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Review Article

GARCINIA INDICA AND HIBISCUS ROSA SINENSIS: A POTENTIAL ANTIGENOTOXIC PLANTS

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The use of traditional herbal plants like *Garcinia indica* and *Hibiscus rosa sinensis* is widespread and still serves as leads for the development of novel pharmacological agents. Many Indian medicinal plants are considered potential source of antioxidant compounds. This study focuses to characterize the active compounds responsible for antibacterial activity of *Garcinia indica* against strains of bacteria, which cause digestive tract disorders and mild skin infections. The attempt to study *Hibiscus rosa-sinensis which* is very popular in India. It's beneficial effects are also reported in ancient Indian Medicinal literature. *Daucus carota, Ocimum sanctum linn, Withania Somnifera*, also have antioxidant activity. The majority of rich diversity of Indian medicinal plants is yet to be scientifically evaluated for such properties.

Key Words: Garcinia indica Choisy Syn Brindonia indica, Kokum, Phytochemistry, Pharmacology, Superoxide dismutase, Catalase, and glutathione peroxidise, Genotoxicity, Hibiscus rosa sinensis, Acute toxicity, Micronucleus assay.

INTRODUCTION

The expression of mutation associated with genotoxic effects is the result of the interplay between risk factors and the responses of the host organism. Genes form the smallest unit of hereditary material. Human beings are exposed to a wide variety of chemicals, pollutants and drugs which are known for their ability to produce unexpected and unidirectional changes in the genome. DNA double strand and single strand breaks caused by some of these drugs, if not repaired, can lead to deleterious gene mutations and such hypermutable cells are prone to be transformed into malignant cells or may even cause congenital malformation.¹⁻² Most of the cancer cells are aneuploid and often show cytological

abnormalities during mitosis. Therefore, clastogenicity and aneugenicity contributes towards tumourogenisis.³

Genetic toxicology is defined as the study of adverse effects on the process of heredity.⁴ As a discipline of toxicological research, it has been given the task of detecting mutagenic chemicals using an array of tests. Genotoxic profile of a drug can be established by *in vitro* and in vivo tests designed to detect genetic damage directly or indirectly by various mechanisms. Genotoxicity tests are commonly used to identify genotoxic chemicals with carcinogenic potential. Cytogenic markers such as chromosome aberrations (abnormality in chromosomal structure and number), micronuclei frequency and sister chromatid



exchanges are relatively rapid, facile and sensitive indicators of genetic damage. Genotoxic agents such as carcinogens can enhance the error rate in the genome reduplication and cause mutation in the DNA of an organism. Cancer patients are often exposed to high level of DNA damaging agents. Somatic cell mutation induced by genotoxic agents has been implicated in the pathogenesis of cancer .5

Environmental and chemical mutagenic drugs disturbs DNA synthesis and cell division, they may have damaging effect on tissues with normally low mitotic indices. They have Cytotoxic and radiomimetic actions generating reactive oxygen species such as Superoxide (O₂-); Nitric oxide (NO), Hydrogen peroxide (H₂O₂) and Peroxy radicals in a biological system.⁶ These reactive oxygen species have been implicated in certain chronic and ageing including diseases. malaria, rheumatoid arthritis, cataracts acquired immunodeficiency syndrome, heart disease, stroke. arteriosclerosis. diabetes. cancer and neurodegenerative diseases (Parkinson's and Alzheimer's diseases)7.

Mammalian cells possess elaborate defence mechanisms for free radical detoxification. Key metabolic enzymes like superoxide dismutase (SOD), catalase (CAT), and glutathione peroxidase (GPX) and high and low molecular weight compounds e.g. albumin, tocopherol, minerals like selenium, copper and vitamins

such as Vit. A and Vit. C etc. play a crucial role in preventing oxidative stress in the biological system⁸. Antioxidants are compounds that help to inhibit the many oxidation reactions caused by free radicals, thereby preventing or delaying damage to the cells and tissues. Therefore, the commercial development of plants as sources of antioxidants to enhance health and food preservation is of current interest. Medicinal plants possessing natural antioxidants polyphenolics such as anthraquinones, flavonoids, aromatic acids, and tannins have been shown to have ROS scavenging and lipid peroxidation prevention effects [9-10-11].

Garcinia indica has been reported to possess cytotoxic activity, ascribed to its chemical constituent. xanthochymol and isoxanthochymol and its antioxidant activity is attributed to garcinol, hydroxycitric acid and other chemical constituents¹²⁻¹³. By virtue of its cytotoxic activity the plant could be expected to possess genotoxic activity and due to its antioxidant property it could prevent Genotoxicity of anticancer drug, when administered with the latter. Due to paucity of information about the plant in this regard, the present study was planned to evaluate aqueous fruit rind extract of garcinia indica for its genotoxicity if any, and its effect on cyclophosphamide induced genotoxicity.

