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A Review on Avocado Seed: Functionality, Composition, Antioxidant and Antimicrobial Properties

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Authors' contributions

This work was carried out in collaboration among all authors. Author TBB designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Author ZHT managed the analyses and edited sessions of the study. All authors read and approved the final manuscript.

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ABSTRACT

The seed of avocado is considered as one of the non-edible part of the fruit, which are usually discarded as residues and can cause ecological problems. Exploring the possible dietary and therapeutic potentials of especially such underutilized wastes will in addition reduce the possible environmental waste burden. The objectives of this review article is to alert the functionality, chemical composition, antioxidant and antimicrobial properties of avocado seed for its use as food and justification for its medicinal use. The composition like proximate (protein, fat, ash, moisture, fiber and carbohydreate), minerals (Ca, Zn, K, Na, P, Fe, Cu, Pb and Co), phytochemicals (Flavinoid, Tanine, Saponine, Total phenolics, Antioxidnt capacity, Oxalates, Phytates, Alkaloids) and Vitamins (A, B1, B2, B3, C and E) were reported to be present in the avocado seed in different proportions. Some poisonous phytochemicals are present in fresh seeds of avocado and not in the dry seeds, hence recommended to dry the seeds before processing for consumption. Its biological

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activities such as antioxidant, antihypertensive, fungicidal, larvicidal, hypolipidemic, amoebicidal and giardicidal activities had reported. Therefore, it can be concluded that, the avocado seed is nutritionally valuable as the other parts of the plant based on the phytochemical and nutrients it constitutes. The consumption of avocado seed is recommendable since it has high nutritional contents that make it enough for possible dietary and ethno-medicinal use.

Keywords: Percea Americana; Composition; antioxidant; antimicrobial; Disease.

1. INTRODUCTION

The avocado (*Percea americana*) belongs to the *Lauraceae* family of tropical and mediterrenian trees and shrubs. It is originated from Mexico and Central and South America; for thousands of years and until today. It has been a popular food, for treating skin eruptions and medicinal purposes due to its high nutrition content as well as for its therapeutic properties [1]. It is a source of carbohydrate, protein, fiber, essential micronutrients for human consumption such as, polyphenols, fats, oils, vitamins (vit. C, E, K, B1, B2, B6, B9) and minerals (P, Na, Mg, K, Fe and Zn [2,3,4,5,6]. Its low sugar content makes avocado very recommendable source of high-energy food for those who are diabetic. It is highly consumed in the world due to the presence of unsaturated lipids and its relevance in improving and maintaining healthy heart and circulatory system [4].

There is a global tendency towards industrial fruit processing and, following such processes byproducts are normally discarded. However, these byproducts can cause ecological problems such as increased numbers of insects and rodents. Thus, studies to investigate the benefits of these byproducts as sources of food supplements or medicinal products are needed [7]. Different parts of avocado pear were used in traditional medications for various purposes including as an antimicrobia. Exploring the possible dietary and therapeutic potentials of especially underutilized agro-food wastes will in addition reduce the possible environmental waste burden [8].

The seed of avocado is one of the under-utilized non-edible parts of the fruit, which are usually discarded as residues. Conducting a research on non-edible parts of fruits is an emerging trend, which may prove to be very profitable in the near future. Mostly, because it involves an important reduction in the production of wastes and the fact that the non-edible parts of many fruits like avocado have high levels of valuable bioactive compounds, particularly natural antioxidants [9,10]. The seed of avocado is redundant during the processing of the pulp. The seed waste may represent a severe ecological problem. However, at the same time, it may be of interest to industry as a source of bioactive compounds. Its chemical composition is comprised of phytosterols, fatty acids, triterpenes, and two new glucosides of abscisic acid. Biological activities of the avocado seed such as antioxidant, antihypertensive, fungicidal, larvicidal, hypolipidemic, and recently amoebicidal and giardicidal activities have been reported [11].

