

Physical, Biochemical and Antioxidant Evaluation of Carrot (*Daucus carota* L). & Mango (*Mangifera indica* L. Cultivar Ataulfo)

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Abstract: The physical, biochemical characteristics and antioxidant capacity of carrot (*Daucus carota* L. cv. Ataulfo) and mango (*Mangifera indica*) were estimated. Different parts of carrot including the whole carrot, cortex (outer part), and core (inner center), were comparatively evaluated. The inner core juice contained the highest amounts of total sugars, chlorophyll a, chlorophyll b, and carotenoids compared to the cortex and whole carrot juice. Based on the reducing power assay, phosphomolybdenum assay, and DPPH radical scavenging assay, the whole carrot juice exhibited the highest total phenolic content and total antioxidant activity while the total flavonoid content was highest in the inner core juice. These results indicate that the whole carrot exhibits superior antioxidant properties. However, in respect of mango, the nutritional components, phytochemicals and antioxidant capacity of pulp, peel, peel fiber were quantified. Sucrose was present in the largest quantity, followed by fructose, in the mango pulp, peel, and peel fiber. Regarding beta-carotene, the mango peel showed the highest value. The highest amounts of phenolics were quinic and ferulic acid, while mangiferin was present in sufficient amounts in the mango peel. The different sections of the mango showed significant amounts of antioxidant activity.

Keywords: *Daucus carota*, *Mangifera indica*, Cortex, Pulp, Peel, Fiber, Sucrose, Quinic Acid, Ferulic Acid, Flavonoid, Antioxidant.

Introduction

Fruits and vegetables play a significant role in reducing the risk of cancer and heart disease, as well as in preventing many other conditions. This protective effect is due to the presence of health-promoting substances, such as dietary fiber, minerals, vitamins, and antioxidant compounds. The carrot (*Daucus carota* L.) is a highly recognized horticultural crop prized for its rich nutritional profile, which includes essential minerals, vitamins (B1, B2, B6, B12), and powerful antioxidants like carotenoids, ascorbic acid, flavonoids, and phenolic compounds^{1,2,3,4}. These bioactive constituents contribute to a wide array of therapeutic properties, including antidiabetic,

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anticancerogenic, anti-inflammatory, cardiovascular-lowering, and immune-boosting properties. It was reported that visually and texturally distinct, carrots feature a sweet, fragrant, and crisp root composed of two main tissues: a flexible, parenchymatic outer cortex and a more rigid, vascular inner core, which vary across a vibrant spectrum of colors.

The ratio of cortex to core indicates carrot differentiation, as the core fraction decreases during ripening in favor of the cortex⁵. Mango (*Mangifera indica* L.) is one of the most popular and appreciated tropical fruits in the world. The main reason for the increase in mango consumption in the United States and the European Union over the last 5 years is probably the growing awareness of its health benefits (1). Despite containing free sugars and dietary fiber, some scientific evidence indicates that consuming mangoes helps reduce the risk of various health disorders, which are primarily involved with inflammatory and oxidative processes^{6,7}.

Mango is a natural source of biologically active phytochemicals or plant components such as carotenoids, ascorbic acid, polyphenols, and mangiferin, which promote beneficial effects on human health through their anti-inflammatory and antioxidant properties. Carotenoids are a type of pigment responsible for the color of mangoes, and their color can range from yellow to red or purple. The chemical structure of carotenoids consists of a 40-carbon skeleton made up of eight isoprene units with nine conjugated double bonds, and an end group at both ends of the polyene chain. β -carotene exhibits high efficiency in quenching singlet oxygen and scavenging superoxide anions, as well as peroxy and hydroxyl radicals⁸. Ascorbic acid, or vitamin C, is widely present in many vegetables and fruits, including mangoes. Ascorbic acid is another powerful antioxidant that reduces volatile oxygen, nitrogen, and sulfur-free radicals. Antioxidants protect DNA and lipids from ROS-induced oxidation and prevent cell-damaging mutations⁹. Various in vitro or laboratory methods are used to determine the efficacy or antioxidant potential of food. For example, considering the chemical diversity of molecules with antioxidant properties, multiple methods should be used to measure antioxidant activity in a complex matrix¹⁰. The aim of this study was to evaluate the physicochemical attributes and antioxidant potential of juices derived from different parts of the carrot, as well as the pulp, peel, and peel fiber of the mango.

