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Introduction of Avocado (*Persea americana*) Fruits in Eastern Himalaya of India: A Review

Saidiksha Subba^{1*}, Sarad Gurung², S. K. Mahato², Bandan Thapa² and Binoy Chhetri²¹Dept. of Pomology and Post-Harvest Technology, Uttar Banga Krishi Viswavidyalaya, Pundibari, West Bengal (736 165), India²Regional Research Station, Hill Zone, Kalimpong, West Bengal (734 301), India

Corresponding Author

Saidiksha Subba
e-mail: saidiklim@gmail.com

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Abstract

Avocado (*Persea americana*) or locally called Phamfal is a subtropical, dicotyledonous, evergreen tree belonging to the family Lauraceae. The avocado tree is originated from a broad geographical area stretching from the eastern and central highlands of Mexico through Guatemala to the Pacific coast of Central America. Avocado is a fruit, produced from tropical trees characterized by a pear shape and blackish green in colour with high nutritional value and creamy texture. Avocado crop can be used in several ways i.e for processed products, exportation and oil extraction, pharmaceutical and cosmetic industries as a raw material thereby generating high value added products. High demand for information on avocado indicates that there is considerable interest in this crop in various parts of India as well as Eastern India. Moreover, avocado can be grown in Darjeeling hilly region and adjoining states of India as the soil and climatic condition is favourable for their growth and development. However, in this region avocado cultivation is very negligible in homestead garden, small and marginal orchard due to lack of scientific knowledge of farmers. So that in this context to identify and conservation of wild and farmers cultivated species of avocado is the major concern for all avocado growers and scientist.

Keywords: Avocado, flower, fruits, importance, nutritional value, uses

1. Introduction

Avocado (*Persea americana*) is a subtropical, dicotyledonous, evergreen tree belonging to the family Lauraceae and order Ranales. It was classified as *Persea gratissima* by Gaertner, and *Persea americana* by Miller. Due to geographical isolation *P. americana* developed subspecies that finally originated different botanical types. The avocado tree is originated in Central America and Southern Mexico and it has been determined that the centre of origin of this fruit is the central part of Mexico which is passing through Guatemala to The Central America and was cultivated first in Mexico as early as 500 B.C. (Duester, 2000, Rainey et al., 1994). Generally, avocado is a fruit, produced from tropical trees characterized by a pear shape and blackish green in colour with high nutritional value, creamy texture and unique taste (Birnbauer et al., 2003, Cervantes Paz and Yahia, 2021).

However, avocados can be divided into three horticultural race such as Mexican (subtropical) *P. americana* Mill. var. *drymifolia*, Guatemalan (semitemperal) *P. nubigena* var. *guatemalensis* and West-Indian (tropical) *Persea americana* Mill. var. *Americana* (Rendon Anaya et al., 2019). The Mexican race, which is originated in the mountains of Mexico and Central America, is characterized by small fruit (ranging

from 75 to 300 g) with thin and smooth skin with higher oil content. Guatemalan race are native to the highlands of Central America and are not resistant to low temperatures as those compared to the Mexican race and is characterized relatively by large fruit (ranging 500–600 g) and thick brittle skin with intermediate oil content. The West Indian race is native to the lowlands of Central America and northern South America and is characterized by the intermediate fruit size with smooth, leathery and sometimes glossy skin with lower oil content (Elhadi, 2012). The avocado tree is never dormant, although its activity is reduced during the winter as compared with spring and summer. The fruit, buds and foliage of young trees are harmed when the temperatures is at or somewhat below the freezing point and also cause serious injury to the mature trees when the temperature are below freezing for only a few hours. Among the three horticultural races, the West Indian is most susceptible to low temperatures whereas the Mexican race is the coldest hardy. Avocado trees can be planted on wide range of soils, ranging from light to heavy.

Area and production of avocado about 349 000 ha area are under production of avocado in about 60 countries, producing more than 2.6 million tons annually, with average yield of about 7.40 tons ha⁻¹. Mexico is the leading producer which is accounting for about 36% of the total production, with other



important producing countries including the United States (8%), Colombia (5.5%), Indonesia (5%), Dominican Republic (4.3%), Chile (4.2%), Brazil (3.5%) and Israel (3.3%) (Elhadi, 2012). Globally, Avocado fruits produced about 7.18 million metric tons in 2019 (Anonymous, 2021). However, Dominican Republic, Indonesia, Peru, and Colombia are other significant contributors and collectively accounted about 1.67 MMTs (30% of world production) (Anonymous, 2017).