Hibiscus rosa sinensis linn (fam: malvaceae) is



one such Indian herbal plant used extensively to treat a spectrum of ailments. It is a conspicuous, ornamental, evergreen, glabrous, showy, 1.5 to 2.4 m high shrub cultivated throughout India and is reported to posses medicinal various properties viz; cardioprotective, hypoglycemic, antioxidant, antifertility, etc. The major chemical constituent of this plant are anthrocyanins and flavonoids other chemicals are cyclopeptide alkaloid. There has been reports of prevention of twostage skin carcinogenesis by Hibiscus rosa sinensis. As per latest information no invivo antigenotoxic or anticlastogenic activity of this drug has been performed, therefore the present study was designed to investigate in vitro antioxidant and genotoxic potential if any and effect on cyclophosphamide induced genotoxity in mice, using micronucleus assay and COMMET assay as experimental models. Genotoxicity can be detected by a variety of tests like Ames test, micronucleus test, chromosomal aberration test, comet assay (SCGE), unscheduled DNA synthesis assay, point mutation assay etc. Comet assay is simple, sensitive and rapid method for screening DNA double and single strand breaks, which can be further confirmed by micronucleus assay.¹²

Hibiscus rosa-sinensis is a bushy, evergreen shrub or small tree growing 2.5–5 m (8–16 ft) tall and 1.5–3 m (5–10 ft) wide, with glossy leaves and solitary, brilliant www.pharmaerudítíon.org Nov. 2019, 9(3), 59-78 red flowers in summer and autumn. The 5petaled flowers are 10 cm (4 in) in diameter, with prominent orange-tipped red anthers.

Hibiscus rosa-sinensis (China Rose)

The flowers are large, conspicuous, trumpetshaped, with five petals and their colors can be white to pink, red, orange, peach, and yellow or purple that are 4–18 cm broad. The flowers



Fig. 1: China rose

from various cultivars and hybrids can be either a single flower or a double flower. Flower color in certain species, such as *H. mutabilis* and *H. tiliaceus*, changes with age This flower has a crown that consists of 15 - 20 leaves which are alternate and ovate.

At the bottom of every hibiscus bud is the calyx which is green in color. The pointed ends of the calyx are the sepals. When the hibiscus begins to bloom, the petals begin to grow which contains multiple petals and multiple colors. The ovary and other female parts of the flower lie in the main structure of



the hibiscus, the pistil, which is long and tubular. The hibiscus has both male and female parts on the same flower. The five hairy red of the flower is spots on the top the stigma (female part) of the flower. The stigma is located at the end of the style branch. At the top of the pistil is known as the stigma, where pollen is collected, and in the middle is the style, which is the section that the pollen travels down to the ovary. The ovary lies at the bottom of the blossom and the hibiscus has only one ovary which is superior.¹³

The male part (stamen) of the flower consists of stem-like filaments and each filament ends with the pollen-producing anther. The anthers, which release the pollen, sits on the filament and these two organs make up the stamen, the male part of the flower. Together, these organs make up the male part of the flower known as the stamen.

Table 1: Classification

Scientific Classification:			
Hibiscus Rosa-sinensis			
Kingdom	Plantae		
Clade	Tracheophytes		
Clade	Angiosperms		
Clade	Eudicots		
Clade	Rosids		
Order	Malvales		
Family	Malvaceae		
Genus	Hibiscus		
Species	H. Rosa-sinensis		
Binomial	Hibiscus Rosa-		
name	sinensi I.		

The hibiscus has hundreds of stamens. Overall, the hibiscus is a dicot, solitary (axillary), complete, perfect, has a superior ovary, regular symmetry, and axile placentation. It has 5 carpels, 5 locules, 5 sepals, and the amount of stamens may vary.

The root is a branched tap root. The stem is aerial, erect, green, cylindrical and branched. The leaf is simple, with alternate *phyllotaxy* and is petiolate. The leaf shape is ovate, the tip is acute and margin is serrated. *Venation* is unicostate reticulate. (Venation is branched or divergent.) Free lateral stipules are present.¹⁴

Nomancleature: Hibiscus rosa-sinensis was named in 1753 by Carl Linnaeus in his *Species Plantarum*. The Latin term *rosa-sinensis* literally means "rose of China", though it is not closely related to the true roses. ¹⁵

Description: Hibiscus rosa-sinensis is a bushy, evergreen shrub or small tree growing 2.5–5 m (8–16 ft) tall and 1.5–3 m (5–10 ft) wide, with glossy leaves and solitary, brilliant red flowers in summer and autumn. The 5petaled flowers are 10 cm (4 in) in diameter, with prominent orange-tipped red anthers.

The flowers are large, conspicuous, trumpetshaped, with five petals and their colors can be white to pink, red, orange, peach, and yellow or purple that are 4–18 cm broad. The flowers from various cultivars and hybrids can be either a single flower or a double flower. Flower color in certain species, such as *H. mutabilis* and *H. tiliaceus*, changes with age This flower has a



crown that consists of 15 - 20 leaves which are alternate and ovate.¹⁶

At the bottom of every hibiscus bud is the calyx which is green in color. The pointed ends of the calyx are the sepals. When the hibiscus begins to bloom, the petals begin to grow which contains multiple petals and multiple colors. The ovary and other female parts of the flower lie in the main structure of the hibiscus, the pistil, which is long and tubular. The hibiscus has both male and female parts on the same flower. The five hairy red top of the flower spots on the is the stigma (female part) of the flower. The stigma is located at the end of the style branch. At the top of the pistil is known as the stigma, where pollen is collected, and in the middle is the style, which is the section that the pollen travels down to the ovary. The ovary lies at the bottom of the blossom and the hibiscus has only one ovary which is superior.