Material and Methods

This study was conducted using secondary data collected from Azizuddin & Qadeer¹¹ and Rocha et al.¹². The materials and methods used are described below:

1. Carrots were washed to remove dirt and dried with a cloth. The peel was removed, and the red cortex and yellow inner core were separated. The juice from both parts was extracted using a home juicer (Nova Multiple Juice Extractor, NJ-506, China), filtered through a cotton cloth, weighed, and subjected to physicochemical analysis.

A 10 mL sample of the juice was mixed with 25 mL of methanol containing 1% HCl, shaken, and left to stand for one hour. The mixture was then centrifuged for 10 minutes at 3500 rpm. The supernatant was used to analyze chlorophyll a, chlorophyll b, total carotenoid content, and antioxidant activity.

The moisture content, ash content, and titratable acidity (TA) of the juice from different parts of the carrots were determined according to AOAC Official Methods¹³. The pH of the juice was measured using a pH meter (Jenway 3510, England), and its viscosity was measured with an Ostwald viscometer. The density of the juice was determined using a relative density (R.D.) bottle, while its conductance was measured with a conductivity meter (Jenway 4510, England).

The sugar content of the juice was determined according to a previously reported colorimetric method¹⁴. The total dissolved solids (TDS) of the juice were measured using a TDS meter (S 518860, Korea), whereas the total soluble solids (TSS) and refractive index of the juice were determined using a refractometer (KRUS DR 6200, Germany).

Chlorophyll a, chlorophyll b, and total carotenoids were determined using a UV-visible spectrophotometer (Jenway 6300, England) according to the method described by Dere et al.¹⁵. The absorbance of the sample was recorded at 400–700 nm on the spectrophotometer. It was observed that chlorophyll a chlorophyll b and total carotenoids showed maximum absorbance at 666, 653, and 470 nm, respectively, from which the amounts of these pigments were calculated.

The total phenolic content (TPC) of the juice was determined with minor modifications according to the Folin-Ciocalteu colorimetric method¹⁶. The total phenolic contents were quantified by comparing the sample absorbance with a standard calibration curve of known gallic acid concentrations (50–500 mg/L, $r^2 = 0.982$).

The total flavonoid content (TFC) of the juice was also determined based on the method by Zhishen et al.¹⁷. The total flavonoid contents were determined using catechin as a standard for the calibration curve (20–200 mg/L, $r^2 = 0.993$).

Antioxidant capacity was evaluated using a reducing power assay (RPA) according to the method of Jayanthi and Lalitha¹⁸. The antioxidant capacity with respect to

ascorbic acid in the juice sample was determined using a calibration curve ($r^2 = 0.981$) plotted with different concentrations of ascorbic acid (50–700 mg/L). The total antioxidant activity of the juice sample was also measured by a phosphomolybdenum assay (PA) with some modifications¹⁹. The antioxidant activity was expressed relative to that of ascorbic acid. A standard curve of ascorbic acid was plotted at various concentrations (100–1000 mg/L). Finally, the percent inhibition of the DPPH radical by the juice sample was calculated according to the method of Yu et al.²⁰. Percent inhibition of DPPH radical by the juice sample was calculated.

Samples were prepared and analyzed in three replicates. Results were expressed as mean $\pm$ SEM. All data were statistically analyzed by ANOVA using the software SPSS 21 to evaluate different parts of carrot (whole carrot, cortex and inner core) at level of significance ($p \leq 0.05$).

