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Review on Distribution, Nutritional and Medicinal Values of *Casimiroa edulus* Llave- An Underutilized Fruit in Ethiopia

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Abstract: Wild edible plants are crucial resources with multipurpose uses and indigenous people have ethno-botanical knowledge of their use and management. Many wild plants have economic, medicinal and forage values in addition to preserving cultural heritages and maintaining ecological balance by providing various ecosystem services. From the past, edible wild fruits have played a very crucial role in supplementing the diet to the people. The dependence on these fruits has gradually decline as more exotic fruits have been introduced. But many people in tribal areas still use them as a supplement of their basic need of food. One of such plants in Ethiopia is *Casimiroa edulus* (L), belongs to the Rutaceae family. The habitation of this plant was reported in different regions of the country as the wild indigenous plant. Similarly, *Casimiroa edulus* (L) were found in some gardens of ethiopia. This plant is used as the shade plant, wood purpose, but fruits are not well utilized as the foods, people awareness also very little regards harvesting, handling, nutritional composition and value addition of fruits. The present review is organized to present the distribution of *Casimiroa edulus* (L) in Ethiopia, basic botanical description of the plant, Nutritional composition and comparison with commonly used fruits and Medicinal importance of the fruits.

Key words: Wild crop · Underutilized crop · *Kasmiriya* · Medicinal plant

INTRODUCTION

Millions of people in many developing countries have shortages of food to meet their daily requirements and a further more people are undersupplied by different micronutrients [1]. Most rural communities depend on wild resources including wild edible plants to meet their food needs in different food crisis. Due to the diversity in wild species they have their own role in contribution to food source and household food security [2, 3]. Some of the researchers reported the knowledge of edible wild plants in different regions of Africa [4, 5, 6].

Food and nutritional securities are the major issues for human wellbeing. Different Researchers, worldwide governments and different organizations working with food and nutrition issues concerned with the nutritional status of the general population and special groups like infants, children, pregnant women and lactating mothers in the developing and under developed countries [7-9]. In under developed countries and developing countries, natural disasters, National economies problems, instability of political issues, more population, improper handling of food commodities, Lack of proper agricultural policies, inadequate availability of food and intake among people are common [9]. To handle the situation, efforts should be focused on scientifically effective use of underutilized wild plants as source of nutrient supplements in improving food and nutritional security.

Utilization of the wild plant sources for food in the different parts of the African continent is most common practice, A study was reported from Zimbabwe mentioned that some poor households rely on wild fruits as an alternative to cultivated food for a 25% of all dry season's meals [10, 11]. Similarly, leafy vegetables and other bush foods are collected as daily supplements to relishes and soups in Northern Nigeria [12]. Indigenous fruit trees which are undomesticated play many important roles in people diet in rural areas of Botswana. Indigenous fruit trees are important traditional sources of nuts, fruits, spices, leafy vegetables, edible oil and beverages [13]. In Botswana indigenous fruit trees yields a good crop in poor rainfall years when agriculture fails due to the low

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rain fall or other natural problems, thereby improving the high food security for rural households. In Swaziland, wild plants is still of great importance and contribute a greater share to the annual diet than domesticated crops [14]. Various reports also noted that many wild edibles are nutritionally rich and can supplement nutritional requirements, especially vitamins and micronutrients [15-17]. Nutritional analysis of some wild food plants demonstrates that in many cases the nutritional quality of wild plants is comparable and in some cases even superior to domesticated varieties [18- 21].

370 indigenous food plants of 70 families reported that in Ethiopia out of that 182 species (40 families) are trees/shrubs with edible fruits/seeds were observed. Out of those 25 marketable fruits/seeds, 21 are marketable in local markets, 2 are reported national (*Mimusops kummel, Ziziphus spina-christi)* 2 species are the international marketable (*T. indica, B. aegyptiaca)*. These reported wild plants were with food/nutritional value, socioeconomic importance, availability, marketability, potential for development through value addition and potential for other uses [22]. The value of wild edible plants to sustained people in a variety of parts of the world has been well documented [23, 24]. In Ethiopia Amhara region, it is estimated that 200 species of wild/semi-wild species are widely used for food purpose [25, 26]. Edible fruit bearing species form one of the most important local survival strategies. This is particularly important because their consumption has been reported to be more common and widespread in food insecure areas [27, 28]. In spite of their importance, wild edible plants, especially fruit bearing species, suffer notable disregard from research and development plans in Ethiopia.

