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Phytochemical, antioxidant, phenolic, and mineral composition of *Mangifera indica L.* (mango) and *Persea Americana Mill.* (avocado) seed and exocarp (peel)

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Abstract
Fruits are known for their nutrients and therapeutic potential. This study aimed to determine the phytochemical constituents, antioxidative prowess, mineral constituents, and total phenolic composition of *Mangifera indica* (mango) and *Persea americana* (avocado) fruits' seeds and their exocarps (peel) respectively. The phytochemical screenings were carried out using standard techniques, and saponins, terpenes, steroids, tannins, alkaloids, flavonoids, and anthraquinones were detected. Both the seeds and peel samples of *M. indica* and *P. americana* have a high percentage of antioxidant activities as recorded with the DPPH method at varying concentrations. The mineral analysis of both fruits' samples shows potassium in the highest amount (127 - 163mg/L), followed by calcium (11 – 26 mg/L), magnesium (6 – 13mg/L), sodium (1.99 – 7.14 mg/L), then iron (2.7 – 4.14 mg/L) in that order. Both lead, chromium, and copper were undetected in the samples. The Follin-Ciocalteus reagent was used to measure the samples' total phenolic contents at different concentrations, and the results were reported in mg/g of GAE. Both have minimal calories and are an excellent source of fiber, antioxidants, minerals, and vitamins C and E.

Keywords: Follin-Ciocalteus, Mangifera indica, Mineral, Persea americana, Phenolic

1. Introduction
The seeds and peels (mesocarps) of *Mangifera indica* and *Persea americana* are sometimes deemed trash and inedible. Mango, (or *Mangifera indica*), is a genus of flowering plants in the Anacardiaceae family. This big fruit tree can reach a height of thirty meters. In contemporary mangoes, there are two different genetic groups. A medium-sized deciduous tree in the Laurel genus is the avocado. It emerged in Mesoamerica around 5,000 years ago and it is native to the Americas. It was valued for its huge and exceptionally fatty fruit back then as it is now. Maintaining a healthy lifestyle with a diet rich in nutrients can help ward off and even reverse disease. Avocados contain nutrients such as vitamins and minerals and healthy fats that keep your body functioning properly and help prevent disease.

2. Literature review

Mango (*Mangifera indica L.*) fruit is an excellent supplier of phenolic chemicals. carotenoids, and ascorbic acid (Maldonado-Celis et al., 2019). These antioxidants have been shown to have a variety of health-promoting qualities, primarily because of their exceptional antioxidant properties (Sogi et al., 2012). Among other health benefits, according to research (Sharifi-Rad et al., 2020; Yahia et al., 2019), biologically active compounds can protect against atherosclerosis, cardiovascular diseases, and several types of cancer.

Figure 1a: *Persea americana* (avocado)

Figure 1b: *Persea americana* (avocado)

Figure 1c: (Hass avocado)

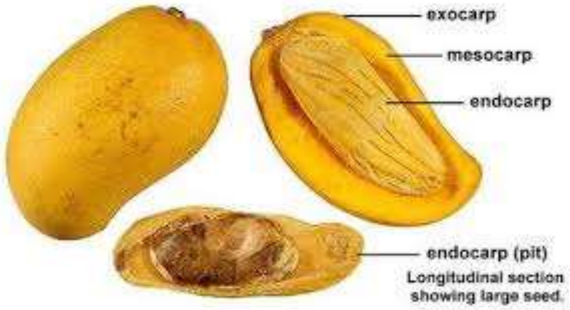

Figure 2: Mangifera indica

Mangoes contain considerable amounts of bioactive chemicals with antioxidant capabilities and potential health advantages when consumed regularly. Due to their high sensory qualities (shining colour, pleasant taste, and exquisite flavour) and nutritional makeup (vitamins, minerals, fibre, and phytochemicals), mangoes are a popular and commercially significant fruit in many regions of the world (Onuh et al., 2017). According to reports, out of numerous mango varieties, the "Ataulfo" mango has the greatest phenolic amount as well as antioxidant capacity (Quirós-Sauceda et al., 2017). Fruits and vegetables' total phenolic content and composition have been linked to their antioxidant ability (Siriamornpun & Kaewseejan, 2017). Numerous factors, including cultivar, agronomic circumstances, post-harvest treatment, and ripeness stage, influence the capacity for antioxidants (Rumainum 2018). Mangos and other fruits have been found to have a lot of phenolic compounds and high antioxidant activity; however, little is known about the makeup of these compounds, how they alter over time, and how much of an antioxidant they can exhibit when ripe. Depending on their location within the structure, several hydroxyl groups, and other structural factors, phenolic compounds have varying capacities as antioxidants (Chung & Shin, 2007; Chen et al., 2022). Fruits' total quantities and compositions of various phenolic compounds—at the very least, the most prevalent ones—should be considered when assessing their antioxidant activity. Individual and combined antioxidant activity is what gives the "Ataulfo" mango its antioxidant activity. To comprehend the actual ripening changes, it is essential to assess the individual phenolic input to the antioxidant activity of "Ataulfo" mangos.