2. The mango fruit was washed with chlorinated water and dried at room temperature before processing. The peel and pulp were separated, frozen at -80°C , freeze-dried, and stored in a desiccator until use. The dietary fiber-rich fraction was obtained from the freeze-dried peels by successive washing with 80% ethanol, 96% ethanol, and acetone, and was oven-dried at 40°C overnight to evaporate the residual solvent (12).

Macronutrients composition analysis: The percentage of moisture, protein, total lipids, ash, dietary soluble and insoluble fiber and total carbohydrates were determined in triplicate according to the official procedures of AOAC²¹.

Bioactive compounds analysis: Ascorbic acid (Vitamin C) content was quantified by high-performance liquid chromatography (HPLC) according to the methodology recommended by Gökmen et al.²². The β -carotene (provitamin A), free phenolic compounds, flavonoid content and antioxidant capacity were determined (12). The experimental design was completely randomized with three replications.

Data were analyzed with Minitab 17 software (Minitab, Inc. State College, PA, USA). One-way ANOVA was performed and differences between means were evaluated using Tukey's method for multiple comparisons and were considered significant at 95 % confidence ($p \leq 0.05$) were described in Rocha et al.

Results and Discussion

1. Physical, biochemical and antioxidant evaluation of carrot (*Dacus carota* L.)

The results are shown in Tables 1 and 2. The ANOVA indicated significant differences ($p \leq 0.05$) among the different parts of the carrot with respect to various parameters. The

total weight of the whole carrot was 217.70 g, in which the weights of the cortex and inner core were 131.62 and 86.08 g, respectively. The weights of extracted juice from the whole carrot, cortex, and inner core were 138.56, 80.59, and 57.97 g, respectively. According to the results, the juice yield of the whole carrot (yellow and red parts) was 63.68%. The cortex and inner core contributed 36.98% and 26.70%, respectively. It was found that the cortex makes a greater contribution to the juice than the inner core (Table 1). The moisture content of the whole carrot was 90.47%. The relative contributions of the cortex and inner core to the moisture content were 45.04% and 45.43%, respectively. This showed that the inner core has a relatively higher moisture content than the cortex. The ash content of the juice of the whole carrot was 0.703%. The ash contribution from the cortex and inner core was 0.404% and 0.299%, respectively, showing that the cortex has a higher amount of ash content than the inner core (Table 1).

The pH values of the juice from the whole carrot, cortex, and inner core were 6.42, 6.39, and 6.40, respectively. The pH of all parts was high compared to the pH reported by Quitao-Teixeira et al.²³, showing that the carrots were less acidic. Generally, pH correlates directly with titratable acidity (TA), which measures the total amount of acids present in the juice. Similar to the pH trends, no significant difference was found in the titratable acidity among the juices of the whole carrot, cortex, and inner core.

The viscosity and density of the whole carrot juice were 0.105 millipoise and 1.035 g/ml, respectively. Comparatively, the viscosity of the cortex juice (0.107 millipoise) was higher than that of the inner core (0.099 millipoise). Density was also significantly higher in the cortex (1.040 g/ml) than in the inner core (1.030 g/ml). Furthermore, electrical conductance was significantly higher in the cortex (8.83 mS). The conductance of the whole carrot juice (8.80 mS) correlated significantly with that of the cortex, while a lower conductance value was recorded in the inner core (7.82 mS). These findings align with similar results reported previously.

This study indicated that the cortex was significantly enriched with a higher amount of total sugar (0.104 g glucose/100 ml) than the inner core (0.044 g glucose/100 ml) and the whole carrot (0.099 g glucose/100 ml). The total sugar content in the whole carrot significantly correlated with that of the cortex, which is capable of storing starch. Therefore, it is clear that the cortex contains a high amount of glucose²⁴.