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sepals, and the amount of stamens may vary. The root is a branched tap root. The stem is aerial, erect, green, cylindrical and branched. The leaf is simple, with alternate *phyllotaxy* and is petiolate. The leaf shape is ovate, the tip is acute and margin is serrated. Venation is unicostate reticulate. (Venation is branched or divergent.) Free lateral stipules are present.17 Floral characters: The flower is Complete (bisexual), Actinomorphic, Bracteate or ebracteate, Bracteolate or ebracteolate. Pedicellate. Dichlamydeous, Regular, Pentamerous, Hypogynous - with superior Ovary Solitary.

Epicalyx are present, valvate aestivation, free. Calyx are gamosepalous, valvate, sepaloid. Corollas are polypetalous, twisted, petaloid. Indefinite stamens, monoadelphous. Gyanoecium pentacarpellary, ovary superior, placentation axile, syncarpous. It can bloom all year round.

Ecology: Despite its size and red hues, which are attractive to nectarivore birds, it is not visited regularly by hummingbirds when grown in the Neotropics. Generalist species, like the sapphire-spangled emerald, *Amazilia lactea*, or long-billed species, like the stripe-

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breasted starthroat, Heliomaster squamosus, are occasionally seen to visit it, however. In the subtropical and temperate Americas, hummingbirds are regularly attracted to it. The endangered Papilio homerus butterfly, the largest in the western hemisphere, is known to feed on the nectar of the Hibiscus. The stamens of the flower are partly fused into a cylinder that surrounds the style.¹⁸

Genetics: Hibiscus rosa-sinensis is one of many plant species with a genetic characteristic known as polyploidy, in which there are more than two complete sets of chromosomes, unlike most other species. A side effect of polyploidy is a condition where the phenotype of the offspring may be guite different from the parent, or indeed any ancestor, essentially allowing possibly random expression of all (or any) of the characteristics of all the generations that have gone before. Because of this characteristic, H. rosa-sinensis has become popular with hobbyists who cross and recross varieties, creating new named varieties and holding competitions to exhibit and judge the many resulting new seedlings and often strikingly unique flowers.



Fig. 2: Pink Hibiscus

Pink Hibiscus in South India

Hibiscus rosa- sinensis is considered to have a number of medical uses in Chinese herbology. Traditional uses in China have been to make a black shoe-polish from its crushed flower petals, or to make a woman's black hair dye. The flowers are also used in China to color various intoxicating liquors. The plant may have some potential in cosmetic skin care; for example, an extract from the flowers of Hibiscus rosa-sinensis has been shown to function as an anti-solar agent by absorbing ultraviolet radiation. 19



Fig. 3: dark pink cultivar A dark pink cultivar

Hibiscus rosa-sinensis is the national flower of Malaysia, called *Bunga Raya* in Malay. Introduced into the Malay Peninsula in the 12th century, it was nominated as the national flower in the year 1958 by the Ministry of Agriculture amongst a few other flowers, namely ylang ylang, jasmine, lotus, rose, magnolia and medlar. On 28 July 1960, it was declared by the government of Malaysia that *Hibiscus rosasinensis* would be the national flower.

The word *bunga* in Malay means "flower", while *raya* in Malay means "celebratory" or



"grand". The Hibiscus rosa-sinensis is literally known as the "celebratory flower" in Malay. The red of the petals symbolizes the courage, life, and rapid growth of the Malaysian, and the five petals represent the five Rukun Negara of Malaysia. The flower can be found imprinted on the notes and coins of the Malaysian ringgit.

In Haiti, the flower has the character of an unofficial national flower, becoming used for a time, as a symbol of the country brand for the promotion of tourism, where it is known in Haitian Creole language as choeblack or rose kayenn. In addition, it is the symbol of the party Fusion of Haitian Social Democrats.

There is very wide range of pathogenic bacteria so there are many variety of diseases caused by them. Medicinal plants have been using to cure many diseases from the ancient time. Plants are the best sources of natural product to maintain human health. Due to development of microbial resistance on antibiotics. researchers are trying to introduce antimicrobial plants. Natural antimicrobial activity of compounds in plants have been found to possess antimicrobial activity. Interest has been revive in herbal medicine due to fewer side effects and limited ability of synthetic pharmaceutical products to control major diseases. Herbal treatment is one possible way to treat disease caused by multidrug resistant bacteria.