In India avocados are also grown on the Western Ghats of India mainly in Karnataka, Tamil Nadu, Kerala, and Maharashtra (Ghosh, 2000). Avocados are grown in Sikkim state, Darjeeling and Kalimpong district of West Bengal and in Sikkim Avocado can be grown upto elevation of 5000 ft above mean sea level with an average rainfall of 2000 mm and temperature 12°C–30°C (Tripathi et al., 2014). Considering the pivotal role of avocado fruit species in ecological and nutritional security along with sustainable livelihood development of local communities in Darjeeling, Kalimpong district and adjoining states of Eastern Himalaya there is need to develop better production technologies and varieties for Indian conditions.

2. Avocado Tree

The avocado tree can attain a height up to 20 m, with large spreading and flat topped crown. The avocado tree is classified as an evergreen but some varieties loose their leaves for a short time before flowering. The tree canopy ranges from low, dense, and symmetrical to upright and asymmetrical. Leaves are 7–41 cm in length and could be of several shapes i.e. lanceolate, elliptic, oval, ovate or obovate (Morton, 1987). They are pubescent and reddish when young and they become smooth, leathery and dark green when mature. The avocado being a subtropical evergreen tree, it is never dormant, although its activity is reduced during the winter as compared with spring and summer. Temperatures at or somewhat below freezing point harm the fruit, buds as well as foliage of young trees and temperature below freezing i.e. for only a few hours can cause serious injury to mature trees of the tree horticultural races i.e. the West Indian which is most susceptible to low temperatures, while the Mexican race is the coldest hardy and it is preferable to plant trees in frost-free areas such as on slopes with good air drainage but all avocado trees need to be protected from heavy frosts as well as strong winds.

3. Flowering of Avocado

Avocado tree in general produces more than a million flowers during the flowering period, but most of them fall without producing any fruit. The avocado flowers are bisexual where each flower has both female and male organs. It is characterized by protogynous dichogamy, which means that each bisexual flower opens twice, with an intermediate closing (Stern et al., 2021). While the first time, the flower opens functionally as female where stigmas are receptive, the second time, it closes and reopens the next day functionally

as male. The stigma is white in colour and becomes receptive to pollen before dehiscence of anthers. Less than 1% of the flowers produced at anthesis are able to set fruits. According to their flowering pattern, the avocado cultivars are grouped into two complementary flowering categories such as A type cultivars and B type cultivars. According to Stout (1923) type A cultivars, the flower opens in the morning functionally as female and it closes at midday and reopens in the afternoon of the following day functionally as male. On the other hand, the flowers of type B cultivars open as females during the afternoon, close overnights and reopen the following morning in the male stage. The flowering behaviour of avocado is highly influenced by environmental factors (Subhash et al., 2021). However, reproductive development and biology led to be confusion on pollination, fertilization and fruit set of avocado (Afik et al., 2006) and environmental condition is an essential element for avocado reproduction and pollination (Montserrat, 2013).

4. Fruiting of Avocado

The avocado fruit can be pear shaped, round or oblong and the skin of the fruit may vary in texture as well as in colour. The skin of the avocado is woody, smooth to rough and green-yellow, reddish-purple, purple or black in colour. The flesh of the fruit is greenish yellow to bright yellow when ripe and buttery in consistency, but the inferior varieties may be fibrous (Biale and Young, 1971, Van Den Dool and Wolstenholme, 1983 and Lewis, 1978). The avocado fruit has one large seed which makes up to 10–25% of the fruit weight (Elhadi, 2012). The fruit of different avocado varieties vary in moisture and oil content, from less than 5% to more than 30% oil of fresh avocados.