The Total Dissolved Solids (TDS) were almost identical between the whole carrot (5.34 g/L) and the cortex (5.33 g/L), showing no significant difference. In contrast, the

inner core contained the lowest amount of TDS (4.67 g/L). Total Soluble Solids (Brix glucose, Brix sucrose, Brix fructose, and Brix invert sugar) were higher in the whole carrot (6.96–7.84°Brix). Additionally, the cortex and inner core were significantly correlated with each other. The results demonstrated that the refractive index of the juice was directly affected by the TDS. Consequently, the refractive index was slightly higher in the whole carrot (1.344) compared to the cortex (1.343) and the inner core (1.342). Chlorophylls (a and b) are fat-soluble pigments found in vegetables and fruits (2-4). Chlorophyll a (2.26 ppm) and chlorophyll b (4.72 ppm) were found to be higher in the inner core of the carrot. Conversely, the lowest amounts of chlorophyll a (0.22 ppm) and chlorophyll b (0.36 ppm) were found in the cortex (Table 1).

Table 1. Physical and biochemical analysis of the juice of different parts of *Daucus carota* L. (carrot)

Sl. No.	Parameter	Unit	Whole carrot (Mean $\pm$ SEM)	Cortex (Mean $\pm$ SEM)	Inner core (Mean $\pm$ SEM)
1	Weight of carrot	g	217.70 $\pm$ 2.64	131.62 $\pm$ 2.75	86.08 $\pm$ 1.71
2	Weight of juice	”	138.56 $\pm$ 4.89	80.59 $\pm$ 2.36	57.97 $\pm$ 1.88
3	Juice yield	%	63.68 $\pm$ 0.93	36.98 $\pm$ 1.05	26.70 $\pm$ 1.73
4	Moisture contents	”	90.47 $\pm$ 0.06	45.04 $\pm$ 0.03	45.43 $\pm$ 0.01
5	Ash contents	”	0.703 $\pm$ 0.00	0.404 $\pm$ 0.01	0.299 $\pm$ 0.02
6	pH	-	6.42 $\pm$ 0.00	6.39 $\pm$ 0.01	6.40 $\pm$ 0.00
7	Titrateable acidity	% citric acid	0.258 $\pm$ 0.06	0.275 $\pm$ 0.03	0.259 $\pm$ 0.03
8	Viscosity	milipoise	0.105 $\pm$ 0.00	0.107 $\pm$ 0.00	0.099 $\pm$ 0.00
9	Density	g/ml	1.035 $\pm$ 0.00	1.040 $\pm$ 0.00	1.030 $\pm$ 0.00
10	Conductance	mS	8.80 $\pm$ 0.02	8.83 $\pm$ 0.01	7.82 $\pm$ 0.02a
11	Total sugar contents	g glucose/100 ml	0.099 $\pm$ 0.001b	0.104 $\pm$ 0.001b	0.044 $\pm$ 0.001
12	TDS	g/l	5.34 $\pm$ 0.04	5.33 $\pm$ 0.01	4.67 $\pm$ 0.01
13	TSS	Brix invert sugar	7.65 $\pm$ 0.12	6.73 $\pm$ 0.02	6.71 $\pm$ 0.03
		Brix fructose	7.08 $\pm$ 0.01	6.85 $\pm$ 0.05	6.76 $\pm$ 0.04
		Brix sucrose	7.84 $\pm$ 0.05	6.67 $\pm$ 0.01	6.62 $\pm$ 0.05
		Brix glucose	6.96 $\pm$ 0.02	6.74 $\pm$ 0.01	6.72 $\pm$ 0.03
14	Refractive index	-	1.344 $\pm$ 0.00	1.343 $\pm$ 0.00	1.342 $\pm$ 0.00
15	Chlorophyll a	ppm	1.96 $\pm$ 0.00	0.22 $\pm$ 0.00	2.26 $\pm$ 0.01
16	Chlorophyll b	”	2.93 $\pm$ 0.00	0.36 $\pm$ 0.02	4.72 $\pm$ 0.01
17	Total carotenoids	”	207.66 $\pm$ 3.74	57.28 $\pm$ 1.45	277.70 $\pm$ 3.54