Hibiscus rosa-sinensis is very popular in India. It is an evergreen shrub which is in leaf all the years. It's beneficial effects are also reported in ancient Indian Medicinal literature. H.rosa sinensis flowers are used in the treatment of excessive and painful menstruation, venereal diseases, mumps, sores and coughs. Flower extracts of H. Rosasinensis was tested against Gram Positive- Staphylococcus aureus and Gram Negative- Salmonella typhimurium , E.coli, Proteus vulgaris, Pseudomonas aeruginosa. Calendula officinalis also known as pot marigold. It is one of the herbal medicine. The flower of Calendula officinalis is used to make herbal drugs. It is a medicinal plant and also used in rash and itching treatment. C. officinalis flowers having antiseptic and antibacterial property. C. Officinalis was tested against Gram Positive- Staphylococcus aureus, subtilis Bacillus and Gram Negative-Pseudomonas aeruginos, E.coli, Salmonella thyphi.20

Description of the Plant

Roots: Cylindrical of 5-15 cm length and 2 cm in diameter, off white in colour light brown transverse elenticies. Its fracture is fibrous. Roots taste sweet and mucilaginous.

Leaves: Leaves are simple ovate or ovatelanceolate. Leaves are entire at the base and coarsely toothed at the apex. Taste is mucilaginous.

Flowers: Flowers are pedicillate, actinomorphic, pentamerous and complete'. Corolla consists of 5petals, red in colour and about 3 inches in diameter.

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Fruit: The fruit (very rarely formed) is a capsule about 3 cm long.

Varieties: Many varieties exist differing in size and colour, in single (or) double forms. The important colors include Red, White, Yellow, and Light Red.²¹

Chemical constituents: Hibiscus rosasinensis contained tannins, anthraquinones, quinines, phenols, flavanoides, alkaloids, saponins. cardiac glycosides. terpenoids. protein, free amino acids carbohydrates, reducing sugars, mucilage, essential oils and steroids.

Hibiscus rosa-sinensis contained cyclopropanoids, methyl sterculate, methyl-2-hydroxy sterculate, 2hydroxysterculate, malvalate and beta-sitosterol. The major anthocyanin in the flower was cyanidin 3sophoroside.

The flowers contained four types of flavonoids, rutin, quercetin, kaempferol and myricetin. The flowers also contained substantial quantities of proanthocyanidins and anthocyanins. Manv compounds were isolated from the flowers included cyclopeptide alkaloids. vitamins. thiamine. riboflavin, niacin and ascorbic acid. Crushed red and magenta flower varities yield dark-purplish dye, anthocyanin pigment and cyandin diglucoside, while flavanoids and cyanidin compounds many (quercetin-3-diglucoside, quercetin 3,7-diglucoside, kaempferol-3-xylosyglucoside, cyanidin-3,5 diglucoside and cyanidin-3-sophoroside-5glucoside) were isolated from other varieties.

Fresh flowers of Hibiscus rosa-sinensis gave essential oils. Many constituents were identified in the essential oils included: 1 - iodoundecane, neopentane, 2, 2, 4-trimethyl 3-pentanone, 1,2benzenedicarboxylicacid isodecyl octyl ester, 2cyclopentylethanol, 2-propeonic acid, 1-4 butanediyl ester, 2-propenamide, 1-tetrazol-2-ylethanone, 4-

Trifluoro acetoxyoctane and amylnitrite.

The extracted mucilage was slightly soluble in water and a dispersion of it yielded a brown, slimy solution and it was practically insoluble in ethanol, acetone and chloroform. A 1% w/v suspension of Hibiscus mucilage in water gave a pH of 6.5. Mucilage of Hibiscus rosa-sinensis contained L-rhamnose. D-galactose, D-galactouronic acid, and D-glucuronic acid. The metals in decoction of Hibiscus rosasinensis leaves were determined by atomic absorption spectrophotometer, were they Sodium. included: Potassium. Calcium. Magnesium, Iron, Zinc, Cobalt, Manganese, Chromium, Nickel and Copper.

Plant Part Constituent Reported

Flowers: Thiamine, Riboflavin, Niacin and Ascorbic acid, Apigenidin, citric acid, fructose, glucose, oxalic acid, pelargonidin, guercetin.

Leaves: Carbohydrates and/or glycosides, Steroids and/or triterpenes, Flavonoids, Tannins, Alkaloids and/or nitrogenous bases, Saponins, Coumarins

Stems: Teraxeryl acetate, ß-sitosterol and the cyclicacids sterculic and malvalic acids.



Roots: Glycosides, tannins, phytosterols, fixed oils, fats, proteins, aminoacids, flavonoids, Saponins, gums and mucilage.

