Review Article

International Journal of Probiotics and Dietetics

Nutritional and Antioxidant Profiling of Guava Fruit Clinical Nutrition & Dietitian

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Submitted: 26 Dec 2021; **Accepted**: 03 Jan 2022; **Published**: 14 Jan 2022

Citation: *Areej Tanveer (2022) Nutritional and Antioxidant Profiling of Guava Fruit Clinical Nutrition & Dietitian. Int J Probiotics and Dietetics 2(1): 18-22.*

Abstract

This study was conducted to determine the effects of guava (Psidium guajava) consumption on total antioxidant status and lipid profile (total cholesterol, triglycerides) Psidium guajava (L.) belongs to the Myrtaceae family and it is an important fruit in tropical areas like India, Indonesia, Pakistan, Bangladesh, and South America. Guava is highly nutritious and a good source of calcium, iron, phosphate pulp it contains significant amounts of dietary fiber (soluble and insoluble), vitamins (A, B, C, β-carotene), essential oils, minerals, proteins (transferrin, ceruloplasmin, albumin), pectin's, antioxidants (flavonoids, flavanols, condensed tannins) and volatile organic compounds. Therefore, this paper aims to review the nutritional and antioxidant composition of the guava fruit. The phytochemical composition of the fruit and has revealed a valuable source of compounds. Data of two years were pooled and subjected to analysis of variance (ANOVA). The significance of the difference between means was determined by Duncan's multiple range test ($p < 0.05$) using SAS. The length and breadth were recorded with the help of a varnier calipers in mm. (TSS) of fruits were recorded with the help of a digital hand refractometer. Titratable acidity was determined using titration method. Maximum fruit length was recorded in KG Guava (73.04 mm). Sugar/Acid ratio among guava was ranged from 6.78 to 13.31. The fruit and leaves can be consumed with minimal risk of adverse side effects.

Keywords: Guava, Antioxidant, Vitamins, Minerals, Dietary Fiber

Introduction

Guava, Psidium guajava L., is a small monoecious evergreen tree with a height of between 2 and 10 meters belonging to the Myrtaceae family [1]. Guava fruit is round, varying from 3-10 cm in diameter, and contains a yellow or pink leaf on the ripening of some species (Lee et al., 2010). Guava fruits range in size from moderate to 3 to 6 cm long. It has pear-like yellow spots in the ripening state. It has a special musky scent when ripe hard but sweet. Its body is a little dark brown with slightly yellow seeds. Seed size is very small and easily chewed. The genus Psidium (Myrtaceae) consists of about 150 genera and about 5000 species, which are widely distributed in the American, Asian and African tropics [2]. The fruit, which matures in approximately 120 days after flowering, is fleshy with a characteristic smell and aroma, contains many seeds and can weigh up to 500g depending on the variety and the environment [1]. It is native to tropical areas of southern Mexico and Northern South America although guava trees have now been grown by many other countries having tropical and subtropical climates, therefore allowing production around the world. The best varieties are sweet and some may be admirable (Yan et al., 2006). The guava fruit has a distinct musky taste, which softens slightly while processing. The weight of guava fruit ranges from 150 to 250 g (Ayub et al., 2005). It bears fruit twice a year but the best fruits are obtained in winter (Bal and Dhaliwal, 2004). Guava fruit is round, varying from 3-10 cm in diameter, and contains a yellow or pink leaf on the ripening of some species (Lee et al., 2010). Its precarious condition, short post-harvest life and prone to cold damage and disease, limit the sale of guava fruit. Fruit storage below 10 ° C can cause cold symptoms of damage in the form of exposed surface, skin and flesh (Singh and Pal, 2007). Guava is a very productive and highly profitable fruit crop. It is popular with fruit growers because of its wide variety and high yielding in each area (Hassan et al., 2012). Commercial varieties of mares in Pakistan include Safeda (Gola and Surahi) and are seedless and other varieties such as Allahabad, Karela, red and apple color are rarely cultivated (Usman et al., 2012). Guava fruit can be taken twice a year which is why guava fruit is often available on the market all year round. White Allahabadi, Red Allahabadi, and loca / Desi Amroad grown in the Kohat valley. White Allahabadi is a commercially available guava fruit because of its good quality, color, shape (dry round and white color) and good shelf life. While Red Allahabadi is also of good quality, round shape and red