According to several studies, the hypolipidemic effects of the avocado seed focused on methanolic extracts [12] and aqueous extracts [3]. The result shows that, hypolipidemic effects provides an interesting alternative since the seed represents 13-18% [13] of the avocado fruit and is discarded during avocado pulp processing. Adeyemi *et al* states that, uses of avocado pear seed include use in the management of hypertension, diabetes, cancer and inflammation [14,15,16]. Several beneficial medicinal properties of compounds present in the avocado seed have been reported, which are related to the elevated levels of phenolic compounds (64% in seed, 23% in peel, and 13% in pulp). In addition, the seeds and peels of avocado also contribute 57% and 38% of the antioxidant capacities of the entire fruit, respectively [17]. Thus, this review article was aimed at reviewing the proximate, functional, anti-nutrients and antimicrobial properties of avocado seed to aware basis for its possible dietary use and justification for its ethno-medicinal use.

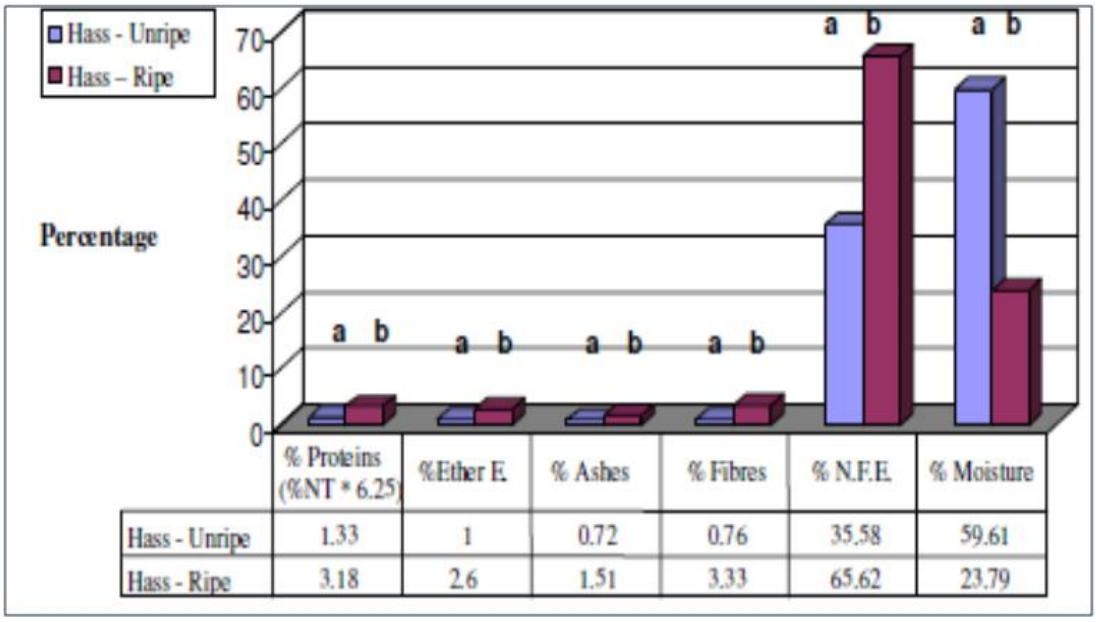
2. FUNCTIONALITY AND COMPOSITION

As discussed in (Table 1), different researchers investigates the nutritional composition: proximate, minerals and phytochemical of avocado seed in different countries. Most of them concluded that, avocado seed possesses nutritional qualities that may be further investigated for application in food industry rather than constituting waste or nuisance to the environment [18,13,19,8,20] Similarly, avocado

seed was also assessed for some vitamins contents and antioxidant properties (in vitro and in vivo), using standard protocols. Their result shows that, there are rich amounts of phytochemicals with the avocados seed containing significantly greater amounts of flavonoids and oxalates than the other species [21,13,22] states that avocados seeds are a potential starch source due to their content around 30%. He stated that, the microscopic evaluation of the elements showed that the presence of characteristics similar to those of corn. The parameters of gelatinization and viscosity are from type C (restricted dilation), which suggests their possible use in food that must be heated up at 100°C (212°F), such as soups and sauces.

Maryam et al. [23], states that, the optimum conditions in the manufacture of dextrin from avocado seed was obtained in the treatment concentration of 0.15 N HCl, the heating time of 30 minutes and the heating temperature of 90°C. Abebe Reda, [24] had obtained bioethanol by dilute acid hydrolysis of avocado seed wastes (6.365%) which was highly satisfactory and hence, it is promising feedstock for bio ethanol production. Besides, the elemental analysis of their work was performed with no detection of chromium and smaller concentration of lead (0.79 mg/L) as compare to the others. Talabi et al. [25] states that, *Persea americana* is a good source of dietary protein and its high fat content could contribute calories to man and animal ration. The limitation to the full utilization of avocado seeds is the high concentrations of antinutritional factors (tannin, phytic acid and alkaloids) which renders it useless for human and animal nutrition. However, processing methods, such as soaking and boiling, reduced the levels of these antinutrients present in the raw seeds.