Microscopic Characters: Transverse section of midrib of leaf showed chained, small and numerous epidermal cells. The mesophyll layer is irregular and comprised of 6-7 layers. Cells of parenchyma varied greatly in shape and size and were sometimes, elongated or lobed. The xylem vessels were numerous, very big in size and circular in shape. Phloem vessels were small in size, numerous and circular in shape. Calcium oxalate crystals were dark stained and numerous in mesophyll parenchyma. Trichomes were absent on both upper and lower surface. Transverse section of lamina showed cuticle and thick walled cells in upper and lower epidermis. Epidermal cells were large in size, elongated and compact. Palisade parenchyma showed 3 or 4 layers of large, compact and dark cells. Dark stained crystals were present in mesophyll layer. The spongy mesophyll was wider comprising of 6-8 layers of lobed tightly interconnected cells. Trichomes were absent on both upper and lower surfaces. Vascular bundles had compact parallel rows of xylem vessels and fibres.22

Garcinia indica Synonym: -Garcinia purpurea Roxb. Family-Clusiaceae, consist of dried fruits rind known as kokum, bark, and young leaves. It is distributed in, Western Ghats, most commonly in the Southern Konkan and Goa. It is an Indian spice used in many parts of the



Fig. 4: plant of Garcinia indica

country for making several vegetarian and nonvegetarian 'curry' preparations, including the popular 'solkadhi'. The fruits are steeped in sugar syrup to make 'amrut kokum', a healthy soft drink to relieve sunstroke, which is popular during summer.²³





Garcinia indica C or commonly known as Kokum and is distributed mainly in peninsular India. This is one of several species of Garcinia found in many tropical regions. The Kokum is



from a tall tropical evergreen tree. The fruit is harvested during April-May of every year. It is used as culinary in several cooking practices. The extract of the fruit has both antifungal and antibacterial properties and therefore, has a potential for use as biopreservative in food applications. The juice has a distinctive acidic flavor. It is a soothing drink in summer months and it provides relief from gastric disorders. It is traditionally used to treat sores, skin ailments such as rashes caused by allergies, dermatitis and chaffed skin, burns, scalds, and to relieve sunstroke. It is also a remedy for diarrhea, dysentery, piles and tumors. It facilitates digestion, purifies the blood and fights cholesterol.

It has been found that rind of the fruit contains hydroxy citric acid [HCA], garcinol and the coloring pigment anthocyanin. HCA, which is claimed to have fat-reducing properties, is often used to reduce obesity, since it inhibits the citrate lyase responsible for enzyme, conversion of carbohydrates into fats. Another major compound reported to be present in the chloroform extract of the fruit is garcinol with a strong antioxidant activity since it contains both phenolic hydroxyl groups as well as a βdiketone moiety and it exerts an antiinflammatory effect. It acts as a free radical scavenger and hence is very important pharmaceutically.

This study focuses to characterize the active compounds responsible for antibacterial activity www.pharmaerudítíon.org Nov. 2019, 9(3), 59-78

Scientific Classification		
Garcinia indi	arcinia indica	
Kingdom	Plantae	
Clade	Tracheophytes	
Clade	Angiosperms	
Clade	Eudicots	
Clade	Rosids	
Order	Malpighiales	
Family	Clusiaceae	
Genus	Garcinia	

Table 2: Classification Garcinia indica

of *Garcinia indica* against strains of bacteria, which cause digestive tract disorders and mild skin infections.²⁴

G. indica

Species

Geographical distribution: Kokum is a tropical evergreen tree of moderate to large size. It is found at an altitude of about 800 meters from sea level. It is a slender tree with drooping branches. It grows to a height of 15-20m. The canopy is dense with green leaves. It is a native of the Western Ghats region of India. It is distributed throughout Konkan, Goa, North & south Karnataka, North Malabar, Coorg & Wynad as well as in West Bengal and Assam. It is androdioecious tree producing male and bisexual flowers on separate plants.

Morphology of plant: The tree grows up to 10-18 meters with drooping branches. It flowers from November to February with fruits ripening from April to May. After 15 years, a properly cared single plant yields about 30 to 50 kg of fruit. The ripe Kokum fruit is red or dark purple colored containing 3-8 large seeds. The fruit is spherical, 2.5 to 3.0 cm in diameter. Seeds are usually connected to the rind by tissue and $\varepsilon g \mid P a \circ e$



embedded in a red acidic pulp. High content of malic acid and little amounts of tartaric and citric acids give pleasant tart taste to the fruit. At present, India produces 10,200 metric tons of Kokum with productivity of 8.5 tons/ha. Because of the sweetish acidic taste and its typical flavor. Different products like dried ripe Kokum rind (Amsul), Kokum syrup are made from the fruit and rind. The normal shelf life of fresh fruit is about 5 days at room temperature. Kokum fruits have longer shelf life at low temperatures. Traditionally, the fruit rinds are sun dried to reduce water activity and increase shelf-life.²⁵