A variety of *Persia Americana* "Hass" is a member of the Lauraceae family, and its fruit resembles a berry (Schaffer et al., 2013). As the "Hass" cultivar ages, it turns from green to black (Cox et al., 2004). Abundant in unsaturated fats that oxidize during storage, such as oleic, linoleic, and palmitoleic acid, is its pulp (Ferreira et al., 2013) The highest concentration of vitamin C, minerals, alkaloids, glycosides, flavonoids, carbs, protein, and triterpenoids are found in it (Adeyemi et al., 2002). Another factor lowering the possibility of cardiovascular disease is the abundance of phytochemical components (Lu et al., 2005). This fruit contains phytochemicals that lower the risk of cancer sickness, including flavonoids, carotenoids, and antioxidant vitamins (Variya et al., 2016). The purpose of this research is to evaluate the nutritional value of the materials (the seeds and skins of avocado and mango fruits), which are typically considered to be wasted components of these well-known, nutrient-dense fruits with several health advantages.

3. Research methodology

Sample preparation: Both *M. indica* and *P. americana* fruits were obtained from a local market and their mesocarps and seed were separated from the fruits' pulps. These were air-dried, powdered, and stored for further use.

Extraction for phytochemical and radical scavenging analysis: The powdered samples were macerated in methanol for three days. The extract was concentrated using a rotatory evaporator after being filtered via filter paper, and any leftover solvent molecules were allowed to evaporate. **Phytochemical screening** was carried out using standard techniques (Mumtaz et al., 2014).

Antioxidant analysis The radical scavenging capability was assessed using the DPPH (2,2-diphenyl-1-picrylhidrazyl) technique, as Sungthong et al. (Sungthong et al., 2018). Various sample concentrations were prepared from the initial sample solution in methanol. After adding 1 milliliter of 0.1-
millimeter DPPH solution to each, they were covered, thoroughly mixed, and allowed to stand in a dark closet for 30 minutes. The absorbance was measured using a UV-visible spectrophotometer at 517 nm. The DPPH solution in methanol was used as the blank, and the experiment was performed three times. The % inhibition was computed using the following formula:

$$\text{Inhibition\%} = \frac{Ablank - Asample}{Ablank} \times 100\%$$

Ablank = absorbance of blank; *Asample* = absorbance of the sample

Mineral analysis

Twenty milliliters of nitric acid were added to a beaker containing two grams of each sample. For thirty minutes, this was placed on the heating mantle at 60ºC. After that, the heat was turned off and it was left to cool. The solution was prepared to a volume of 50 milliliters in a volumetric flask by diluting it with distilled deionized water. The same process was used to prepare a blank, which was then put into a plastic bottle. Using the proper operating standards, the samples were examined for metals on a Thermo Scientific iCE 3000AA02134104 Atomic Absorption Spectrometer (Otemuyiwa et al., 2022).

Total amount of phenolics

With the Folin-Ciocalteu reagent (FCR), the total quantity of phenolic molecules in the samples was determined. 50 milliliters of the extract solution were combined with 2.0 milliliters of 7.5% $Na2CO3$ and 2.5 milliliters of 10% Folin-Ciocalteu reagent. The combination was then incubated at 45°C for 15 minutes. Using a UV-visible spectrophotometer, the sample absorbance at 765 nm was determined. The value of absorbance of gallic acid was plotted against its concentration to construct the garlic acid standard curve. The milligrams of gallic acid equivalents, or mg GAE/g extract, or gallic acid equivalents, were used to express the total phenol content of the samples. The measurements were made three times over (Munteanu et al., 2021).