Zemede and Mesfin [29] reported that about 8% of the nearly 7000 higher plants in Ethiopia are edible. Of these, 203 wild and semi-wild plant species are documented. Still many more wild species are believed to be edible and undocumented yet. More recently, some ethnobotanical studies have undertaken in some parts of the country. However, the majority of these studies have dealt with medicinal species and little emphasis has been paid to wild edible plants. Like vegetables, indigenous fruit trees provide vitamins and minerals essential for the proper maintenance of human health [30]. According to FAO [31] and Maghembe *et al*. [32] the nutritional value of indigenous fruit bearing tree species indicate that many are rich in energy sources (sugars), essential vitamins and minerals while others are high in vegetable oil and proteins. Indigenous fruit trees are particularly used during the seasonal food shortages and are often the only available fruit source of high nutrients. Indigenous people living in particular areas depend on the use of wild plants or plant parts to fulfill their needs and often have considerable knowledge on their uses. The people generally depend on nearby forest areas to supply their needs. The biological resources are used in many ways: such as timber, fuel wood, food, wild vegetables, spices, wild fruits and often important medicines [32].

Wild plants, aside from being used by people live under developed countries, also mostly used today as a supplement for healthy diets in even the most developed regions of the world [25]. Approximately 75, 000 species of plants world-wide are believed to be edible [33]. Over the centuries, people have been dependent on this resource for their subsistence as they are efficient and cheap sources of several important micronutrients [34]. Burlingame noticed that some wild food plants are nutritionally grater to some of the domesticated plants [35]. However, these plant resources and their indigenous use are in danger of being lost in areas where environmental and cultural transformations have led to changes in feeding practices. Many indigenous communities abandon or change their traditional customs and thereby lose their plant knowledge over time [36 - 38]. Basic information pertaining to wild fruit species is available from the local people who are the custodians of these resources and knowledge about them [39]. At present, due to the catastrophic destruction of their natural habitats, wild edible plant resources are degrading fast along with the associated indigenous knowledge. Yet, documentation and preservation of this knowledge in the country remains scanty [26, 39]. As such, assessment and better understanding of the wild fruit resources and associated knowledge is crucial.

The major objective of this paper is to illustrate the distribution in Ethiopia and nutritional composition and comparison of *Casimiroa edulis* (L) with other commonly used fruits in Ethiopia.

***Casimiroa edulis* (L) Distribution in Ethiopia:** Different researches were reported the presence of *Casimiroa edulis* (L) in the different parts of the Ethiopia. Mathewos Agizea et al., reported the habitation of *Casimiroa edulis* in Loma and Gena bosa districts of southern Ethiopia in their study on the indigenous knowledge on management of home gardens [40]. The major utilization of this crop in southern Ethiopia as food consumption, people considered as that the consumption of the fruits of this plant as the stimulant. Reta Regassa reported the

presence of the *Casimiroa edulis,* in Hawassa, southern part of Ethiopia*,* local name of the plant reported as the *Kasmire* and it is determined as the indigenous to the reported place [41]. Tigist Wondimu *et al*., reported the presence of the *Casimiroa edulis,* as a cultivated food plant in the home gardens of the Dheeraa town Aarsi, Central Ethiopia, Oromia National Regional state [42]. They are also stated that this plant is growing as a big tree and fruit are using as the edible part. Mesele Negash *et al*., identified the presence of *Casimiroa edulis* in the forest area of south-eastern rift vally, Ethiopia [43]. They are considered that this plant placed under the fruit-coffee agro-forest category. These plants are acting as the trees which provide shade for coffee plants in cultivation; they are providing the fruits as the food source. A study of diversity and regeneration status of woody species in Tara gedam, Abebaye forest reported by Haileab Zegeye et al., reported that *Casimiroa edulis* is a tree, which predominantly present in Abebaye forse as the tree [44]. Lalisa *et al*. [45]reported the study on the woody plants diversity and possession and their future prospects, in their study they reported the relative density relative frequency of 0.16 % and 2.15% respectively for *Casimiroa edulis,* they reported that the plant is useful in the food crop (fruit), The wood of the plant is used for Fuel (fire wood) also, this species improves the Soil Fertility, not showing any nitrogen fixation.