Composition of fruit: Garcinia is a rich source of active compounds including garcinol, xanthochymol, isoxanthochymol and Hydroxycitric acid. These are flavonoids, benzophenones, xanthones, lactones and phenolic acids. The fruits contain citric acid, malic acid, ascorbic acetic acid, acid. hydroxycitric acid and garcinol. The major constituent of Kokum rind is garcinol, a polyisoprenylated benzophenones, isogarcinol and camboginol. Garcim-1, Garcim-2 and cambogin are the chief oxidative products of garcinol, along with isogarcinol, gambogic acid, mangostin, clusianone, macurin, oblongifolin (A, B, C), guttiferone (I, J, K, M, N). Kokum fruit is naturally very acidic with a pH between 1.5 to 2.0. The rind of ripe Kokum fruits consists of hydroxyacetic acid and hydroxycitric acid. It also contains 2.4% pigment as a mixture of two

anthocyanins namely, cyanidin-3-sambubioside and cyanidin- 3-glucoside in the ratio 4:1. Studies have shown that the fresh rind of Kokum contains 80% moisture, 2% protein, 2.8% tannin, 5% pectin, 14% crude fiber, 4.1% total sugars, 1.4% fat, 2.4% pigment, 22% hydroxycitric acid, 0.06% ascorbic acid7. Kokum leaves are reported to contain Lleucine, 75% moisture, protein 2.3g, fat 0.5g, fiber 1.24g, carbohydrates 17.2g, iron 15.14mg, calcium 250mg, ascorbic acid 10mg and oxalic acid 18.10mg per 100g. Hydroxycitric acid lactone and citric acid are present in leaves and rinds in minor quantities. Kokum seeds are rich in glycerides of stearic acid (55%), oleic acid (40%), palmitic acid (3%), linoleic acid (1.5%), hydroxyl capric acid (10%) and myristic acid (0.5%).Kokum seed contains about 25% edible fat commonly known as Kokum butter. It is extracted mostly by crushing seeds, boiling them in water and removing fat from top orby churning the seeds in water. Sometimes it is also separated by solvent extraction. It is used as edible fat or adulterant of ghee. Crude Kokum butter is yellowish, while when refined, it is white in colour. Refined Kokum butter is comparable with high quality hydrogenated fats. Free fatty acids are present up to 7.2% of total Kokum butter. It is an excellent emollient used by the cosmetic industry for preparations of lotions, creams, lip-balms and soaps. It has relatively high melting point and is considered as one of the most stable exotic butter which



does not need any refrigeration.26

Pharmacological and biological properties:

Antioxidant and Hepatoprotective activity: Deore et studied antioxidant al. and hepatoprotective effect of aqueous and ethanolic extract of Garcinia indica Linn fruit rind on carbon tetrachloride (1.5 ml/kg) induced liver toxicity on Wistar albino rats. The degree of liver protection was measured by using biochemical parameters such as aspartate transaminase (AST), alanine transaminase (ALT), alkaline phosphatase (ALKP) and serum bilirubin (SBRN). Whereas antioxidant effect was determine by using biochemical parameters like sulphoxide dismutase (SOD), glutathione (GSH), lipid peroxidation (LPO) and catalase (CAT). Gogoi et al. evaluated methanolic fruit rind extract of Garcinia indica fruit rind for determination of free radical inhibition property and total phenolic content. Selvi reported the free radical scavenging property of chloroform extract of kokum rind by using DPPH assay and β -carotene linoleate assay. Marketed concentrated syrup, cold and hot aqueous extract of kokum also exhibited free radical scavenging activity. Methanolic extract of kokum fruit showed potent antioxidant activities comparable to standard ascorbic acid. Garcinol was found to have superoxide anion scavenging activity in phenazine methosulphate/ NADH nitroblue tetrazolium system²⁷.

Anti-neoplastic activity: Garcinia indica fruit rind extract exhibited dose dependent cytotoxic activity by inhibiting cultured Balb/c 3T3 mouse fibroblasts. Previous reports showed that elicited inhibitory effect garcinol on Azoxymethane (AOM) - induced colonic aberrant crypt foci (ACF). Moreover, garcinol also improved liver glutathione-S-transferase and Quinone reductase levels, reflecting hastening of detoxification mechanisms. Garcinol showed significant suppression in 4-NQO induced oral carcinogenesis. It also diminishes tongue carcinoma. Garcinol prevented DNA damage, by scavenging the hydroxyl radical and inhibit carcinogenesis. Furthermore, garcinol and its derivatives, cambogin, garcim-1, and garcim-2 showed potent growth-inhibitory effects on the neoplastic colon cancer cells, as well as in normal immortalized intestinal cells. Antiproliferative effects of garcinol was elicited in HeLa cells, human colorectal cancer cell line, human leukemia HL-60 cells, human breast cancer cells, prostrate and pancreatic cancer cells. Isogarcinol and xanthochymol induce apoptosis through activation of caspase-3 in neoplastic cells. In vivo studies predicted reduction in number of non-malignant and malignant skin tumors per mouse in skin carcinogenesis model by Cyanidin-3-glucoside. Cyanidin-3-glucoside provided protection toCaco-2 colon cancer cells against the peroxyl



radical (AAPH)-induced oxidative damage and reduce its cytotoxicity .²⁸

Antimicrobial and Cytotoxic Effects: Antimicrobial properties of Garcinia indica on certain microbes and cytotoxic properties of Garcinia *indica* on Balb/c 3T3 mouse The fibroblasts. minimum inhibitory concentrations of the water extract against bacteria were, 0.5mg/ml in Escherichia coli, 5mg/ml in both Bacillus subtilis and Enterobacter aerogenes and 50mg/ml in Staphylococcus aureus. The minimum inhibitory concentrations against fungi were 50mg/ml for both Candida albicans and Penicillium sp. Garcinia indica fruit rind extract showed inhibitory effect on cultured 3T3 mouse fibroblasts. The cell concentration decreased with increasing concentration of the extract. The Garcinia indica extract has both antifungal and antibacterial properties.29

Anti-fungal activity: Varalakshmi and coworkers demonstrated antifungal activity of aqueous extract of kokum rind against candida albicans and penicillium sp. Chloroform extract of kokum rind inhibited the growth of Aspergillus flavus and production of aflatoxin.