SEM = Standard error of the mean of triplicate analysis. Means with different superscripts lower case letters (a - c) in the same row are significantly different ($p \leq 0.05$), were analyzed by ANOVA. Source: Azizuddin & Qadeer (11)

Total carotenoid content was also higher in the inner core (277.70 ppm) than in the cortex (57.28 ppm), while the total carotenoid content in the whole carrot was 207.66 ppm. This indicates that the inner core accumulated more carotenoids. These results show a similar trend for carotenoids to those reported earlier (5,25). The findings also demonstrated that the inner core majorly contributes to the chlorophyll a, chlorophyll b, and carotenoid contents. Finally, the unequal distribution of carotenoids between the two tissues, as discussed earlier, confers a better color to the cortex²⁵.

Table 2. Antioxidant analysis of the juice of different parts of *Daucus carota* L. (carrot).

Sl. No.	Parameter	Unit	Whole carrot (Mean $\pm$ SEM)	Cortex (Mean $\pm$ SEM)	Inner core (Mean $\pm$ SEM)
1	Total phenolic contents (TPC)	mg GAE/l	177.83 $\pm$ 2.57	108.50 $\pm$ 4.95	115.50 $\pm$ 4.95
2	Total flavonoid contents (TFC)	mg CE/l	86.33 $\pm$ 4.04	46.37 $\pm$ 5.62	112.40 $\pm$ 2.46
3	Reducing power assay (RPA)	mg AA/l	45.27 $\pm$ 4.04	35.00 $\pm$ 0.40	36.40 $\pm$ 0.70
4	Phosphomolybdenum assay (PA)	mg AA/l	326.20 $\pm$ 0.99	252.00 $\pm$ 7.31	258.65 $\pm$ 9.41
5	DPPH radical scavenging assay	% inhibition	17.60 $\pm$ 0.49	12.39 $\pm$ 0.62	12.61 $\pm$ 0.62

GAE = Gallic acid equivalent, CE = Catechin equivalent, AA = Ascorbic acid, SEM = Standard error of the mean of triplicate analysis. Means with different superscript lower case letters (a - c) in the same row are significantly different ($p \leq 0.05$), analyzed by ANOVA. Source: Azizuddin & Qadeer (11)

Table 2 represents the total phenolic content (TPC), total flavonoid content (TFC) and antioxidant activity using reducing power (RPA), phosphomolybdenum (PA) and DPPH free radical scavenging assays. The antioxidant activity of phenolic compounds is mainly due to their redox properties, which play an important role in absorbing and neutralizing free radicals, quenching singlet and triplet oxygen, and decomposing peroxides²⁶. Particularly, the results showed that the total phenolic content (TPC) was higher in the whole carrot (177.83 mg GAE/L) in comparison with the inner core (115.50 mg GAE/L) and cortex (108.50 mg GAE/L). Hence, it is clear that the whole carrot has a greater ability to scavenge free radicals than the inner core and cortex. Flavonoids are highly effective scavengers for various oxidizing molecules, including singlet oxygen and several free radicals. The total flavonoid content (TFC) in carrots reached its highest value of 112.40 mg CE/L in the inner core. The total antioxidant

activity of the juice is connected to the amount of bioactive compounds like phenolic acids, flavonoids, carotenoids, and vitamins (1). Antioxidant activity measured through the reducing power assay involves the conversion of Fe^{3+} to Fe^{2+} . Compounds with reducing power act as electron donors and can reduce the oxidized intermediates formed during lipid peroxidation. In the phosphomolybdenum (PA) assay, molybdenum $[\text{Mo(VI)}]$ is reduced to a green phosphate $[\text{Mo(V)}]$ complex in the presence of antioxidant compounds. Whole carrots exhibited the highest reducing power and phosphomolybdenum antioxidant activities, at 45.27 and 326.20 mg ascorbic acid/L, respectively.