Casimiroa edulis is locally called as *Ambuka* it is a cultivated plant and the Leaves and fruits are used in the Babile elephant sanctuary, Ethiopia, Which is located in the eastern part of the Ethiopia [46]. Assefa F. *et al*. [47] reported a detailed study on the distribution, feeding potential, of *Casimiroa edulis* and they reported that this plant is one of the dominant food trees in this region, 85% of these plants are owned by the farmers and available in their house back yard, remaining 15% is growing in the Agro-forest system. And these authors reported that C*asimiroa edulis* is a seed propagate and easily establish, adoptable, demands less agricultural practice, drought tolerance plant. These plants are currently utilized as source of feed, fuel, shade for livestock and coffee, fence and fruit. *Casimiroa edulis* is an ever green plant but not intensively utilized as feed source due to lack of awareness among the respondents. Ghislaine Bongaers, reported that Casimiroa edulis is present in the Meskan district, Ethiopia, as the fruit tree, this tree is predominately growing in home gardens no need of any type of protection at all, it is also reported that, this called as the Mexican apple and consumed as the fruit [48]. Other name of this fruit is white sapote. *Casimiroa edulis* is reported in Walmara District, Central Ethiopia the local name is *Abokar*, it is a tree present home garden and acting as the source of Bee forage, Fuel wood, Fruit source [49].

Emelda Miyanda Hachoofwe reported the presence of *Casimiroa edulis* in the Tigray region and acting as the food source they present around the house [50], Melaku Girma reported that *Casimiroa edulis* is a plant provide the flowing all round the year with vernacular and common name as *Kazamier, Kasmer* respectively and they are acting as the bee forage plants[51]. Talemos seta et al., reported the *Casimiroa edulis*, is a tree, available in the home gardens of the wolayta southern Ethiopia, acting as the source of edible fruits [52].

Botanical Description of *Casimiroa edulis* (L): English common name of *Casimiroa edulis* is white zapote, white sapote, mexican sapote, Mexican apple, casimiroa; in Spanish zapote blanco, matasano, chapote, sapote blanche (French). Originated from Mexico, Central America, it is normally distributed in cool tropic areas and subtropics of the world but not common outside tropical America. The cultural requirements are Subtropical or tropical highland climate with medium rainfall. Tolerant of variety of soil conditions, seasonal dry period, frost [53].

Plant Description: *Casimiroa edulis* is an evergreen tree to normally 18 m tall, with spreading, often drooping branches and a broad leafy crown. Bark light-grey, thick and warty. Leaves palmately compound, alternate, digitate; stipules absent; petiole 5-9.5 Cm, finely pubescent; leaflets sessile or subsessile, 3-7, elliptic, ovate or broadly ovate, 4.5-12 Cm long, 1-5 Cm wide, apex acuminate or occasionally rounded, base cuneate, margins subserrate, bright green, glabrous or with scattered pubescence on the veins, vennation pinnate, anastomising at the margins. Inflorescence paniculate; flowers are odour less, small, regular, unisexual, 5- merous, hermaphrodite or occasionally unisexual because of aborted stigmas. Sepals lacinate, hirsute; petals greenish-yellow, 3-7 mm long; stamens 5, filaments subulate, thickening at the base; ovary superior, 5- celled, stigma sessile, lobate [54].

A number of varieties are described some of these may actually be chance hybrids. Some have been named and propagated: 'Blumenthal', 'Chapman', 'Coleman', 'Dade', 'Flournoy', 'Galloway', 'Gillespie', 'Golden' or 'Max Golden', 'Johnston's Golden', 'Harvey', 'Lenz', 'Lomita', 'Maechtlen', 'Maltby' or 'Nancy Maltby', 'Nies', 'Page', 'Parroquia', 'Pike', 'Sarah Jones', 'Suebelle', or 'Hubbell', 'Walton', 'Whatley', 'Wilson', 'Wood', 'Yellow'.

Occurrence and Distribution: The common white sapote occurs both wild and cultivated in central Mexico. It is planted frequently in Guatemala, El Salvador and Costa Rica and is occasionally grown in northern South America, the Bahamas, West Indies, along the Riviera and other parts of the Mediterranean region, India and the East Indies. It is grown commercially in New Zealand and to some extent in South Africa. Horticulturists in Israel took serious interest in white sapotes around 1935 and planted a number of varieties [55].

