone B, cudracuspixanthone A, cudraxanthone L, 2-deprenylrheediaxanthone B, 8-prenylxanthone, cudracuspixanthone B, cudraxanthone B, cudracus-pixanthone D showed moderate inhibition of lipopolysaccharide-stimulated nitric oxide production in RAW 264.7 cells, with IC50 values ranging from 16.1 to 24.8mM against Aminoguanidine	(Jo et al., 2016).
bannaxanthones A(New) bannaxanthones B(New) bannaxanthones C(New) bannaxanthones D(New) bannaxanthones E(New) bannaxanthones F(New) bannaxanthones G(New) bannaxanthones H(New) guttiferone E xanthochymol	*Garcinia xipshuanbanna ensis*	acetone	Cytotoxic assay	cytotoxic activity were evaluated using MTT method against cancer cells	bannaxanthones D, garcinone E, γ-mangostin were most effective in inhibiting cancer cell growth and promoting cancer cell death with lower TGI and LC50 against Camptothecin & Etoposide	(Han et al., 2008)

Garcinone E allanxanthone C isojacareubin garcinone C γ-mangostin						
afzeliixanthones A (New) afzeliixanthones B (New) 1,5-dihydroxyxanthone 1,7-di-hydroxyxanthone 1,3,7-trihydroxy-2-(3-methylbut-2-enyl)xanthone	*Garcinia afzelii ENGL.*	mixture of CH2Cl2/MeOH	Antioxidant assay	antioxidant activity was evaluated using the DPPH free radical scavenging method on TLC.	afzeliixanthones A, afzeliixanthones B showed high antioxidant activity against BHA (3-t-butyl-4-hydroxyanisole).	(Kamdem Waffo et al., 2006)
caloxanthone O (New) caloxanthone P (New)	*Calophyllum inophyllum*	EtOH	Cytotoxic bioassay	Cytotoxic activities were evaluated against the SGC-7901 cell line using the MTT method.	caloxanthone O showed cytotoxic activity against the SGC-7901 cell line with the IC50 value of 22.4 μg mL-1 caloxanthone P was inactive (IC50 > 100 μg mL-1)	(Dai et al., 2010).
Caloxanthone Q 2-deprenylrheediaxanthoneB jacareubin 6-deoxyjacar-eubin	*Calophyllum inophyllum*	EtOH	Cytotoxic bioassay	cytotoxic activities were evaluated against K562, SGC-7901 and SMMC-7721 cell lines using the MTT method,	All compounds were inactive (IC50 . 20g/ml)	(Wei et al., 2011).
caloxanthone N (New) gerontoxanthone C 2-hydroxyxanthone	*Calophyllum inophyllum*	EtOH	Cytotoxicity bioassay	in vitro cytotoxic activities were evaluated against the K562 cell line using the MTT method.	caloxanthone N, gerontoxanthone C showed cytotoxic activity with IC50 values of 7.2 and 6.3 gml-1	(Xiao et al., (Xue et al., 2020)2008).

					2-hydroxyxanthone was inactive (>20gml-1).	
garcibracteamones A (New) garcibracteamones B (New) garcibracteamones C (New) garcibracteamones D (New) garcibracteamones E (New) Macluraxanthone bracteaxanthone XII 1,3,5,6-tetrahydroxy-4-(1,l-dimethylprop-2-enyl)-7-(3-methylbut-2-enyl) xanthone Inoxanthone 10-O-methylmacluraxanthone 5-O-methylxanthone V1 assiguxanthone A 2-deprenyl-rheediaxanthone B hyperxanthone D 1,3,7-trihydroxy-2-(2-hydroxy-3-methyl-3-butenyl)-xanthone	*Garcinia bracteata*	EtOH	Antiproliferative activity bioassays Anti-inflammatory activity bioassays	antiproliferative activities were evaluated against HepG2, T98, MCF-7 cell lines by the CCK-8 method. anti-inflammatory activities were evaluated by measuring the nitric oxide production inhibitory activity of lipopolysaccharides-stimulated RAW 264.7 cells in vitro.	Macluraxanthone, 10-O-methylmacluraxanthone,5-O-methylxanthone V1 exhibited mild inhibitory effects against NO pro-duction with the IC50 values of 10.68 ± 0.81, 16.39 ± 0.26, 14.19 ±1.23μM against dexamethasone(IC50: 9.58 ± 3.34)	(Xue et al., 2020)
5-farnesyltoxyloxanthone B (New) α-mangostin rubraxanthone isocowanol	*Garcinia merguensis*	MeOH	Cytotoxicity assay	Cytotoxic activities were evaluated against MCF-7,MDA-MB-231,NCI-H-460 and SF-268 cell lines	rubraxanthone gives highest activity at 9.0 and 12.1 μM against MCF-7 cells .	(Kijjoa et al., 2008).
3-O-methylcowaxanthone cowaxanthone 7-O-methylgarcinone α-mangostin γ-mangostin	*Garcinia cowa*	EtOH	Cytotoxicity assay	Cytotoxicity of 3-O-methylcowaxanthone was evaluatedagainst HL-60, SMMC-7721, A549, MCF-7	3-O-methylcowaxanthone was inactive against HL-60, SMMC-7721, A549, MCF-7 and	(MAHABUSARAKAM et al., 2006).

				and SW480 cell lines by MTT assay	SW480 cell lines with IC50 values over 40 μM against cis-platinum (MW 300) and taxol).	

Chapter 5

Discussion

To treat a number of different diseases and ailments, medicinal plants have gained significant importance. When compared to current medications, medicinal plants are more appealing as potential therapeutic agents because of their widespread availability and the lower overall cost that they impose. Several treatments are available in form of pharmaceuticals, over-the-counter supplements, as well as dietary supplements. However, the significance of medicinal plants and the contribution that phytomedicine makes to the health and wellbeing of a huge portion of the global population has attracted the attention of researchers from a wide range of academic fields. The overall safety features of the product are frequently rated adequate in terms of overall protection against potential harm. And there is potential that natural products may prove to be highly helpful in the encounter against disease. Therefore, we were also curious to find some alternative options. In order to determine whether or not medicinal plants have their essential components, phytochemical analysis is an absolute necessity. The presence of xanthone was identified in this study on a number of different medicinal plants as xanthone has potent therapeutic qualities includes antioxidant, anti-tumor, anti-inflammatory, anti-bacterial, anti-fungal etc. Moreover, based on the observations, it was shown that xanthone has a good therapeutic effectiveness, which implies that it might be regarded as a potential therapeutic alternative for various diseases.

Chapter 6

Conclusion & Future prospective

It is noticeable that the medicinal use of xanthone has the potential to be expanded owing to its efficacy and positive responses in the treatment of diseases that can threaten a patient's life. In addition to the result of the continuing study, the development of new pharmacological substances is something that may be undertaken. Moreover, there are many compounds with medicinal properties that can be analyzed for their biological activity. However, most of the structures are non-natural compounds which can be studied more. Additionally, mechanisms of actions for most of the xanthones compounds were not properly explained therefore we have more scope to study further. In conclusion, based on what this study found xanthone has the potential to be employed as a therapeutic agent.

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