In comparison, the inner core showed greater antioxidant activity than the cortex. In the presence of an antioxidant, the DPPH radical is converted into DPPH-H (diphenylhydrazine). The discoloration of the solution occurs due to a decrease in DPPH radicals²⁷. The DPPH assay showed the highest antioxidant activity in the whole carrot (17.60%). It was also observed that the antioxidant activity of the inner core (12.61%) was higher than that of the cortex (12.39%). Ultimately, all assays demonstrated the same trend in antioxidant activity. All antioxidant assays showed that the juice of the whole carrot had a greater antioxidant capacity compared to the cortex and inner core. These parts contributed individually, resulting in the highest antioxidant activity being exhibited by the whole carrot. Antioxidant activities across all assays also showed a strong correlation with TPC. Comparatively, the juice of the inner core demonstrated better antioxidant activity in scavenging free radicals than that of the cortex.

2. Physical, biochemical and antioxidant evaluation of mango (*Mangifera indica* L. cv Ataulfo)

Table 3 shows that the highest fat content was for the Peel fraction (2.68%) compared with pulp and peel fiber.

Table 3. Average percent (Dry basis) and standard deviations (n =3) of the nutritional components in Pulp, Peel and Fiber from peel of ripe mango Ataulfo.

Component	Pulp	Peel	Peel fiber
Water	6.92 ± 0.12	5.38 ± 0.01	8.55 ± 0.09
Protein	3.26 ± 0.24	3.57 ± 0.70	5.31 ± 0.22
Fat	1.29 ± 0.0	2.68 ± 0.02	1.38 ± 0.02
Ash	2.38 ± 0.04	3.98 ± 0.24	6.05 ± 0.04
Carbohydrates			
Total dietary fiber	10.7 ± 0.73	40.4 ± 2.71	81.0 ± 1.69
<i>Insoluble Fiber</i>	4.5 ± 0.6	21.9 ± 0.3	41.0 ± 1.4
<i>Soluble Fiber</i>	6.2 ± 0.12	18.5 ± 3.0	39.9 ± 2.3
Free sugars	73.2 ± 2.78	31.7 ± 0.49	0.94 ± 0.30
<i>Sucrose</i>	52.9 ± 2.5	20.2 ± 0.17	0.70 ± 0.15
<i>Fructose</i>	15.3 ± 0.25	8.2 ± 0.45	0.2 ± 0.04
<i>Glucose</i>	5.1 ± 0.4	3.2 ± 0.06	0.07 ± 0.02
Micronutrients			
Vitamin C (mg/100 g)	667 ± 52.6	1017 ± 32.3	ND
Vitamin A (mg/ 100 g)	44.3 ± 5.3	60.4 ± 5.2	1.72 ± 0.2
mEq. Retinol	369.4 ± 44.0	503.7 ± 43.5	14.4 ± 1.6

Source: Rocha et al. (12)

Carbohydrates were the major component, ranging from 72% to 80% across the fractions of Ataulfo mango; however, their proportion differed significantly among the pulp, peel, and isolated peel fiber, with the highest concentration found in the pulp (Figure 1).