color but its shelf life is not up to standard. Local / Desi varieties, with two distinct motives namely, circular and oval. They were also commercially accepted because of its low shell life (Pervaiz et al., 2008). The characteristics of guava varieties vary widely. Fruit-shaped fruits range from round to pear. The skin color of ripe fruit can be various shades of green or yellow. The color of the flesh can range from white to yellow to pink and red. The texture and taste of different guavas and seed content also vary (Augustin and Osman, 1988). Under tropical conditions, guavas have two crops a year (summer and winter crops) and are always available for 8-9 months on the market (Samson, 1986). Guava begins to bloom between April-May and November-December and is harvested during the months of July-August and February-March in both summer and winter. Asian Journal of Agriculture and Food Sciences (ISSN: 2321 - 1571) Volume 04 - Issued 02, April 2016 Asian Online Journals (www.ajouronline.com) 97 times in a row. „Gola" and Surahi "are two of the best guava varieties in Pakistan with an average yield of 19.2 and 18 ha-1 tons, respectively [3-6].

100 grams of guava fruit contains the following nutrients:68 calories, 14 grams carbohydrate, 3 grams protein, 5 grams fiber, 228.3 milligrams vitamin C (254 percent DV), 0.2 milligrams copper (22 percent DV), 49 micrograms folate (12 percent DV), 417 milligrams potassium (9 percent DV), 22 milligrams magnesium (5 percent DV), 40 milligrams phosphorus (3 percent DV), 624 International Units vitamin A (3 percent DV), Guavas have been dubbed the "ultimate superfood" and are widely considered one of the top antioxidant foods, supplying loads of vitamin C and lycopene in each serving. Guava contains a large number of antioxidants and phytochemicals including essential oils, polysaccharides, minerals, vitamins, enzymes, and triterpenoid acid alkaloids, steroids, glycosides, tannins, flavonoids and saponins. Guava contains high content of vitamin C and vitamin A. Guava is also an excellent source of pectin which is an important dietary fiber. It has a high content of flavonoids, fructose sugar, and carotenoids. It is known that guava is commonly used in many parts of the world to treat many ailments such as diarrhea to reduce fever, diarrhea, stomach, high blood pressure, diabetes, rot, to relieve pain and wounds. Antioxidants are particles that slow down the oxidation process. Oxidation reactions can produce free radicals that damage cells by initiating various chain reactions. Free radicals damage cancer cells and many other diseases. Antioxidants eliminate free radicals and stop the chain reaction. Examples of antioxidants include beta-carotene, lycopene, vitamins C, E and A and other substances. Oxidative reactions are one of the most important destructive responses. Free radical damage faces many human disorders such as emotional disturbances, inflammation, conversations and viral infections. When drugs are absorbed into the body free radicals are produced. Sometimes environmental and hormonal changes are the result of free production. These free radicals are responsible for all oxidation reactions. Guava contains a high number of antioxidants and anti-inflammatory nutrients that are important not only for health but also help control free radicals. It also contains a variety of phytochemicals that are essential for human health such as diabetes, obesity and high blood pressure. There are two common ways in which antioxidants reduce free radicals namely DPPH and FRAP assay. The removal of guava from living water and solvents contains a large number of antioxidants that can inhibit oxidation reactions. The filtering of these compounds is enhanced by increased concentration. The pink guava also has great antioxidant activity. Guava is rich in antioxidants that help reduce the incidence of degenerative diseases such as cerebral palsy, inflammation, heart disease, cancer, arteriosclerosis and arthritis. In fruit, the most common oxidants are polyphenols and ascorbic acid. Polyphenols are mainly flavonoids and are found mainly in glycoside forms and esters. Free elagic acid and glycosides of apigenin and myricetin are also found to be present in guava. Guava extract from organic solvent influences sperm production. It can increase sperm concentration due to the presence of antioxidants. Ethanolic extract can increase sperm quality and quantity. Therefore, it can be used for the treatment of infertile men. Ascorbic acid is an important antioxidant, present in overweight people. Guava has a high content of protocatechuic acid, quercetin, ferulic acid, ascorbic acid, quercetin, gallic acid and caffeic acid which are important in antioxidants. Some studies suggest that guavas have the ability to protect radiation through antioxidant activity [7-9].