In Mexico, flowering occurs in January and February and the fruits mature from June to October. In Florida there is usually just a spring-summer crop. In California, 'Pike' and 'Yellow' varieties bloom in the spring and again in late summer and fall, the fruits from late blooms maturing gradually over the winter. 'Suebelle' blooms for 6 to 8 weeks in spring and again in midsummer and fruits ripen in September and October. *C. edulis* is hermaphroditic, occasionally unisexual due to aborted stigmas. The white sapote, *Casimiroa edulis* (family Rutaceae), surely ranks among the really good but neglected fruits of the world. A native of the highlands of Central America and Mexico, the white sapote appears to be well adapted and can be found from the warm Temperate Zone to the hot lowland Tropics. Although the literature often reports that it is of limited value in the Tropics below 900 meters of elevation, we have seen the tree grown successfully at low elevations in Florida, Hawaii and Puerto Rico [56].

Fruit Characteristics: There is a great variation in the amount of pollen produced by seedlings and grafted cultivars. Some flowers bear no pollen grains; others have abundance. Sterile pollen or lacks of cross pollination are suggested causes of aborted seeds and heavy shedding of immature fruits. The fruit is green at first but ripens to a pale yellow. The epidermis is thin and easily damaged. The pulp of the fruit is white, cream, or yellowish and very soft, without fiber. It is sweet but has a characteristic bitter taste that some people do not like. They are edible and having nutritional food value, which provides the minerals like sodium, potassium, magnesium, iron, calcium, phosphorus etc. They are immune to many diseases and often used in different formulation of Folk- medicine. They provide fibers which prevent constipation. It is consider that special attention should be paid in order to maintain and improve this important source of food supply. In order to remedy, a wider and sustained acceptance of wild fruits as important dietary components must be stimulated [57].

Nutritional Composition and Comparison with Other Commonly Utilized Fruits with *Casimiroa edulus*: *Casimiroa edulus* is a fruit with the good sources of the different nutrients as showed in Table 1, in Ethiopia, Apple, Avocado, Banana, Mango, Guva are the five major fruits which commonly consumed all the areas of country. The *Casimiroa edulus* has greater water content than Avocado while mango, Guava, Apple and Banana are reported with higher amount of the moisture than *Casimiroa edulus* (Table 1).

Casimiroa edulus is containing less amount of the protein when compared to other five fruits. Fat content also is much less than the all other discussed fruits. High amount of the carbohydrate is reported in *Casimiroa edulus* then all the fruits, it is a good indication that these are good source of ready energy.

Casimiroa edulus reported the energy higher than apple, Banana, Mango, Guava. But Avocado has reported the highest amount of the energy then the all it is due to the high amount of the fat content.

Casimiroa edulus fruits reported the high amount of ash then the apple, but less than the Avacado, Mango, Guava and Banana. The high ash content of the fruit indicates the good mineral source which is very important for the metabolism. The fiber content of the *Casimiroa edulus* fruit is less than other fruits. Calcium content of 9.9 mg/100 g of *Casimiroa edulus* was reported which is higher than banana and apple and equals to mango. The phosphorus content of 20.4 mg/100gm was reported in *Casimiroa edulus* which is higher than apple, mango and almost all equals to banana less than Guava and Avocado. Iron content (0.33 mg/100g) was reported grater in *Casimiroa edulus* than the apple, Mango, Banana and Guava.

In vitamins, Thiamine content is greater in the *Casimiroa edulus* than Apple, Banana and Mango. The avocado and Guava reported the higher amount of the thiamine then the *Casimiroa edulus*. Riboflavin content of 0.043 mg/100g *Casimiroa edulu* was reported. It is higher than the riboflavin content then apple, Mango and Guava fruits. Niacin content is higher than the apple but lower than the Avocado, Mango, Guava and banana.

