Journal of Global Biosciences
ISSN 2320-1355
Volume 3, Number 6, 2014, pp. 872-880
Website: www.mutagens.co.in
E-mail: submit@mutagens.co.in
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Research Paper

A COMPARISON ON THE PHYSICO-CHEMICAL PARAMETERS OF SEED-BUTTERS OF SELECTED INDIAN *GARCINIA* SPP.

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Abstract

The physico-chemical parameters and the composition of the fatty acids from the seed butter of four species of *Garcinia* namely *G. indica*, *G. xanthochymus*, *G. gummigutta* and *G. mangostana* grown in the Western Ghats region of India were studied. *Garcinia* seed kernel is an important source of fatty acid with a yield of 30-40% butter. The results indicated that it is a high quality oil with 7 important constituent of fatty acids namely palmitic acid, stearic acid, elaidic acid, oleic acid, linoleic acid, arachidic acid and eicosenoic acid. Chemical analysis indicated the abundance of long chained and unsaturated fatty acids, which was confirmed by GC-MS. The percentage of saturated fatty acids and unsaturated fatty acids were almost equal. The chemical properties of the seed-butters were of range of the commonly used cooking oils. The melting point of butters was high (40°C), which could be an ideal fat for use in confectionaries.

Key words: *Garcinia*, seed-butter, fatty acids, physico-chemical properties.

INTRODUCTION

Vegetable oils and margarine are most commonly used in foods. Healthy oils are supposed to lower cholesterol, blood pressure, and improve overall health. The most commonly used vegetable oils are rapeseed (canola oil), soybean (soybean oil), corn, sunflower, safflower etc. *Garcinia* seed oil is important oil with medicinal values, but is under-exploited. Some of these vegetable fats are actually very helpful to maintain a healthy metabolism, ensure a healthy skin and also provide protection from heart diseases. Although the term oils, fats and lipids are all used to refer to fats, in reality fats are subset of lipids. Oil is usually used to refer to the fats that are liquid at room temperature, while fats/butters is usually used to refer to a fat that is solid at normal room temperature [20].

Essential fatty acids (EFA's) are essential because the body cannot synthesise them from any other substances, which means they can only be obtained from the food. They

help to generate and maintain the fatty membranes, which coat every cell body. They are important for memory and brain function; and they actively maintain healthy hair, skin and nails. There has been an abundance of research on these fatty acids and their activity in the human health.

Garcinia is an under-utilized medicinal crop belonging to the family Guttiferae (Clusiaceae). It is a large genus of polygamous trees or shrubs, distributed widely in the tropical Asia, Africa and Polynesia. It consists of 200 species, out of which, 35 species are found in India. Through GIS studies and surveys reported the occurrence of various *Garcinia* species in Konkan and Malabar regions of South India and in the foothills of North-eastern Himalayan regions [27]. The genus *Garcinia* shows a very high degree of diversity. Previous researches show the variation in molecular and enzymatic levels [21]. Asish *et.al.,* (2008) reported the occurrence of an anti-obesity compound, Hydroxy citric acid (HCA) in certain Western Ghats species [16]. HCA and a few other beneficial organic acids were also reported in fruits of Indian *Garcinia* species [24]. The demand of *Garcinia* is increasing recently due to its medicinal properties, but cannot be fully exploited as it is included under the list of endangered species [23].

The seeds of the fruit have edible fat, commonly known as 'Garcinia butter' due to its solid state in room temperature. Previous investigations, *G. indica* butter (known as kokum butter) was found to improve the hardness of chocolate [12]. Though *G. indica* and *G. mangostana* butter are in use in Karnataka, Maharashtra and Goa [9], the biochemical properties of the butter is yet to be reported. In the present investigation, we report the chemical composition of the seed butters of four *Garcinia* species grown in Western Ghats.