5. Beneficial Uses of Avocado

Oil extracted from avocados can be used for cooking and preparation of salads, sauces as well as marinades. Avocado oil also can be used for skin care products such as sunscreen lotions, sunscreen lotions, cleansing creams and moisturizers, and can also be used for hair conditioners and makeup bases. Besides its use in the oil, cosmetic, soap, and shampoo industries, avocados are greatly consumed as a fresh fruit all over the world. Unlike many fruits that typically have a sweet or acidic taste; avocados have a smooth and buttery consistency with rich flavour. A popular use of avocado is as a salad fruit, but avocados are also processed into guacamole which can be used in sandwich spreads. Avocado paste can also be used to make ice cream with flavour extracts and skimmed milk. Numerous uses have been added all around the world, for an example, in Mexico and Brazil, it is added to ice creams and sorbets; in Japan it is eaten in sushi rolls; in Cuba the pulp is mixed with capers, green olives, lemon juice and olive oil to make a sauce which is served with steamed fish; and in Nicaragua it is stuffed with cheese, fried and baked. In other countries such as Taiwan, it is eaten with milk and sugar;



in Korea it is mixed with milk and used as a facial cream and body lotion; in Indonesia it is mixed with coffee, rum and milk to make a refreshing beverage; in the Caribbean it is mixed with salt, garlic, and coconut and served as an entree; in the Philippines the avocado puree is mixed with sugar and milk to make a beverage which is served as dessert (Yahia, 2003).

6. Avocado Oil and Uses

'Margarida' an avocado oil variety contains a greater diversity of sterols, and β -sitosterol which represents 71.8% of the total sterols, besides lower cholesterol levels i.e (0.3%), which can achieve up to (2.3%) in other varieties (Salgado et al., 2008b). According to Santos et al. (2014b) the oil from Fortuna avocado which was extracted with petroleum ether and subjected to drying under forced air i.e (40°C) discovered 87.6% β -sitosterol, 12.41% campesterol, and 0.04% stigmasterol of the total phytosterols. Avocado has a carotenoid named lutein which helps in protecting against prostate cancer and eye diseases like cataracts and macular degeneration (Johnson, 2005). The avocado pulp has high lipid content, which makes the pulp the portion of greater interest. Lipids vary from (5–35%) which is being formed mostly by the unsaturated fatty acids (60–84%) (Borges and Melo, 2011). The avocado varieties having lower core and shell percentage such as variety quintal are most preferred for oil extraction due to higher pulp yield (Tango et al., 2004). The high moisture content in fresh pulp is the main hindrance for obtaining avocado oil as it greatly affects the extraction yield and also the production costs. Thus, the varieties which are most suitable for the oil extraction (considering 18% lipids and low moisture levels in the pulp are Hass, Gloria and Fuerte, followed by the varieties such as Itzamna, Wagner, Anaheim, Ouro Verde, Collinson, Carlsbad and Mayapan (Tango et al., 2004). The traditional cold pressing method for vegetable oils was replaced by the solvent extraction as some authors have reported that a yield of 59% in oil extraction was obtained from fleshy pulp when using hexane, but when acetone was used as solvent this value decreased to about 12% (Abreu et al., 2009). However, the hexane residue in the extracted oil as well as cake may pose some risks. The extraction of yield from Fortuna avocados oil as a function of the drying process i.e freeze-drying or air flow at (40–70°C) and extraction method i.e pressing and solvent of a pulp containing about (5–6.5%) moisture and reported that oil contents between 25 and 33% by cold pressing and between 45 and 57% by solvent extraction, while the freeze-drying method showed higher oil yield as compared to the oven drying under forced air (Santos, 2013). The enzyme-assisted aqueous extraction has emerged as an excellent alternative as well as environmentally friendly extraction process (Abreu et al., 2009).

The small avocado oil volume which is currently being produced by some of the countries is used in its raw form by the cosmetics and pharmaceutical industries, once its unsaponifiable fraction is responsible for regenerative