Chaudhary et al. [26] reviewed that, everyone knows about Avocados but some of us did not know that Avocado Seeds are full of great health benefits. Avocado Seeds have more antioxidants than most fruits and veggies on the market and polyphenols like green tea, plus they are full of more soluble fiber than just about any other food. In fact Avocado Seed has 70% of the antioxidants found in the whole Avocado, Avocado Seed Oil is also full of antioxidants, lowers cholesterol, helps fight off disease, and studies show that Avocado Seed has more soluble fiber than oatmeal and just about any other food. Avocado Seed helps to prevent cardiovascular disease, lower cholesterol and prevent strokes.



	% Proteins (%NT * 6.25)	%Ether E.	% Ashes	% Fibres	% N.F.E.	% Moisture
Hass - Unripe	1.33	1	0.72	0.76	35.58	59.61
Hass - Ripe	3.18	2.6	1.51	3.33	65.62	23.79

Fig. 1. Percentage evolution of protein, ether extract, ashes, nitrogen-free extract and moisture in stones of Hass avocado, [28]

Table 1. Composition of avocado seed (proximate, minerals, antioxidant and vitamins) by different researchers

Parameters		**[18]**	**[13]**	**[19]**	**[8])**	**[20]**
Proximate	Moisture	8.6	34.28 ±0.45	9.92±0.01	13.09±0.14	14.05
(%)	Fat	14.1	6.66 ±0.10	16.54±2.10	0.33±0.00	0.71
	Fibre	7.1	26.33 ± 1.53	3.10±0.18	2.87±0.00	4.91
	Ash	2.4	3.50 ± 0.58	2.40 ±0.19	3.82±0.00	2.83
	Protein	23.0	1.33 ± 0.01	17.94±1.40	2.64±0.01	7.75
	Carbohydrate	44.70	54.23 ± 0.02	48.11±04.13	80.12±0,16	74.65
Mineral	Ca	0.82	0.43	14.15± 3.01	NR	
(mg/100 g)	Zn	0.18	0.05	0.09± 0.01	NR	
	K	4.16	14.50	100.83±5.64	NR	
	Na	1.41	0.20	0.30±0.02	NR	
	P	0.09	NR	31.33± 6.11	NR	
	Fe	NR	0.55	0.31±00.03	NR	
	Cu	NR	0.01	0.98±0.13	NR	
	Pb	NR	0.00	NR	NR	
	Co	NR	0.00	NR	NR	
Phytochemicals	Flavinoid	0.11	20.33 ± 0.01	1.90 ± 00.07	1.81±0.01	
(%)	Tanine	1.41	0.76 ± 0.17	0.24 ± 0.12	1.14±0.01	
	Saponine	4.44	0.52 ± 0.42	19.21± 02.81	8.10±0.01	
	Total phenolics	0.53	NR	NR	0.29±0.01	
	Antioxidnt capacity	44.65	NR	NR	NR	
	Oxalates	NR	4.40 ± 0.30e	NR	NR	
	Phytates	NR	0.44 ± 0.01b	NR	NR	
	Alkaloids	NR	5.40 ± 0.00b	0.72 ± 0.12	2.14±0.00	
Vitamins	[21]		[13]			
	A	10.1± 0.01 mg/100 g	96.87 mg/g	NR	NR	
	B1	0.33 ± 0.00 mg/100 g	5.87µg/100g	NR	NR	
	B2`	0.29 ± 0.00 mg/100 g	NR	NR	NR	
	B3	0.06 ± 0.00 mg/100 g	NR	NR	NR	
	C	97.8 ± 0.00 mg/100 g	6.98	NR	NR	
	E	0.12 ± 0.01 mg/100 g	3.64 µg/100g	NR	NR	