MATERIALS AND METHODS

Garcinia seed-butter was extracted from the seeds of *Garcinia gummi-gutta* Robs*., G. indica* Chois*., G. xanthochymus* Roxb. and *G. mangostana* Linn., in the traditional wet-process. Seeds from the fresh fruits were separated and dried thoroughly. About 100g of kernels were separated from the seeds and washed in hot water to remove all impurities. Kernels were then slightly roasted in a gentle heat in a pan and then finely grinded. It was then boiled with 1litre water in an open pan for 4-5 hours. The oily upper layer was decanted in to a clean beaker and allowed the water to evaporate. Dried fat, known as butter is stored in a dry air tight container [18].

Fatty acid extraction

For analysis, fats were extracted by solvent method. Five grams of dried seed kernels were taken in a metal mortar and homogenized. The sample is then placed into a cellulose paper cone and placed in a Soxhlet apparatus. The extraction was performed using 200 ml petroleum ether (boiling point of 60°-80°C) for 3 hours. Then, the solvent was evaporated at 50 °C using a rotary evaporator. Finally, the lipid content of samples was determined gravimetrically [8].The dried lipid was stored in a clean and dry vial and tightly closed in a refrigerator at 0-4°C.

Analysis of Physical Parameters

Pour point and Melting point for the butters were estimated in the standard way by treating the samples to the particular temperature for a minute duration and observing the physical state of the sample.

Fatty Acid Methyl Esterification (FAME)

Fatty acids are non-volatile and cannot be analyzed in Gas-liquid chromatography. So they were converted into Fatty acid methyl esters (FAME), which were volatile by modified Odham and Stenhagen (1972) method [2]. In the first step, fatty acids are

separated from steroids and other contaminants from 500mg of the extracted butter by saponification using alcoholic Sodium hydroxide (3N NaOH-Methanol 2:1). The saponified fatty acids were separated in aqueous phase by fractionation with water-hexane mixture. It is the desaponified using 6N HCl and extracted with 5 ml of hexane. The pure free fatty acids were then converted to FAME using 5 ml of acidified methanol (methanol-Concentrated HCl 5:1), and incubating at 70°C for 5 hours. It was then fractionated in a separating funnel and extracted as hexane phase. The FAME samples were de-moisturized using anhydrous Sodium sulphate, filtered and stored in air tight vials at 0-4°C.

Analysis by GC-MS

One microlitre of sample was injected onto a GC equipped with a MS and a polar capillary column (HP-Innowax polyethylene glycol), 0.25mm internal diameter, 30m in length and 0.25mm film in thickness) to obtain individual peaks of fatty acid methyl esters. The carrier gas was helium with a flow rate of 1.5 mL/ min. The detector temperature was 270 °C and the column temperature was 150 ◦C held for 1min and increased at the rate of 15 ◦C/min to 200 ◦C and the rate of 2 ◦C/min to 250 and held for four minute. The run time was 45min. The mass spectrometer operated under the following conditions: ion ionization voltage, 70 eV, mass range, 50- 450 m/z and scan and inter-scan delay times of 0.45sg and 0.05sg, respectively. The fatty acid methyl esters peaks were identified by comparison of their mass spectra with the Wiley (New York, USA) mass spectrum library. Percentage of the fatty acid was calculated on the basis of the peak area of a fatty acid species to the total peak area of all the fatty acids in the oil sample.

Analysis of Chemical Parameters

Acid value, free fatty acid percentage, saponification value and iodine number were estimated by standard procedures [1,3,26].

Total sterols in the butter were determined using Liberman-Burchard reagent as described by FSSAI, (2012) [26].

Vitamin E in the butter was determined by comparing the UV-absorption at 285nm against a series of standard Tocopherol acetate solution [7].

RESULTS AND DISCUSSION

In comparison to other vegetable seed fats like Castor seed (50%), ground nut kernel (42%), mustard (35%), palm kernel (36%), sunflower (32%) sesame (50%) and copra (60%), *Garcinia* has (30-40%) oil, indicating it as an important source of fatty acids.