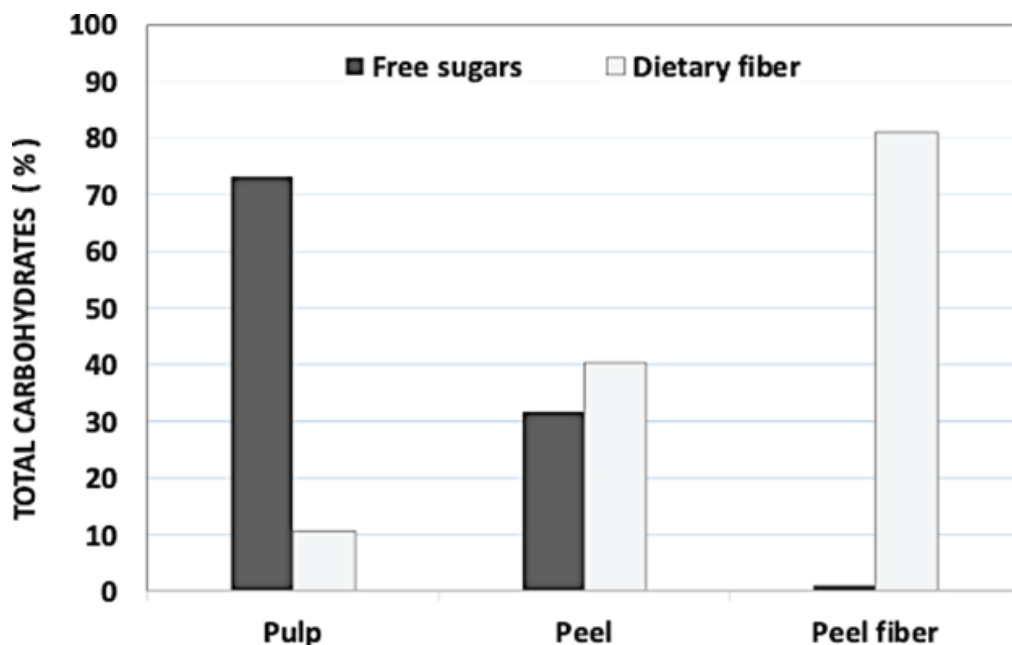


Figure 1. Dietary fiber and free sugars profile of Pulp, Peel and Fiber from peel of ripe mango Ataulfo.Source: Rocha et al. (12)

Significant differences were found among the three mango sections ($p \leq 0.05$). As expected, the dietary fiber content in the mango peel flour (MPF) at 81% was eight times higher than in the mango pulp (MP) and twice that of the mango peel. However, the proportion of insoluble to soluble dietary fiber did not vary significantly among the fractions, remaining close to a 1:1 ratio. While mango pulp is often restricted in nutritional programs due to its high sugar content, growing evidence suggests its bioactive compounds actually help prevent metabolic disorders, diabetes, and cardiovascular diseases. This creates a paradox: traditional guidelines advise limiting fructose-rich fruits to avoid risks like hepatic steatosis (fatty liver), heart disease, and cancer, yet whole mango consumption demonstrates protective, anti-inflammatory effects²⁸. The combination of dietary fiber and available sugars in fruits like mangoes gives them a low glycemic index. This higher fiber content and lower glycemic impact are directly associated with a reduction in molecular markers of inflammation. Adequate dietary fiber intake is associated with reduced blood cholesterol, a lower risk of CVD, and a healthier gut microbiota²⁹.

The ascorbic acid content was considerably high in both the peel and pulp (1,017 and 667 mg 100 g⁻¹, respectively). Although vitamin C is highly susceptible to oxidation, these high levels were preserved because both fractions were immediately frozen and freeze-dried. Significant differences ($p \leq 0.05$) in vitamin C content were found among the mango fractions; the peel contained nearly double the concentration found in the pulp, whereas the peel fiber lost this component during the solvent washing and drying processes. Regarding β -carotene content, the peel presented the highest value (60.4 mg 100 g⁻¹), followed by the pulp (44.3 mg 100 g⁻¹). Table 3 also displays these values as vitamin A retinol activity equivalents (RAE), using a conversion factor of 12 μ g of β -carotene to 1 μ g of retinol according to the Institute of Medicine (US). Ultimately, significant differences ($p \leq 0.05$) in β -carotene levels were observed across all three mango materials, with the peel exhibiting the highest content, followed by the pulp, and the mango peel fiber (MPF) containing the lowest.

Quinic and ferulic acids were the most abundant phenolic acids in the three mango sections, followed by gallic and coumaric acids; the peel contained 3,244, 2,650, 149.2, and 5.6 mg/100g, respectively (Table 4).