NR = Not report

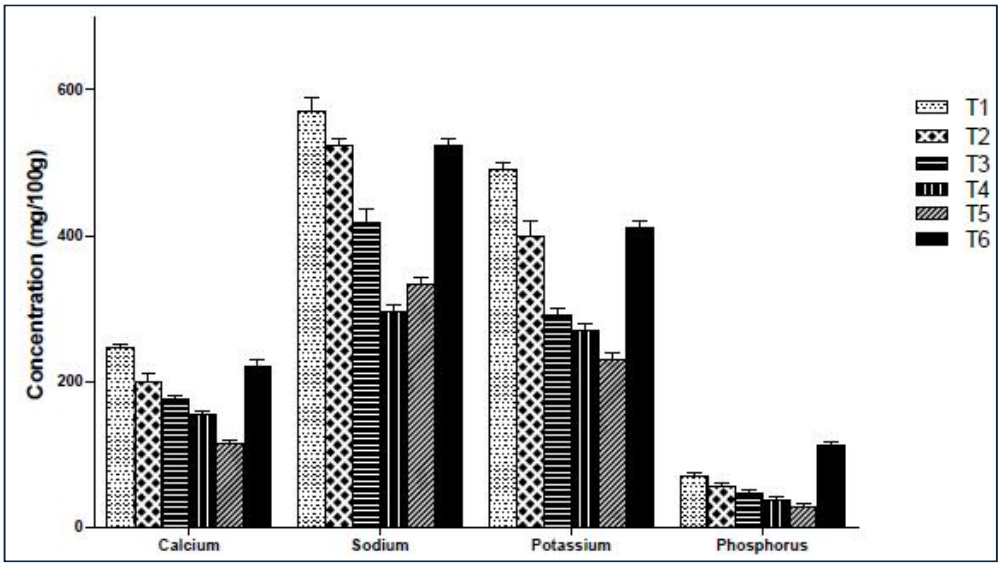


Fig. 2. Effect of processing on mineral composition (mg/100 g on dry matter basis) of avocado seeds [20]

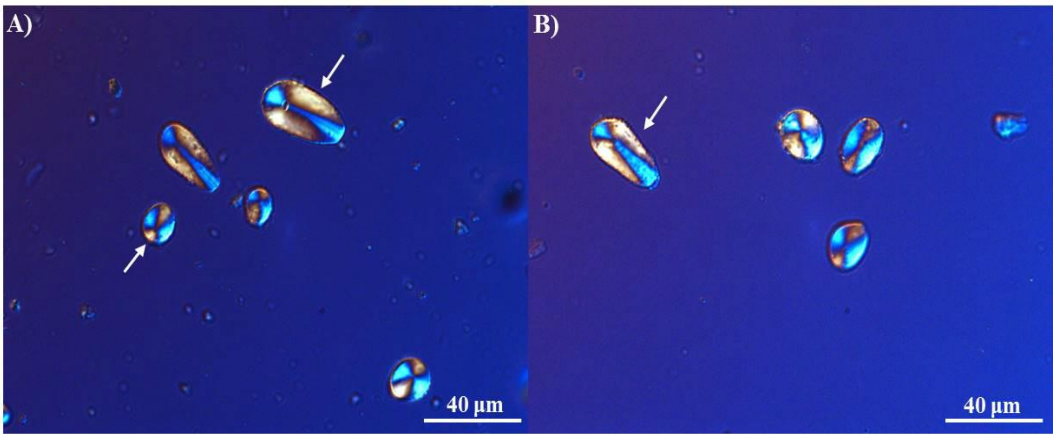


Fig. 3. Shapes of starch granules found in avocado seed powder. A) Starch granules with oval shape. B) Some modified starch granules with irregular morphology (white arrow) [29]

In Tanzania [27] conducted a research on nutritional efficiency of avocado seed. They reported that, both dry and fresh avocado seeds were tested for presence of saponnin, flavonoids, tannin, carbohydrates, proteins and vitamin C. Tannins and flavonoids were indicated only in fresh avocado seeds but none in dry samples. Saponins were found in both dry and fresh seeds. Proteins, carbohydrates and Vitamin C were indicated in both fresh and dry seeds. The compounds are reported to be present in the edible part of avocado in different proportions. Interestingly, Tannin, a widely distributed compound in most unripe fruits, with the main role in protection of the fruit from predation. They concluded that, that the avocado seed is nutritionally valuable based on the phytochemical and nutrients it constitutes. Tannins that are said to be poisonous are normally present in fresh seeds and not in the dry seeds, hence recommended to dry the seeds before processing for consumption.