properties of the epidermis. Avocado oil can be easily absorbed by the skin, with the high absorption power of perfumes and it can be of great value to the cosmetics industry. Moreover, it forms an emulsion very easily which is ideal for the manufacture of fine soaps (Tango et al., 2004). In comparison to other vegetable oils, avocado oil is characterized by having high levels of monounsaturated fatty acids i.e oleic and palmitoleic acids, low polyunsaturated fatty acids i.e linoleic acid, and high levels of saturated fatty acid i.e palmitic and stearic acids. This fatty acid composition is greatly influenced by the cultivars, anatomical region of the fruit, maturity stage and geographic location for the plant growth (Tango et al., 2004). Rocha (2008) reported that avocado oil from the varieties such as Hass, Fuerte, Wagner and Fortuna had high levels of monounsaturated fatty acid (MFA) ranging from (59–72%) of total fatty acids which is followed by saturated fatty acids (SFA), ranging from (17–23%), and polyunsaturated fatty acids (PUFA) to a lesser extent with levels ranging between (10 and 14%). The fatty acids profile of avocado cultivar Fortuna by evaluating the effect of the pulp drying process i.e freeze-drying or air circulation at 40 and 70°C and oil extraction method i.e solvent or pressing as reported by Santos et al. (2014a). The authors reported that oleic fatty acid represented more than half of the total fatty acids of this raw material, together with substantial amounts of unsaturated linoleic and palmitoleic acids. They also verified that the dehydration of the pulp can affect the fatty acid profile since the oil extracted from the lyophilized pulp contained higher levels of unsaturated fatty acids. With respect to the extraction method, no significant effects were observed. Avocado oils from the varieties Quintal, Northrop, Duke, Fuerte and Wagner are characterized by having more than 63% oleic acid, while the oils from other varieties such as Waldin, Prince Rincon, Barker and Panchoy showed less than 50% of this fatty acid. Palmitic acid content from different varieties ranged between 15.38 and 32.37% in oils. Hence, the avocado variety greatly affects the levels of palmitic acid as well as oleic acid and the varieties with high oleic acid levels had low palmitic acid levels and vice versa (Bleinroth and Castro, 1992). In addition to its fatty acid composition, these oils contain other bioactive minor components such as squalene, β -sitosterol, tocopherols, campesterol, and cycloartenol acetate having positive effects on health (Dembitsky et al., 2011) and (Santos et al., 2014b). Moreover the possibility of using pure avocado oil as a substitute for the olive oil, the combination of olive oil and avocado oil in order to replace olive oil mixtures i.e. using soybean oil which is usually offered by the internal market has proved to be a promising alternative in order to reduce the costs of Brazilian olive oil imports (Salgado et al., 2008b). Avocado oil which is used for salad dressings should be subjected to winterization in order to eliminate the saturated triglycerides, which can mask the oil stored at low temperatures (Salgado et al., 2008b). However, the lipid extraction process produce large pulp residues in the processing industries, therefore



the high fiber content of this by-product allows its use for the preparation of flour which are used in bakery products like breads, cookies, and pasta by increasing the supply of fiber-rich products (Chaves, 2013).

7. Nutritional Value of Avocado

Avocado fruits are with a tough outer layer, a fleshy centre, and a shell around a seed. Fruits can be with pale yellow green flesh, which is smooth and buttery, with a faintly nutty flavour and texture like a firm, mature banana. It is full of healthy fats, than others fruits crop. However, avocado fruits contain several types of vitamins such as Vitamin K [26% of the daily value (DV)], Folate (20% of the DV), Vitamin C (17% of the DV), Potassium (14% of the DV), Vitamin B5 (14% of the DV), Vitamin B6 (13% of the DV) and Vitamin E (10% of the DV) in a single 3.5 ounce (100 g) serving. It also contains small amounts of magnesium (Mg), manganese (Mn), copper (Cu), iron (Fe), Zinc (Zn), phosphorus (P), and niacin (vitamin B3) (Dreher and Devenport, 2013), (Fulgoni et al., 2013) and (Gunnars, 2021). Fruits of avocado content higher potassium than bananas and have lot of potassium which are a typically high potassium food, a 3.5 ounce (100 g) portion contains 14% of the recommended daily intake (Gunnars, 2021). Avocado fruits are heavy in fat, which content of higher monounsaturated fatty acids are proven to good for heart health. It contain 77% fat calories and high in oleic acid, monounsaturated fatty acid which good for health (Gunnars, 2021) and (Mendez Zuniga et al., 2019).

8. Conclusion

Avocado can play an outstanding role in alternation of industry as it can be used in several ways i.e for processed products, exportation and oil extraction, and in the pharmaceutical and cosmetic industries as a raw material thereby generating high value added products. So, therefore there should be an increase in production and exploitation of the raw material of avocado in order to get its benefits as well as to improve the livelihood security of rural people and farmers.

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