4. Results and discussion

The phytochemical screening result (Table 1) showed that the fruits of both M. indica and P. americana seeds, and peels contain alkaloids, saponins, tannins, steroids, flavonoids, and anthraquinones. Flavonoids are compounds used to lower the body's damage caused by free radicals and treat diarrhea, fever, and pain (Variya et al., 2016; Wang et al., 2021). Alternative names for flavonoids include spasm inhibitors and anti-cancer drugs. The properties of phenols and flavonoids include anticancer, anti-inflammatory, antiallergenic, antibacterial, and antioxidant effects. They are crucial to the growth and reproduction of living things. Defense against harmful microorganisms and predators is provided by phenolic compounds (Abreu-Naranjo et al., 2020; Enechi et al., 2016). Tannins are well known for their capacity to scavenge free radicals and accelerate the healing of wounds (Fadeyi et al., 2022; Zeng et al., 2023). Natural compounds called alkaloids contain nitrogen and have sedative and analgesic properties. Treatment for hypertension involves the use of alkaloids. Moreover, it is utilized as a tranquilizer, stimulant, analgesic, antimalarial, diabetic, and for heart problems. It has been shown that alkaloids are useful in reducing the signs and symptoms of depression and stress. Alkaloids are dangerous in high dosages because of their stimulatory actions, which can cause excitation associated with nerve and cell disorders (Nwaji et al., 2022; Fadeyi et al., 2023). According to Tukur et al., (2022), saponins are terpenoids or steroidal glycosides that are present in plants and possess antiallergic, anticancer, antiviral, immunomodulating, antihepatotoxic, and antifungal activities. Because saponins have adjuvant activity, which enhances immune response, they are shown to be highly helpful in veterinary vaccinations. In intracellular histochemistry, a variety of saponins can be employed to facilitate the passage of antibodies past intracellular protein molecules. Mineral analysis results (Table 4 and Figure 3) shows that both samples are tremendously rich in potassium (K). Calcium (Ca) and magnesium (Mg) are also significantly present, followed by sodium (Na), iron (Fe) and zinc (Zn). It is noteworthy to mention that lead (Pb), Chromium (Cr) and copper (Cu) were not detected in the samples. It is possible to narrow the functions of antioxidants to flavonoids and phenolic substances. The findings of this study provide compelling evidence in favor of looking for different fruit-based antioxidant sources.

Table 1: Qualitative phytochemical analysis

	MIS	*MIP*	*PAS*	*PAP*
Flavonoids	+	+	+	-
Alkaloids	+	+	+	+
Saponins	+	+	+	+
Tannins	+	+	+	+
Steroids	+	+	+	+
Terpenes	+	+	+	+
Anthraquinones	+	+	+	-

Key: + = present; - = absent

Table 2: Antioxidant activities

Conc. (mg/mL)	**MIP**	**MIS**	**PAP**	**PAS**	**AA**
0.4	87.94	98.78	13.24	92.30	95.44
0.5	87.61	97.35	12.18	91.56	91.82
1.0	7.39	97.35	39.91	90.88	95.19
2.0	85.40	97.24	48.97	92.60	95.69
3.0	84.07	97.12	59.71	91.26	95.88
4.0	82.97	96.68	73.89	91.56	95.93
5.0	80.86	95.58	83.70	91.48	95.01

MIP = *M. indica* peel; MIS = *M. indica* seed; PAP = *P. americana* peel; PAS =*P. americana* seed; AA = ascorbic acid

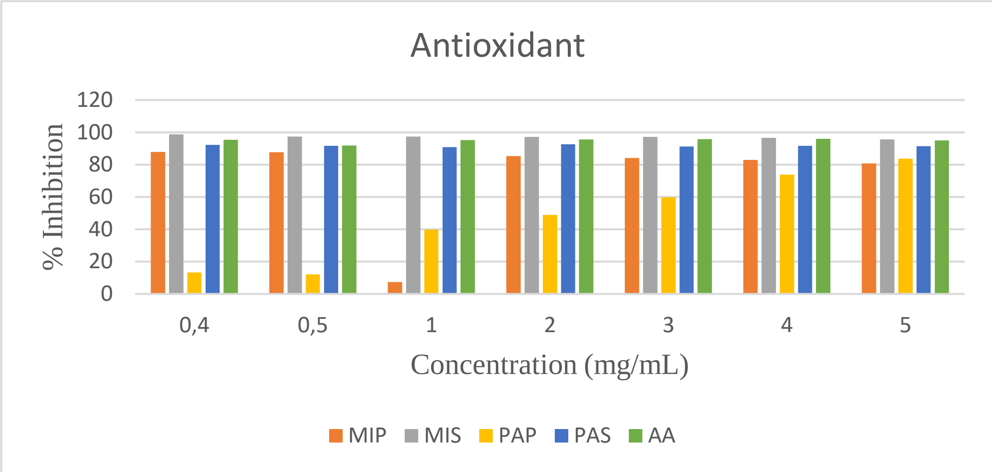

Figure 3: Plot of %Inhibition Vs. Concentration of extracts and ascorbic acid

Table 3: Total phenolic content

Conc. (mg/mL)	GA	MIP	MIS	PAP	PAS
1.0	1.1045	1.277	0.497	0.154	0.177
2.0	0.805	1.365	0.512	0.084	0.313
3.0	0.9225	0.482	0.441	0.088	0.093
4.0	1.3655	0.748	0.355	0.095	0.142
5.0	1.9175	0.443	0.417	0.082	0.199