Table 1: Nutritional composition of *Casimiroa edulus* and Apple, Avocado, Banana, Mango and Guava (values per 100 g)

Component	Unit	*Casimiroa edulus* [55]	Apple[a]	Avocado[a]	Banana[a]	Mango[a]	Guava[a]
Moisture	g	78.3 g	85.56	73.23	74.91	83.46	80.80
Protein	g	0.143 g	0.26	2.00	1.09	0.82	2.55
Fat	g	0.03 g	0.17	14.66	0.33	0.38	0.95
Carbohydrate	g	23.25*	13.81	8.53	22.84	14.98	14.32
Energy	Cal	93.84*	52	160	89	60	68
Fiber	g	0.9	2.4	6.7	2.6	1.6	5.4
Ash	g	0.48	0.26[59]	1.52[60]	0.9[61]	1.2[62]	0.66[63]
Calcium	mg	9.9	6	12	5	11	18
Phosphorus	mg	20.4	11	52	22	14	40
Iron	mg	0.33	0.12	0.55	0.26	0.16	0.26
Thiamine	mg	0.042	0.017	0.067	0.031	0.028	0.067
Riboflavin	mg	0.043	0.026	0.130	0.073	0.038	0.040
Niacin	mg	0.472	0.091	1.738	0.065	0.669	1.084
Ascorbic Acid	mg	30.3	4.6	10.0	8.7	36.4	228.3

[a] USDA Food nutritional Data Base [58]

* Calculated from available data (The total carbohydrate content was calculated based upon difference method. Gross energy (in Kcal) was calculated according to the method indicated in Osborne and Voogt (1978) [64];

Table 2: Some of the Recipes reported in different web sites with *Casimiroa edulus* (white sapote)

S.No	Name of the Recipe	Other Components/ Ingredients	Reference
1	White Sapote Sorbet	Peeled, seeded ripe sapote chunks, sugar, water, lemon juice	http://www.fruitsinfo.com/White-sapote-Exotic-fruits.php
2	White Sapote Smoothie	peeled, seeded sapote, plain yogurt, orange juice, cracked ice, ground ginger	http://www.fruitsinfo.com/White-sapote-Exotic-fruits.php
3	Jellies, sherbets, ice creams, pies, or drying,	NA	http://www.cooksinfo.com/white-sapote
4	The Dreamer's Dream	Brandy, orange-brandy liqueur (Gran Gala, Grand Marnier), lemon juice, white sapote, egg white, Nutmeg	http://theliquidcultureproject.com/2012/10/01/white-sapote-fruit-and-the-dreamers-dream-cocktail/
5	White Sapote Oat Porridge	Small White Sapote Fruits, Instant Oats, Plain Yogurt, Apple Juice, Shredded Coconut, Vanilla Extract, Salt Squeeze of Lemon	http://chowwithxhico.blogspot.com/2014/01/recipe-white-sapote-oat-porridge.html
6	White sapote Ice cream	Sapote pulp, heavy cream, milk, coconut milk, brown sugar, lemon juice, Vanila, Table salt, Agave nector	http://tinkeringwithdinner.blogspot.com/2009/06/white-sapote-ice-cream.html
7	White sapote Clafouti	White sapotes, pink guava, flour, eggs, nutmug, lime, suger, milk, butter	http://www.a1cookbook.com/white-sapote-clafouti/
8	Yellow sapote shortbread	Sugar, butter, eggs, Sapote pulp, Castor sugar, Coconut	http://www.capetrib.com.au/recipeyellowsapoteshortbread.htm
9	Smoothie sweet sapote	Ripe sapote, fat free milk, sliced strawberries, honey, Crushed ice	http://www.foodreference.com/html/sweet-sapote.html
10	Mixed juices	Mixed with desired fruits	http://juicing.about.com/od/Juice-Away-Diseases/r/Delicious-Sapote-Juice-amp-Smoothie-Recipe.htm

Vitamin C content in Casimiroa *edulus* reported higher then apple, Avocado and banana but lower then Mango and Guava. The Nutritional compositions of all the fruits (*Casimiroa edulus,* Apple, Avocado, Banana, Mango and Guava) are presented in Table 1.

Some Recipes of *Casimiroa edulus*: There were no much data not reported on the processing, preservation and value addition of the *Casimiroa edulus* fruits. So it is a good area to do scientifical research. Some of the recipes are available in the Internet. By this recipes came to understand that people are using the *Casimiroa edulus* (white sapote) for the different types of the food preparation, like Juices, Smoothies, Jellies, Pies, Dried fruits, Ice creams, Porridge, Phort breads, mixed juices are preparing. Some of the recipes and their ingredients are presented in Table 2.