Anti-bacterial activity: Hexane and benzene extracts of the rinds of kokum and its active constituent garcinol possess powerful antibacterial activity of its own. It also potentiated the effects of clarithromycin on H. Pylori. Even the kokum leaf extract possesses inhibitory activity against pathogenic bacteria salmonella typhi, salmonella paratyphi A and Salmonella typhimurium. Aqueous extract of kokum rind is reported to have highest antibacterial activity Bacillus subtilis. against followed by Escherichia coli, Enterobacter aerogenes and Staphylococcus aureus. The phytoconstituents and garcinol, isogarcinol xanthochymol exhibited inhibitory effect on the growth of methicillin resistant S. Aureus.³⁰

Anti-inflammatory activity: Kokum rind aqueous and ethanolic extract was investigated for its anti-inflammatory potential, by using carrageenan induced paw edema model. Both the extracts showed powerful reduction in inflammation, in acute study. Moreover, significant reduction in lysosomal enzymes acid phosphate and alkaline phosphate confirms its anti-inflammatory activity.³¹

Deore et al. reported the ulcer protective effect of aqueous and ethanolic extract of Garcinia *indica* Linn fruit rind. The aqueous and ethanol extract of Garcinia indica Linn were investigated for ulcer protective activity against indomethacin induced ulcerogenesis and HCI/ethanol induced gastric lesion. Oral administration of the aqueous and ethanol extracts of Garcinia indica fruit rind at the dose 500 mg/kg provided significant (p<0.001) reduction of ulcer index in the HCI/ethanol and indomethacin induced gastric lesion rat models.³²

Anti- obesity activity: Darji and his coworkers reported that the methanolic extract of the dried



fruit of kokum showed remarkable antihyperlipidemic activity in rats, using cholesterol induced hyperlipidemic model. Significant decrease in total cholesterol, triglycerides, LDL-C, VLDL-C levels and increase in HDL-C [36]. Many studies have shown that intake of hydroxycitric present in kokum reduces appetite, inhibits lipogenesis and reduces body weight. In vitro studies demonstrated increase in adipocytokine secretion and upregulation of adipocyte specific gene expression without activation of PPARy on treatment of rat adipocytes with cyaniding 3glucoside. Furthermore, in vivo studies also showed increase in gene expression of adiponectin in the white adipose tissue. Lipase inhibitory property and anti-obesity activity of isogarcinol was also shown.33

Hypoglycemic activity: The whole fruit extract of kokum significantly lowered fasting blood glucose levels in streptozotocin induced hyperglycaemic rats in acute as well as chronic study. The acute administration of aqueous extract at 400 mg/kg significantly improved oral tolerance, revealing glucose its antihyperglycemic activity. Garcinol purified from Garcinia indica rind was reported to have potent glycation inhibiting activity, as it suppresses protein glycation in a bovine serum albumin/fructose system.34

5.10 neuroprotective potential against 6-OHDA, indicating its antiparkinson's activity in rats. Garcinol also reduced the expression of LPS induced anti-inflammatory mediators. iNOS and COX-2 and prevented nitric oxide accumulation in LPStreated astrocytes. It was also found to have anticholinesterase property. Cyanidin-3glucoside prevent the neurite outgrowth and the expression of neurofilament proteins demonstrating its neuroprotective potential.

Antiageing activity: Kokum pigments are useful in skin disorders for skin care due to its UV light absorbing properties. Kokum exhibits anti hyaluronidase and anti elastase activities which favours skin care.³⁵

Botanical Description: A slender evergreen tree of moderate height with dropping branches, bark dark brown, smooth; young twigs cylindrical, with four elevated lines, Leaves opposite on rather long glabrous. petioles; blade oblong-lanceolate or oblongoval, 2.5-3.5 inches long and 1-1.5 inches broad, obtuse or acute at the apex, tapering at the base, entire, thin, glabrous, bright green, reddish when young. Flowers small, unisexual, sub-dioecious, the male on short glabrous pedicles arranged in threes at the end of the branchlets, or 2 or 3 together in the axils of leaves; the female sessile, solitary or rarly 2 or 3 together in the leaf axils. ³⁶

Male flower: - sepals 4, rounded, very obtuse, pubescent on the outside; petals 4; about twice as long as the sepals, thick, scarcely longer then the sepals. Stamens very numerous, the filaments completely fused in to a quadratecylindrical mass, anther nearly sessile, ovoid,



2-celled, dehiscent longitudinally, interiors, basified. Female or sub-bisexual flowers: -Sepals and petals as in the male; androecium's represented by 4 groups opposite the sepals, of 2-7 erect, small stamens or staminate in 1 or 2 rows, about as long as the ovary. Ovary globular, fleshy, smooth, walls very thick, cells 5 to 8 very small, stigmas sessile, large, spreading, very papillose.