Table 4: Elemental analysis

	Zn	Fe	Cd	Pb	K	Mg	Cr	Ca	Na	Mn	Cu
MS	0.269	2.697	0.055	ND	127.407	13.204	ND	11.170	2.434	0.784	ND
MP	0.535	4.014	0.061	ND	142.636	14.120	ND	44.612	5.453	1.884	ND
AS	0.452	3.286	0.076	ND	136.002	6.233	ND	14.233	1.985	0.757	ND
AP	0.921	3.730	0.103	ND	163.557	7.047	ND	26.413	7.145	1.062	ND

Key: ND = not detected

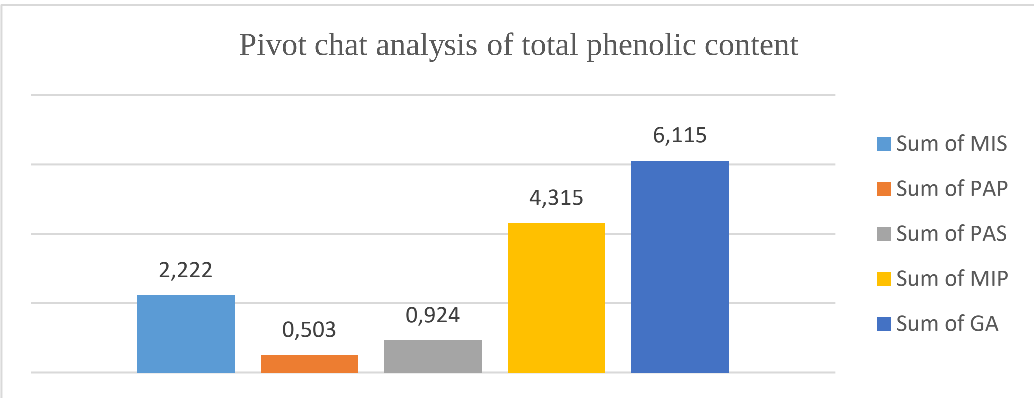

Figure 4: Comparison of total phenolic contents of *M. indica* seed (MIS) & pulp (MIP), *P. americana* seed (PAS) and pulp (PAP), with garlic acid (GA)

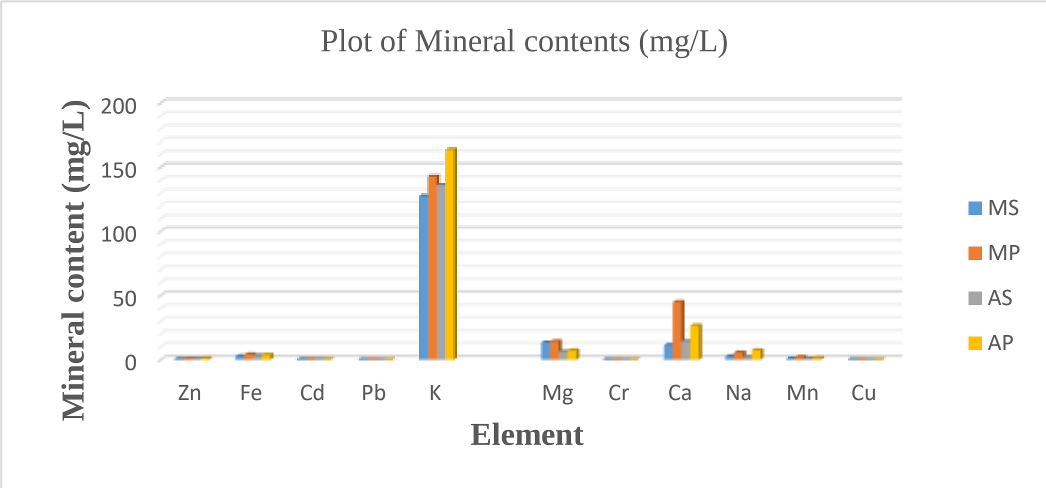

Figure 5: Plot of Mineral contents of *M. indica* and *P. americana* seed and pulp

5. Contribution of the research

Fruit peels and seeds are a good source of rich bioactive compounds and have high nutritional values, as demonstrated by this and other research works (Slavin and Lloyd, 2012; Yahia *et al.*, 2019). The study has shed light on the usefulness of these previously considered waste and less significant fruit components.

6. Conclusion

The peels (exocarps) and seeds of both avocado fruit and mango fruit are rich in essential mineral elements that promote health, especially in the building of strong teeth and bones, muscles, nerves and, regulating bodily fluids both within and outside of cells, converting food into energy and supporting a healthy cardiovascular system. They are equally endowed with phytochemicals such as phenols, saponins, tannins, and other phytochemicals that promote healthy living, especially against several pathogens. After all, the supposed waste components of these fruits are as useful to the body as the mesocarp parts of the fruits studied.

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