Table 4. Average concentrations and standard deviations (n =3) of the principal phytochemicals quantified in pulp, peel and fiber from peel of ripe mango Ataulfo expressed as mg.100 g⁻¹(Dry basis).

Component	Pulp	Peel	Mango peel fiber
Quinic acid	128.5 $\pm$ 18.4	3244.0 $\pm$ 402	263.4 $\pm$ 35.3
Ferulic acid	91.5 $\pm$ 18.4	2649.6 $\pm$ 221.6	220.2 $\pm$ 9.9
Gallic acid	5.3 $\pm$ 1.1	149.2 $\pm$ 29.2	16.2 $\pm$ 2.1
Coumaric acid	0.54 $\pm$ 0.09	5.56 $\pm$ 1.6	0.46 $\pm$ 0.05
Mangiferin	0.8 $\pm$ 0.1	1728.7 $\pm$ 213	752.1 $\pm$ 38
Quercetin	0.04 $\pm$ 0.0	4.0 $\pm$ 0.25	2.5 $\pm$ 0.26
Luteolin 7-O-glucoside	0.02 $\pm$ 0.0	0.54 $\pm$ 0.04	0.35 $\pm$ 0.07
Apigenin glucoside	0.01 $\pm$ 0.0	0.35 $\pm$ 0.05	0.18 $\pm$ 0.06
Quercetin 3-O-rhamnoside	ND	0.26 $\pm$ 0.05	0.19 $\pm$ 0.03

Source: Rocha et al. (12)

Among the flavonoids, quercetin was the most prevalent, measuring 4.0 mg/100g in the peel, 2.5 mg/100g in the mango peel fiber (MPF), and 0.04 mg/100g in the pulp. The remaining flavonoids, ordered by abundance, were luteolin 7-O-glucoside, apigenin glucoside, and quercetin 3-O-rhamnoside. Significant differences ($p \leq 0.05$) were found among the pulp, peel, and isolated peel fiber for all flavonoids except quercetin 3-O-rhamnoside, which was absent in the pulp and showed no significant variation between the peel and peel fiber. Finally, mangiferin concentrations peaked at 1,728 mg/100g in the peel, followed by 752.1 mg/100g in the MPF (Table 4).

Table 5. Overall antioxidant capacity evaluated by ORAC, FRAP and ABTS assays for pulp, peel and peel fiber of ripe mango Ataulfo

	mMol TE/ g		
	ABTS	FRAP	ORAC
Pulp	7.08 ± 1.1	98.87 ± 11.2	7.08 ± 1.7
Peel	372.9 ± 42.7	252.14 ± 16.6	347.97 ± 9.8
Peel fiber	8.5 ± 1.2	82.21 ± 10.9	9.25 ± 2.1

(TE)= Trolox equivalent, ABTS (free radical of 2,2'-azinobis-(3-ethylbenzothiazoline- 6 sulfonic acid); FRAP (ferric reducing ability of plasma); ORAC (oxygen radical absorbance capacity).

Source: Rocha et al. (12)

Mango peel showed significantly higher antioxidant activity ($p \leq 0.05$) than the pulp, with ABTS, FRAP, and ORAC values of 372.9, 252.1, and 348 mMol TE/g, respectively (Table 5). Conversely, no significant differences were found between pulp and peel fiber across all three assays; pulp values reached 7.1 mMol TE/g for both ORAC and ABTS, while peel fiber yielded 8.5 and 9.2 mMol TE/g. Additionally, FRAP assays revealed higher TEAC values overall, though the differences between the pulp and peel remained statistically insignificant. The antioxidant activity and in vitro results confirmed that mango peel possesses superior functional potential compared to mango pulp and peel fiber. These findings align with previous data comparing nine mango varieties³⁰. Additionally, the findings further support the exceptional

nutraceutical potential of mango peel, which is driven by its superior antioxidant capacity.

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