The DPPH method shows that guava has an amazing content of antioxidants and these antioxidants do not damage human neutrophils. Exposure to different solvents shows that antioxidant guava activity is more dependent on phenolic chemicals than flavonoids. Methanol and water extraction show significant activity. Ethanolic guava extract shows low activity in all antioxidant trials such as DPPH and FRAP assay. Thanks to the antioxidant activity of guava you can control diabetes. It shows significant control of diabetes in mice. Quercetin, quercetin-3-O-glucopyranoside and morin can be separated from the leaves. These compounds show anti-oxidant activity. Quercetin has a free balance function. Its reducing power is much higher than that of any other computer. It is considered to be the most effective and powerful antioxidant in guava leaves. Comparisons were made between the oven-dried convection structures and the new fire extinguishers. Convection oven drying has been announced to retain all the complete content of phenolic (TPC), ascorbic acid equivalent to antioxidant power (AEAC) and ferric power to reduce energy (FRP) kava. However, the drought has led to a dramatic decline in AEAC, TPC and FRP [10].

The antioxidant content and activities of two types of guava fruit have been tested; the results were based on the ability to extract DPPH of fruit extracted from 50% ethanol, binding to the Fe (II) ion and reducing Fe (III) to Fe (II). The results were compared with similar analyzes of other local fruits such as orange, water apple, sugar apple, star fruit, dragon fruit and banana. Guava fruit has been found to be rich in antioxidants. It shows high antioxidant potential compared to other fruits e.g. orange, but exhibits a lower secondary antioxidant capacity. When the guava fruit is stored at 4° C then an increase in ascorbic acid content is observed. The total amount of phenol and ascorbic acid content is higher than peeled fruit compared to peeled fruit. Bananas have been described as a

second potent antioxidant, however, weaker than orange as a primary antioxidant. The power of guava extracting antioxidants has provided a new therapeutic approach to combating various disorders and ailments. Further research is needed in this regard to determine the exact mechanism of antioxidant activity and other aspects of guava treatment (Naseer, 2018) [11].

Review Literature

This review paper focuses on providing information on guava production, utilization, preservation and processing in relation to Kenya based on literature findings. Guava Cultivation in Kenya Fruit production including guavas in Kenya is mainly carried out by farmers with insufficient resources highly hindering fruit species experimentation and diversification [12]. Various varieties of red/pink fleshed, white fleshed and strawberry guava with diverse morphological and genetic diversities grow in Kenya due to the different agro-ecological zones in the country [7, 13-15]. Naturalized guava cultivation is quite common in rural areas across all the agro-ecological regions both in the wild and on farms except in the arid areas [16]. The guava trees grow widely with minimal care from sprouts of randomly dispersed seeds according to the Horticultural Crops Directorate (HCD, Kenya). There has been increased guava production over the years in the country according to HCD data [7, 17]. The total acreage under guava farming was estimated to be 1260 - 1806 Ha between 2014 to 2016 and a projected increase in production in the subsequent years. The total production was estimated at over 9800 - 11, 327 tons. However due to low economic value, the guava prices have poor returns to farmers resulting to high post-harvest losses. The guava value chain therefore remains widely untapped despite its nutritional significance and economic potential. Guavas in Kenya are mainly consumed at household level and there is limited research and development aimed at domesticating and commercialization of the fruit which have hindered the establishment and improvement of structured guava value chains in Kenya [7, 18, 19]. Furthermore, 0there are scattered and conflicting information on the guava production as well as very limited documentation on the development programs for the crop. There is also limited information on guava production for consumption and commercial purposes as well as lack of documentation of known guava plantations in Kenya. Moreover, the guava varieties and their performance in the country are yet to be profiled as very minimal studies related to the crop have hidden hunger. Guava value addition in Kenya remains extremely low and therefore there is need for a structured system for policy formulation focused on its trade with an aim of reducing the post-harvest losses, increase employment opportunities as well as maximization of the fruits' value to farmers. Value addition through new products development while ensuring minimal destruction of nutrients is essential so as to combat malnutrition especially during the harsh weather conditions and can generate income that can be utilized to meet household food security for the farmers through commercialization of guava fruits and the processed products.