The physical properties of the four species show that the yield of butter is very high in *G. gummi-gutta*, (47%) while in *G. indica* and in *G. xanthochymus* it was around 30% and in case of *G. mangostana*, it was lesser, around 24% (Table 1). *Garcinia* butter is solid at room temperature. It is quite hard, almost as hard as cocoa butter and is a good substitute, in the recepies where cocoa butter is needed. Reports are available for the use of *G. indica* butter with cocoa butter for chocolates. Kokum fat is added in various proportions replacing cocoa butter in dark and milk chocolate formulations. Hardens of both dark and milk chocolates are increased with increase in addition of kokum fat [12]. The presence of fatty acid in high concentration and the solidification properties of the butter make it ideal confectionary fat. The melting point of *Garcinia* seed-butter is high (about 40°C), hence it can be used along with the cocoa butter to increase the heat resistance property and hardness of the chocolate. It is helpful in preventing heat induced softening and loss of consistency of chocolates, mainly in hot climatic regions [25].

The fatty acid profile presented in the Figure 1 and the Table 2 show that the Garcinia-butter has 7 important fatty acids with various percentages in various species. The major fatty acids present were palmitic acid, stearic acid, elaidic acid, oleic acid, linoleic acid, arachidic acid and eicosenoic acid.

Palmitic acid is present in very high (47%) in *G. mangostana* while it is moderate in other species (Peak no.1 in Fig. 1). Palmitic acid is an ionic surfactant, which has a pleasing sensation to the body. It is thus mainly used to produce soaps, cosmetics and releasing agents. Palmitic acid is the commonest saturated fatty acid in the plants and animal lipids. Kokum butter (from *G. indica*) is popular in skin care products because of its ability to soften skin and heal ulcerations and fissures of the lips, hands, and soles of feet. Palmitic acid helps to control obesity and helps to recover some reproductive abnormalities [5]. It is reported that the diet enriched with palmitic acid is good for diabetes [19].

Stearic acid is present in very high concentration (30-40%) in *G. gummi-gutta, G. indica* and *G. xanthochymus*; while its percentage is less in *G. mangostana* (2.3%) (Peak no. 3 in Fig. 1). Stearic acid is commonly used in the manufacture soaps, detergents, shampoo, shaving creams and other cosmetic products. It is one of the most common saturated fatty acids found in the nature following palmitic acid [14]. Butter rich in stearic acid is solid at room temperature. It is also used in many food products because it remains stable at high temperatures. It is commonly used in margarine and other spreads. A few plants which have Stearic acid more than 30% in its seed oil, like *Butyrospermum Paradoxum* (Shea), *Shorea robusta* (sal), *Vateria indica* (dhupa). Garcinia could be taken as good source of stearic acid. It is reported that the total plasma cholesterol decreased by an average of 14% during the consumption of high stearic acid diet [6]. Oleic acid also present in a good percentage in all the four species (26-35%) (Peak no. 4 in Fig. 1). High oleic acid makes the butter less susceptible to spoilage, so could be useful in food preservation. Oleic acid may hinder the progression of adrenoleukodystrophy, a fatal disease that affects the brain and adrenal glands [4]. Oleic acid may be responsible for the hypotensive effects of olive oil [17]. Linoleic acid is another important acid which is present with a moderate percentage (5-11%). The use may include, helping people loose body fat [11] and possibly preventing colon or breast cancer [15]. It is a strong antioxidant with benefits such as lowering high cholesterol and controlling weight. Arachidic acid (1-8%) is a saturated fatty acid. It is a minor constituent of peanut oil (1.1-1.7%) and corn oil (3%). Arachidic acid is used for the production of detergents, photographic materials and lubricants. The food rich with arachidonic acid is known as anti-inflammatory diet [10].

Table 3 describes the chemical properties of *Garcinia* seed-butters. Acid value and percentage free fatty acids represent the freshness and storage quality of an oil or fat. It is the measure of susceptibility and its extend of decomposition. The acid value of the four species of *Garcinia* varies from 3.7-4.5; which shows the butter is good for the consumption (Table 3). Free fatty acid content is commonly called the free acidity percent; lesser the value better is the fat. Other than *G. indica* oil, all are having very low value (table 3).