Fruits globes or spherical, supported at the base by the persistent calyx and marked by a depression at the apex, about 1-1.5 inches in diameter, smooth dark purple when ripe, fleshy, indehiscent; pericarp, thick soft, entirely filled with a firm juicy dark purplish-red pulp imperfectly divided by the fibrous remains of the axis and dissepiments into 5-8 unequal segments, each containing in the center a single seed, to which the pulp is adherent.

Seeds large 0.5-0.75 inch long, oblong reniform in outline, very blunt at each end, rounded on the back, thinner on the inner edge, smooth, shiny and brown, somewhat compressed testa rather thin, soft veined, embryo occupying the whole seed, homogeneous, entirely without cotyledons, but with the minute depression at the apex.³⁷⁻⁴⁰

Chemical Constituents:- The fruit rind contains Garcinol and Isogarcinol, prescribed for stimulating digestive power, for quenching thirst and for disease of the mouth. The root and bark is used as astringent. The kernel of seeds produces kokum butter. It contains glycerides of Stearic, oleic, Hydroxylcapric, Palmitic and Linoleic acids.

One of the ingredients of kokum, Hydroxycitric acid (HCA), has been patented for use as a hypocholesterolaemic agent. HCA is a potential anti-obesity agent. It suppresses fatty acid synthesis, lipogenesis, and food intake and induces weight loss.

Garcinol



Xanthochymol



Isoxanthochymol



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Garcinol, a polyisoprenylated benzophenone purified from *Garcinia indica* fruit rind. Apart from HCA and garcinol, kokum contains other compounds with potential antioxidant properties. ⁴¹

Antigenotoxic properties of Hibiscus Rosa-Sinensis and Garcinia indica: Genetic toxicology, unlike other disciplines in toxicology, does not study a specific adverse health effect; rather potential genotoxic effects are evaluated since they are considered important prequel to the development of adverse health effects such as cancer. By definition, it is the study of adverse effects on the process of heredity. Studies are designed to assess the effects of chemicals on genetic mechanisms and the consequent risk to organisms, including human beings.

Environmental and chemical mutagenic drugs disturbs DNA synthesis and cell division, they may have damaging effect on tissues with normally low mitotic indices. They have Cytotoxic and radiomimetic actions generating reactive oxygen species such as superoxide (O_2^-) ; nitric oxide (NO), hydrogen peroxide (H_2O_2) and peroxy radicals in a biological system. Reactive oxygen species (ROS) is a collective term which includes not only the oxygen radicals (O_2^-) and OH) but also some none radical derivatives of oxygen. These include hydrogen peroxide $H_2 O_2$, hypochlorous acid (HOCL) and ozone (O_3) .

The antioxidant defence system in the body can only protect the body when the amount of free radicals is within the normal the physiological level. But when the balance is shifted towards more of free radicals. increasing their burden in the body either due to environmental condition or produced within the body, it leads to oxidative stress, which may result in various diseases. There are several endogenous defence mechanism against foreign organisms e.g. Phagocytic cells such as neutrophils or macrophages defend against foreign organisms by generating O₂- and nitric oxide as a part of killing mechanism.

The use of traditional herbal plants like *Garcinia indica* and *Hibiscus rosa sinensis* is widespread and still serves as leads for the development of novel pharmacological agents. Many Indian medicinal plants are considered potential source of antioxidant compounds. *Daucus carota, Ocimum sanctum linn, Withania Somnifera,* also have antioxidant activity. The majority of rich diversity of Indian medicinal plants is yet to be scientifically evaluated for such properties.

Genotoxicity can be detected by a variety of tests like Ames test, micronucleus test, chromosomal aberration test, comet assay (SCGE), unscheduled DNA synthesis assay, point mutation assay etc. Comet assay is simple, sensitive and rapid method for screening DNA double and single strand



breaks, which can be further confirmed by micronucleus assay.

CONCLUSION

Garcinol from *Garcinia indica* fruit reported the free radical Scavenging activity and antiulcer activity. Orally administered garcinol prevented acute ulceration in rats induced by indomethacin and water immersion stress caused by radical formation. These results suggested garcinol might have potential as a free radical scavenger and clinical application as an antiulcer drug.

Hibiscus rosa sinensis flowers have been used in traditional medicine as treatment for several diseases. The methanolic flower extract of *hibiscus rosa sinensis* was evaluated with respect to its genotoxic potential through micronucleus assay in Balb/c mice. The frequency of micronuclei in groups of animals treated with *hibiscus rosa sinensis* showed no differences as compared to the negative control (vehicle); therefore, it is considered that the *hibiscus rosa sinensis* showed no genotoxic activity in the micronucleus test.

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