In 2011, a study by *Hyderabad's National Institute of Nutrition* in India investigated the antioxidant characteristics of a number of fruits including apples, bananas, grapes and more. Interestingly enough, the study concluded that guava fruit packed the greatest antioxidant punch compared to other fruit.

A 2012 study in Pakistan concluded that fully ripe guava contained the most concentrated content of vitamin C, so it's best to enjoy the mature fruit to get the most bang for your buck.

A 2017 review in the *International Journal of Molecular Sciences* concluded that the fruit and leaves of guava are not associated with any significant side effects and can be consumed safely by most healthy adults.

A Review of Production: Losses and Processing Technologies of Guava Instant guava-drink-powder samples are obtained by dehydrating the concentrated guava juice using different drying techniques. Dehydration of guava juice into powdered particles gives a considerable reduction in volume and is an effective method of prolonging the shelf life. Mahendran (2010) produced guava powders using tunnel drying freeze and spray drying methods and evaluated the effects of drying on the quality characteristics of the fruit powders. He conducted consumer preference test to determine the sensory attributes of the reconstituted guava juice and compared the final product with the commercial products available in the market. Studies indicated that freeze dried product had superior sensory and nutritional qualities, though spray dried powder was stable and highly economical to prepare free flowing guava powder having good stability. Low caloric sweetened dehydrated guava slices is an intermediate moisture candy type product and is a readymade best food for diet conscious people of all ages and especially for diabetic patients. Ayub et al. (2005) prepared low caloric sweetened dehydrated guava slices using non-nutritive sweeteners. They conducted a study to evaluate the effect of various concentrations of non-nutritive sweeteners individually and in combination along with chemical preservatives i.e., potassium metabisulphite (PMS) and potassium sorbate (PS) and antioxidants including citric acid (CA) and ascorbic acid (AA) on microbial and sensory characteristics of dehydrated guava slices during storage period of 90 days. Samples treated with chemical preservatives found to have negligible microbial population throughout storage. Studies showed that guava slices treated with non-nutritive sweeteners were leathery in appearance due to severe loss of moisture. Maximum overall acceptability was found in the slices treated with potassium metabisulphite and ascorbic acid (Nutrición, 2001).

Materials and Methods

Plant material and growing site: Different cultivators of guava fruit were included in this study which were collected regional agricultural research institute Bahawalpur and University of Agriculture Faisalabad morphological characters of guava fruit and seed weight, length, width, flesh thickness and pulp weight recorded.

Agronomic attributes

Weight, size, and specific gravity

The fruits were weighed carefully with the help of electronic balance in gram. The length and breadth were recorded with the help of a varnier calipers in mm and average size was worked out. The specific gravity of fruit was recorded from the selected fruit by measuring their weight (gm) in air by the volume of the fruit obtained by water displacement method.

Total soluble solids, acidity, and total sugar contents

Total soluble solids (TSS) of fruits were recorded with the help of a digital hand refractometer. Titratable acidity was determined using titration method and expressed as percentage of citric acid. Total sugar contents were estimated by using copper titration method as devised by Lane and Eyon. The sugar/acid ratio was determined by dividing the sugar content of fruits by their acidity.