Saponification number gives the information concerning the character of the fatty acid present in the fat. It shows in average, how large the fatty acids that are present in the fat. Fats with the high saponification number yield quite soluble soaps. Here the value ranged 140-200. The saponification value of the olive oil is 187-196, for sunflower it is 188-194, for ground nut it is 188-195, for mustard oil it is 169-176 and for sesame oil it is 188-195, while it is very high in coconut oil and ghee (251-263 and 220 respectively)

Table 4. Iodine value is a measure of the unsaturated nature of a fat. The iodine value preferably should be 25-50 and more preferably 30-45 in good fat (Table 4). In *Garcinia* butter it varies from 37-51; in different species (Table 3). This value allows predicting the tendency of fat to become rancid. In coconut oil, the iodine value is very low (7.5-10.5) (Table 4) and hence shows a high tendency to go rancid. Table 4 represents the iodine value of some common oils and fats.

Phytosterols are more commonly known as plant sterols which have been shown in clinical trials to block cholesterol absorption sites in the human intestines, thus helping to reducing cholesterol in human. Nevertheless, high percentage is not considered as good. In *G. mangostana* the sterol value is 0.10, in *G. xanthochymus* it is 0.96, in *G. gummi-gutta* it is 0.45, while for *G. indica*, it is little higher (1.02).

Vitamin E is a fat soluble compound. Vitamin E has many biological functions, antioxidant function being the most important and best known. Vitamin E in different *Garcinia* species varies from 9.0-20.01 mg/g. Vitamin E in palm oil and Ghee are 25 and 36 mg/g respectively, while it is 1.5 mg/g in sesame oil, 11 mg/g in coconut, 14 mg/g in olive oil [20].

Monounsaturated fats improve heart health, help to lose belly fat and keep cholesterol down. Polyunsaturated fats are definitely good, healthy and a key part of fat intake as being the essential fatty acids. Research has shown that it lowers the LDL cholesterol level, raises HDL cholesterol level and reduces inflammation. Coconut oil and ghee has saturated oil has 52 and 64% while sunflower oils, olive oil and mustard oil has unsaturated fat 88%, 83% and 81% respectively [20, 26].

The butter obtained from the seeds of *Garcinia* is an ideal fat with all desirable qualities, though the use is not common, hence it could be a welcome introduction. Stearic acid by virtue of its heat stability makes the *Garcinia* butter good confectionary oil. *G. indica* butter also referred to as Goa butter and is used as substitute for ghee [13] in the localities. *Garcinia indica* and *G. gummi-gutta* are the crops of future for south India, which needs further attention and research and the reports on ITK (indigenous technical knowledge) indicate that in Northern Karnataka as well as in Goa, women self-help groups are involved in the extraction of the seed butter as the cottage industry. If care taken, the food and nutraceutical product of *Garcinia* can provide additional source of income to local people. There is a need of creating awareness among the local people about its value for both for its food and nutraceutical properties. *Garcinia* species, except in some homesteads are forest crops, and is prone for habitat destruction. Lack of awareness, excessive deforestation, habitat destruction; and low germination and growth rate of Garcinia make it to be endangered [22]. Creating awareness about its value would prevent this and would encourage the organized plantations.

CONCLUSIONS

Butters from Garcinia seed kernels were solid at room temperature and had pleasant appearance and aroma. Chemical properties of Garcinia-butter were similar to that of major cooking oils such as peanut oil, sesame oil and sunflower oil.

Even though the physical properties such as higher melting point and higher flash point were similar to that of Ghee and hydrogenated fats, the relatively high unsaturated fatty acid composition makes Garcinia-butter healthier than them.

Hence, as the physico-chemical properties are in the optimum ranges of that for an ideal confectionary fat, it could be concluded that Garcinia-butters can also be used as solid-fat substitutes in confectionary formulations.