Some Medicinal Applications of *Casimiroa edulus* Plant Parts: Navarro Ruíz *et al*. [65] reported the Anticonvulsant activity of *Casimiroa edulis* in comparison to phenytoin and Phenobarbital. An aqueous extract of Casimiroa edulis leaves was tested in adult male Wistar rats for anticonvulsant activity utilizing two models of experimental epilepsy. Single dose of 100 mg/kg C. edulis vacuum dried aqueous extracts (VDA) orally administered to experimental animals. Two firmly established antiepileptic drugs in human therapy, phenytoin (PHT) and phenobarbital (PB) used as the control. In the final conclusions they are confirmed that the seizure abolition observed in C. edulis VDA treated rats was comparable with the anticonvulsive pattern exhibited by PHT and PB. From the experimental results suggest that potentially antiepileptic compounds are present in C. edulis extracts that deserve the study of their identity and mechanism of action.

Aiko Ito *et al*., [66] reported an Antimutagenic Constituents of *Casimiroa edulis* with Potential Cancer Chemopreventive Activity of an ethyl acetate extracted derivatives from seeds. The extract successfully inhibited the mutagncity in *Salmonella typhimurim* model which is induced by 7, 12- Dimethylbenz[á] anthracene (DMBA). On the mice studies in-vitro studies showed the inhibition of the lesions in the mammary glands. Bio assay-guided photochemical investigation of the extract showed the furocoumarins and phellopterins. Finally they are concluded that these are the responsible for the anti-mutagenic effects.

Effects produced by the hydroalcoholic extract of leaves from Casimiroa edulis on the central nervous system, different behavioral tests and animal models of depression and anxiety were reported by Mora S *et al*. [67], The extract was administered orally and intraperitoneally in male and female rats and tested the different behavioral tests like spontaneous motor activity, locomotor activity, exploration of an elevated plus-maze (EPM) and in the forced swimming test (FST). Finally from the research they are determined that the hydroalcoholic extract of Casimiroa edulis may contain sedative principles with potential anxiolytic and antidepressant properties and recommended the need of further investigation.

Anxiolytic-like actions of an aqueous extract of the leaves of Casimiroa edulis were studied in male Wistar rats in the elevated plus-maze test by Molina-Hernandez *et al.* [68] Finally concluded the leaves of Casimiroa edulis produced anxiolytic-like actions in male Wistar rats, with several side actions, namely, reduced locomotion and neutralization of the antidepressant-like actions of desipramine. The effect of an alcoholic extract of seeds of *Casimiroa edulis* on blood pressure and heart rate was determined [69]. The extract induced hypotension, accompanied at high doses by tachycardia. Zapotin is a component which is present in *Casimiroa edulis* fruits. Zapotin was found to be inducing both cell differentiation and apoptosis with cultured human promyelocytic leukemia cells. Finally, suggested the need of more research for the further investigation of the Zapotin for the potential cancer chemopreventive agent [70].

Amani S. Awaad *et al*., reported antihypertensive activity of the extract of Casimiroa edulis was investigated. They have identified the ethanol and total alkaloids (in chloroform) extracts were found to have antihypertensive properties at doses of 500 and 200 mg/kg, respectively. Four quinolinone alkaloids were isolated and identified. Finally concluded from the study the four isolated alkaloids showed antihypertensive activity at doses of 50, 100, 200 and 300 mg/kg, respectively [71].

CONCLUSIONS

Wild plants are the very important for different purposes; they are playing a major role in the food, agriculture and as the source of wood. One of the underutilized wild plants is *Casimiroa edulis,* which is the native to Central America but present in different countries like Ethiopia. It is widely distributed in the Agro forestry and home gardens of the all most all the parts of the Ethiopia, but the density of the plant is less. It is a plant which is using as the tree for shade, for fuel wood. The fruits of the *Casimiroa edulis* is using as the food sources in some places, but there is no clear evidences of the fruits post harvest handling and value addition. Even some researchers are proposed that different extracts of the fruit, seed and leaves are having anti-cancer and anti-mutagenic activities. Further recommending the more research has to take on the nutritional and health benefits of the *Casimiroa edulis* fruits and their post harvest handling, preservation, processing and value addition. By that the underutilized fruit crop may be became a beneficial food source for humankind.

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