Pigment Analyses

Chlorophyll (a & b) and Carotenoids

Pigments (chlorophylls and carotenoids) were measured according to previously described method. The quantitative determination of chlorophyll a (chl. a), chlorophyll b (chl. b) and carotenoids in certain whole pigment extract depends mostly on solvent system. Herein, samples (1 g) were extracted with 80% acetone until pellets were colourless. Supernatants were combined and absorbance was measured at 452.5, 646.8 and 663.2 nm. Pigment concentrations were calculated using equations appropriate for used solvent (80% acetone) according to Lichtenthaler and Buschmann. chl a (mg/g FW) = (12.25 x A663.2–2.79 x A646.8) x V/1000 x mchl b (mg/g FW) = (21.50 x A646.8–5.10 x A663.2) x V/1000 x mcar (mg/g FW) = [4.75 x A452.5–0.226 x (chl a + chl b)] x V/1000 x mWhere.

V = combined extract volume (mL)
M = sample dry weight (g)

Lycopene

For determining the lycopene content, 1 g of pulp was ground with 50 mL of hexane-ethanol-acetone (2:1:1, v/v). The extract was taken in separating funnel in which 10 mL of distilled water was added. Upon separation of phases after 5 min, lower phase was discarded. After filtration, the absorbance of upper phase was recorded at 502 nm using a UV–vis spectrophotometer and result was expressed in mg/100 g

Statistical Analysis

Data of two years were pooled and subjected to analysis of variance (ANOVA). The significance of the difference between means was determined by Duncan's multiple range test ($p < 0.05$) using SAS.

Results and Discussion

Agronomic attributes

Fruit weight

There was a significant difference in fruit weight among all cultivars as depicted in Table 1. Fruit weight was ranged from 74.9 to 353.75 g. The order of hierarchy was Salithong > Kimchu > KG guava > Allahabad Safeda > Lalit. The variation in fruit weight may be due to phenotypic and genotypic influence over different cultivars, which is in conformity with the findings of Deshpande and Jana et al. Values observed in this experiment were relatively similar to previous reports of Biswas and Ram et al. as 310 g and 75–300 g, respectively, in different guava cultivars. The recorded fruit weight was lower than those reported by Hoque et al. in Kazi Piara (446.3 g) but higher than values observed by Girwani et al., Aulakh and Gohil et al. as 16–167.50, 49.50–116 and 105–261.7 g, respectively. It has been suggested that growing localities affect fruit weight of a particular cultivar. Similarly, while studying with different guava cultivars under different agro-climatic condition, Jana et al., Patel et al. and Kaur et al. reported fruit weight to vary as a function of cultivars.

Table 1: Physical characteristics of different guava cultivars. Values (mean ± S.D., n = 4) in the same column with different letters are significantly different ($p < 0.05$).

Varieties	Fruit weight (g)	Fruit length (mm)	Fruit diameter (mm)	Specific gravity	Fruit shape index
Allahabad Safeda	118.38 ± 4.84^{d}	45.28 ± 3.96^{c}	61.62 ± 3.18^{b}	1.04 ± 0.03^{b}	0.73 ± 0.06^{b}
Lalit	74.88 ± 9.04^{e}	32.73 ± 0.37^{d}	41.25 ± 1.53^{c}	1.09 ± 0.06^{ab}	0.79 ± 0.04^{b}
Salithong	353.75 ± 7.31^{a}	65.65 ± 3.33^{b}	86.35 ± 3.48^{a}	1.07 ± 0.03^{ab}	0.76 ± 0.07^{b}
Kimchu	307.00 ± 8.96^{b}	64.64 ± 4.68^{b}	80.89 ± 7.54^{a}	1.12 ± 0.13^{ab}	0.80 ± 0.02^{b}
KG guava	226.75 ± 12.28^{c}	73.03 ± 2.96^{a}	67.83 ± 1.69^{b}	1.19 ± 0.05^{a}	1.08 ± 0.08^{a}

Fruit length

A significant difference in fruit length was observed among cultivars (Table 1). Maximum fruit length was recorded in KG Guava (73.04 mm) and Lalit recorded the minimum fruit length (32.73 mm).