3. ANTIOXIDANT AND ANTIMICROBIAL PROPERTIES

Avocado seed contains elevated levels of phenolic compounds and exhibits antioxidant

properties. Researchers investigated the effect of Avocado Seed Flour (ASF) on the lipid levels in mice on a hyperlipidemic diet. The total phenolic content in the methanolic extract was 292.00 ± 9.81 mg gallic acid equivalents/ g seed dry weight and the antioxidant activity resulted in 173.3 µmol Trolox equivalents/g [30]. The therapeutic use of avocado and its oil can be attributed to the presence of a diverse array of bioactive compounds. Bioactive compounds are responsible for various pharmacological activities exhibited by the butter fruit and its oil [1].

According to Cardoso et al. [31], the high nutritional value and biological activities of avocado, as antioxidant, antimicrobial and analgesic properties, have been thoroughly investigated. The results indicate that the avocado seed is a potential source of antimicrobial substances and arouses considerable interest in new research with more purified extracts for the identification of compounds responsible for the antimicrobial activity. Glutathione as an antioxidant protects cells against reactive oxygen species and other toxic substances [32]. Leaf and seed extracts of avocado have been used for a variety of medical application including treatment of diarrhoea, dysentery and as an antibiotic [33].

Oil extracted from avocado seed was assayed for its physiochemical properties and antioxidant potential using various standard methods. The physiochemical parameters determined were; acid value (4.51 ± 0.08 mgKOH/g), % FFA (2.26±0.08), peroxide value (2.40±0.57 mg O2/Kg), ester value (31.26±0.03 mgKOH/g). The results of the antioxidant activities of the seed oil showed that the flavonoid content (80 ± 1.41 mgQE/g) was ~10 folds higher than the phenolic content (8.27 ± 0.06 mgGAE/g) [34].

The oral LD_{50} for ASF was 1767 mg/kg body weight, and treatment with avocado seed flour (ASF) significantly reduced the levels of total cholesterol, LDL-C, and prediction of the atherogenic index. Therefore, the antioxidant activity of phenolic compounds and dietary fiber in ASF may be responsible for the hypocholesterolemic activity in a hyperlipidemic model of mice [30]. The Polyphenols, Vitamin C, carotenoids, vitamin E are compounds with antioxidant effects that help to protect cells from free radical harm. These compounds also have anti inflammatory effects that may help prevent atherosclerosis or the thickening and hardening of the arteries associated with heart disease [35].

Egbuonu *et al,* reported that, the avocado seed extract (ASE) elicited antibacterial activity (mm) against *Proteus mirabilis* (23±0.14), *Staphylococcus aureus* (16 ± 0.04) and *Pseudomonasaeruginosa* (15 ± 0.11) though lower than the corresponding activity by the standard, Ciprofloxacin. They also reported that, ASE had higher activity (18 ± 0.31mm) against the fungus, *Aspergilus niger* compared with the standard antifungal, Ketoconazole (8 ± 0.22mm) while it had a comparable activity as the standard against *Candida albicans* but no activity against *Penicillum notatum* in contrast to the standard drug (6 ± 0.24mm). Avocado seed had a broad spectrum antibacterial activity, a selective antifungal activity and an overriding activity against *Aspergilus niger* [8]. Dennis et al. [36], reported that, ethanol extract of avocado seed has an antibacterial effect *in vitro* against *Porphyromonas gingivali*s with 50% - 60%.

Ruth et al. [37], states that, there is secondary metabolite compounds contained in avocado seed. They determined cytotoxic effect from aqueous and ethanolic extracts of avocado seeds against T47D breast cancer cell lines. Thus, ID50 values obtained by using MTT assay on aquoues extract, ethanolic extract, and doxorubicin hydrochloride were 5560.2, 107.15 and 0.26 µg/mL respectively. The result of the study by Zakariya *et al*. [38], indicates that the daily oral administration of the aqueous and phenolic extract of *Persea americana* seed for a period of 3 weeks at a dose of 500 mg/Kg has shown a Hepatotoxic effect.

The study by Neboh EE et al. [39] shows that administration of methanolic seed extract of significantly affected the intrinsic pathway (APTT) more than the extrinsic pathway (PT) in treated mice. Although both pathways were affected, the extrinsic pathway (PT) was however significantly affected at higher doses of the extract whereas all the doses administered caused a significant change in the intrinsic pathway (APTT) compared to the control mice.