Table 1: Physical Parameters of *Garcinia* butter

Physical Parameters	***G.gummi-gutta***	***G.indica***	***G. xanthochymus***	***G.mangostana***
Total fat content (% of seed)	46.54	29.33	25.71	24.20
Colour	Light brown	Pale white	Creamy-yellow	Creamy-yellow
State at room temperature	Solid	Solid	Solid	Solid
Melting point (ºC)	39.4	40.3	38.2	37.9

Table 2: Fatty acid profile of four Garcinia butter

Fatty acid composition (%)	***G. gummi-gutta***	***G. indica***	***G. xanthochymus***	***G. mangostana***
Palmitic acid	6.31	3.25	3.05	47.20
Stearic acid	30.61	49.33	44.53	2.31
Elaidic acid	9.54	3.00	1.51	-
Oleic acid	26.23	34.42	35.33	34.02
Linoleic acid	11.38	5.25	4.82	1.32
Arachidic acid	5.41	1.20	1.00	8.04
Eicosenoic acid	-	2.25	1.01	0.51
Other fatty acids	10.52	2.30	8.75	6.61

Table 3: Chemical properties of seed butter of four species of Garcinia

Chemical Parameters	***G. gummi-gutta***	***G. indica***	***G. xanthochymus***	***G. mangostana***
Acid Value (mg NaOH/g of oil)	3.7	4.9	4.8	4.5
Saponification number (mg KOH/g of oil)	187.9	200.2	190.3	140.5
Iodine value	50.2	39.4	37.4	51.8
Free fatty acids (%)	1.42	5.64	2.82	2.21
Sterols	0.54	1.02	0.96	0.10
Vit. E (mg/100g)	14.31	20.01	10.63	8.45
Total Saturated FA (%)	48.64	52.78	48.58	57.55
Mono Unsaturated FA (%)	35.77	39.67	37.85	34.53
Poly Unsaturated FA (%)	11.38	5.25	4.82	1.32

Table 4: Iodine value and saponification value for commonly used oils

Oil	Iodine Value	Saponification Value
Coconut oil	7.5-10.5	251-263
Olive oil	79-90	187-196
Palm oil	4-22	245-255
Sunflower oil	125-140	188-194
Ghee	26-38	220
Groundnut oil	84-100	188-195
Mustard oil	98-110	169-176
Sesame oil	103-116	188-195

Figure:

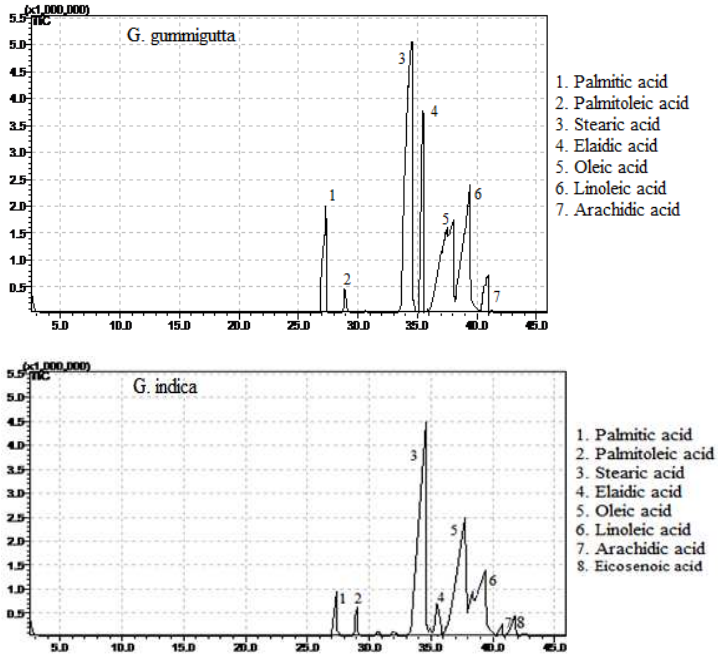

Figure 1: The GCMS chromatogram showing major fatty acids

ACKNOWLEDGEMENT

The financial assistance by CSIR-HRD group in the form of senior research fellowship to Mr. O.P. Nandakishore is gratefully acknowledged. Authors thank The Director, IISR Kozhikode for providing necessary facilities.

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