The length of fruit in decreasing order was KG Guava > Salithong > Kimchu > Allahabad safeda > Lalit. The variation in fruit length can be attributed to genetic constitution of a cultivar . The observed results are in agreement with previous reports of Pandey et al. and Patel et al., who reported the variation in fruit length ranging between 58.3 to 72.7 mm and 51.6–70.8 mm, respectively, in different guava cultivars. The values recorded in this work were lower than those reported by Mahour et al. Their values ranged between 35.7 to 87.9 mm in Allahabad Safeda and China red. Recently, Methela et al. characterized 12 guava cultivars and reported fruit

length to vary from 44.3 (cv. Sayedi) to 93.8 mm (cv. Chiangmai long). Fruit size is purely a varietal character, which is influenced by environment conditions, growing seasons and locations. Marak and Mukunda, Biradar and Mukunda and Patel et al. also reported the varying range of fruit length in different guava cultivars as 56.5–42.6, 57.1–44.8, and 65.6–50.4 mm, respectively, when grown under different agro-climatic conditions.

Fruit Diameter

It is evident from Table 1 that there were significant variations among cultivars with respect to fruit diameter. The highest fruit diameter was recorded in cultivar Salithong (86.35 mm), whereas the lowest was recorded in Lalit (41.25 mm). The order of the hierarchy was Salithong > Kimchu > KG guava > Allahabad Safeda > Lalit. Recently, Methela et al. morphologically characterized different indigenous and exogenous guava cultivars and reported fruit diameter to vary from 42.7 to 88.0 mm. The values obtained in this experiment are relatively similar as recorded by Mahour et al. While studying with different guava cultivars, they found that average fruit diameter ranges from 84.4 to 35.6 mm. The values recorded in this experiment were higher than those reported by Pandey et al Patel et al. and Babu et al. showing diameter of guava fruits, belonging to different cultivars, ranging between 58.3-72.7, 56.3–69.1 and 55.5–66.3 mm. Varietal variation for physical characters have also been reported by Gohil et al. and Singh et al. This variation in fruit diameter may be attributed to phenotypic and genotypic interactions among the cultivar.

Sugar/Acid Ratio

In fruits, sugars impart the sweetness while sugars and organic acids together influence its flavor. Sugar/Acid ratio among guava cultivars was ranged from 6.78 to 13.31. The highest value was recorded in cultivar Allahabad Safeda, whereas the lowest value was recorded in Salithong. The order of hierarchy was Allahabad Safeda > Lalit > KG guava > Kimchu > Salithong. This variation may be a varietal character that is associated with total sugar content and titratable acidity of fruits as also reported by Agrawal and Negi et al. in different guava cultivars. The variation in sugar/acid ratio might be affected by heavy rainfall, temperature, and humidity at the time of fruit development and growth.

Conclusions

Psidium guajava (guava) is well known tropic tree grown in tropic areas for fruit. Guava is useful in food and many other commercial and industrial applications. Guava fruit is not only a rich source of vitamins and antioxidants but also a good source of minerals. It is found to be effective in diarrhea, dysentery, gastroenteritis, hypertension, diabetes, caries, pain relief, cough, oral ulcers and to improve locomotors coordination and liver damage inflammation. Its skin contains a lot of phytochemicals in intuits fruit which is rich in vitamins (A & C), iron, phosphorus and calcium and minerals. The phenolic compounds in guava help to cure cancerous cells and prevent skin aging before time. The leaves contain many fungistatic and bacteriostatic agents and important oxidants. Its ethyl acetate extract contains quercetin which can stop the germ infection and thymus production. Guava possesses anti-viral, anti-inflammatory, anti-plaque, antinociceptive activity and anti-mutagenic activities. Due to these biological activities, it is can be quite helpful for the preventions and treatments of diseases. Ethanolic extract of guava can increase the sperm quality and quantity and can be used for the treatment of infertile males.

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