Avocado methanolic seed extract can be useful in anticoagulant therapy in treatment of coagulation disorders. However, consumption in treatment of other conditions should be properly monitored to avoid doses capable of causing prolonged coagulation. Experiments conducted by Ozolua et al. [40], to determine the oral median lethal dose (LD50) and other gross toxicological manifestations on acute basis indicatesd that, the animals were administered

2.5 g/kg per day of the extract for 28 consecutive days. Animal weight and fluid intake were recorded during the 28 days period. Terminally, kidneys, hearts, blood/sera were obtained for weight, haematological and biochemical markers of toxicity. Results show that the LD50 could not be determined after a maximum dose of 10 g/kg. Sub-acute treatment with the extract neither affected whole body weight nor organ-to body weight ratios but significantly increased the fluid intake ($P < 0.0001$).

Adesina et al. [41] investigated that, the percentage mortality of the mosquito species was tested after 24 hrs of exposure to different concentration of the seed extracts. Mortality was dose dependent; ethyl acetate extract recorded higher mortalities after 24 hours at 40µl and similar trend was equally observed in other extracts. LC50 value was lowest for chloroform extract thus suggested to be more toxic than other extracts evaluated.

According to the study of Daihan et al. [42], avocado seed *u*sed in traditional medicine for the treatment of various ailments and has antibacterial, antifungal, anti-viral and wound-healing properties. They reported that, antioxidant potential of plant extracts was evaluated by means of total phenolic, total flavonoids content and DPPH radical scavenging activity. The highest phenolic and flanovoid content was observed in methanol extract while the lowest was achieved in aqueous extract. At concentration of 500 g/mL, DPPH radical scavenging activity was found to be highest in methanol extract (70%) and lowest in aqueous extract (51%). Antibacterial activity of different extracts was evaluated by using the disk diffusion method. Highest antibacterial activity was observed with methanol extract against *S. pyogenes,* while minimum activity was observed with aqueous extract against *E.coli.*

Results of the research by Kristanti et al. [43] showed that both all-level doses of infusion and methanolic extract of avocado seeds have a significant reduction on the mice paw edema. They also reported that, all level doses of methanolic extract of avocado seeds have a significant reduction on the number of abdominal writhes induced by acetic acid, but only the lowest dose of infusion showed a significant reduction. Their findings suggest that avocado seeds are rich with potential anti inflammatory and analgesic compounds which support its traditional use.

The study by Temitope et al. [44], also indicates that essential oils serve as an important source of antibacterial compounds that may provide renewable sources of useful antibacterial drugs against bacterial infections in human. According to their result, the essential oils from the stem bark of *Persea americana* and *seed* shows varying degrees of antibacterial activity against clinical isolates. From the study, it can be inferred that essential oil extract shows significant growth inhibiting effects on Gram-positive (*Staphylococcus aureus*) and Gram-negative bacteria (*Escherichia coli*).

Several researchers had reviewed that, the medicinal importance of avocado seed. Thus, the efficacy of stem bark of *Persea Americana* and *seed* against these microorganisms provides a scientific ground for the application of the herb in the prevention and treatment of bacterial infections caused by various pathogenic bacteria such as *Staphylococcus aureus* and *Escherichia coli*, which have the ability of developing resistance to antibiotics [45,46,47,48,40,49,50, 51,52].

4. CONCLUSION

There were different studies to investigate the benefits of avocado seed as sources of food supplements or medicinal products. As reviewed from different literatures, the avocado seed is not only important for nutritional value, but also applicable for different medicinal purposes. Researchers investigates the nutritional composition: proximate, minerals and antioxidant and antimicrobial properties of the avocado seed. Most of them reported that, it possesses nutritional qualities that may be further investigated for application in food industry rather than constituting waste or nuisance to the environment. Its biological activities such as antioxidant, antihypertensive, fungicidal, larvicidal, hypolipidemic, and recently amoebicidal and giardicidal activities had reported. Therefore, it can be concluded that, the avocado seed is nutritionally valuable as the other parts of the plant based on the phytochemical and nutrients it constitutes. The consumption of avocado seed is recommendable since it has high nutritional contents that make it enough for possible dietary and ethno-medicinal use.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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