

## EVALUATION OF THE PHYTOCHEMICAL COMPOSITION, ANTIOXIDANT CONSTITUENTS, NUTRITIONAL AND ANTI-NUTRITIONAL QUALITIES OF AVOCADO, CUCUMBER AND DATE FRUITS

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### ABSTRACT

Fruits constitute an essential component of human nutrition, providing health benefits and potentially mitigating various ailments. This study investigated the nutritional and anti-nutritional qualities, antioxidant activity, and phytochemical contents of three commercially important fruits: Avocado, Cucumber and Date. Standard methods were employed for proximate analysis, mineral composition determination and phytochemical assays. Significant variations were observed in nutritional composition among the three fruits: Avocado exhibited the highest carbohydrate content of  $10.38 \pm 0.01\%$ . Crude protein and fibre contents were also highest in Avocado at  $2.21 \pm 0.02\%$  and  $2.32 \pm 0.03\%$ , respectively. Antioxidant activities, assessed via DPPH and hydrogen peroxide ( $H_2O_2$ ), were also highest in Avocado ( $88.98 \pm 0.19\%$  and  $78.90 \pm 0.32\%$ , respectively) followed by Cucumber ( $87.99 \pm 0.69\%$  and  $76.36 \pm 0.22\%$ , respectively). Date had the least antioxidant activity at  $68.54 \pm 0.39\%$  and  $59.21 \pm 0.06\%$ . Anti-nutritional factors were minimal, with negligible levels of oxalates and phytates while tannins were not detected in all the fruits. Phytochemicals detected in the three fruits were most abundant in flavonoids and alkaloids and were within the range of  $0.22 \pm 0.001$  to  $0.25 \pm 0.001\%$ . Glycosides and total phenol contents were highest in Date. Saponin content was similar in concentration in all the three fruits, while chalcones were not detected in any of the fruits. Date had the highest amount of the minerals, with the potassium concentration of  $4320.94 \pm 0.62$  mg/kg, sodium ( $1619.29 \pm 0.84$  mg/kg), and calcium ( $530.47 \pm 0.56$  mg/kg). The fruits are rich in valuable complementary nutrients which are beneficial to humans.

**Keywords:** proximate analysis; plant-derived supplements; health benefits; antioxidant activity; minerals.

## INTRODUCTION

Fruits are primary sources of essential compounds that play crucial roles in human health, growth, and development, particularly in disease prevention. Recent trends indicate increasing consumer awareness of the health-promoting potentials of plant-derived supplements from fruits and vegetables (Sodimu *et al.*, 2020). Of the approximately 200,000 known phytochemicals, about 20,000 have been identified in fruits, vegetables and grains (Patra, 2012). Epidemiological studies have demonstrated that high consumption of fruits and vegetables correlates with reduced incidence of diseases such as cancer and cardiovascular disorders. These phytochemicals neutralize harmful free radicals produced in the body due to environmental stress. Anti-nutritional factors are compounds that interfere with critical metabolic pathways, particularly digestion, reducing the bioavailability of essential nutrients including proteins, vitamins and minerals (Philip *et al.*, 2018). Despite this concern, the demand for vegetables has increased due to their perceived health benefits (Tegen *et al.*, 2021).

Avocado (*Persea americana* Mill) is a principal tropical fruit; Date (*Phoenix dactylifera* L.) is reported to be a wild tropical fruit (Ding, 2017); Cucumber (*Cucumis sativus* L.) is a vegetable fruit. These three commercially-significant fruits hold immense nutritional and medicinal values across various cultures. While each belongs to different botanical families, they share common health-promoting properties, including rich antioxidant contents, essential vitamins, and dietary fibre (Mytton *et al.*, 2014). Avocado belongs to the *Lauraceae* family, and Genus *Persea*, originated from Central America and has become an integral part of Nigerian cuisine. Avocado is a significant source of

phytochemicals and nutrients which have been associated with reduced risks of cardiovascular diseases, hypertension and improvement of lipid profile (Monge *et al.*, 2023; Okobi *et al.*, 2023). It also has hypoglycemic, antimicrobial and antiviral properties (Al-Hammood *et al.* 2024; Setyawan *et al.*, 2021). The seed has various applications in traditional medicine, including treatments for dysentery and ulcers, cholesterol reduction and cosmetic uses (Okafor *et al.*, 2005). The fruit's pulp has been reported (Yahia and Woolf, 2011) to contain 1.0-3.0 % protein, 0.80-4.80 % carbohydrates, 1.40-3.00 % dietary fibre composed of insoluble fibres at 70% and soluble fibres at 30%, vitamins and minerals (0.80-1.50 %) and high lipid content (12.0-24.0 %), mostly unsaturated fatty acids. These constituents play significant roles in the improvement of health of its consumers. Cucumber (*Cucumis sativus* L.), a member of the *Cucurbitaceae* family, is widely cultivated globally, alongside other economically important crops such as melon, watermelon, and squash (Vivek *et al.*, 2017). Its high nutritional value comprising proteins, fats, carbohydrates, and dietary fibre, contributes to its widespread consumption. *C. sativus* contains essential vitamins and antioxidants beneficial to human health (Uthpala *et al.*, 2020). In traditional medicine, it has been used to treat jaundice, bleeding disorders, and anuria, while its seeds are considered highly nutritious (Saeedi, 2020).

These fruits are not only staples in global diets but also play crucial roles in traditional medicine, offering benefits such as cardiovascular protection, digestive health support, and immune system enhancement (Mytton *et al.*, 2014). Their wide-ranging applications highlight their importance in both modern and traditional healthcare systems. Subsequently, healthcare delivery has been signifi-

cantly enhanced by integrating phyto-medicine and traditional medicine in many regions, particularly in Asia, Africa, and the Middle East. Given the importance of these plants in conventional medicine, there is a critical need to investigate the nutritional and anti-nutritional qualities, antioxidants activity and phytochemical contents of the three fruits: Avocado, Date, and Cucumber. This will enable an understanding of the qualities of the bioactive compounds in their fruits which could be responsible for their health benefits and possibly infer from the results of the study if consumption of the three fruits combined will improve the quality of health of its consumers better than taking solely. The optimal utilization of the fruits in both dietary and medicinal applications could also be deduced from this study.

## MATERIALS AND METHODS

### Sample Collection, Identification and Preparation

Fresh healthy samples of Avocado (*Persea americana*); Date (*Phoenix dactylifera*) and Cucumber (*Cucumis sativus*) were obtained from Obada market in Ijebu-Igbo, Ogun State, Nigeria and were identified at the Department of Plant Sciences, Olabisi Onabanjo University, Ago-Iwoye, Nigeria. The samples were transported to the Central Research Laboratory of The Polytechnic Ibadan, where they were washed with deionized water, sectioned, and stored in a controlled environment prior to analysis.

### Phytochemical Analysis

Secondary metabolites were quantified using standardized laboratory procedures. Total phenolic content was determined spectrophotometrically following Singleton *et al.* (1999). Flavonoid content was assessed using the method described by Boham and

Kocipai-Abyazan as reported by Shraim *et al.* (2021), alkaloid content was determined by the method of Harborne as reported by Ganan *et al.* (2023), and saponin content following Obadoni and Ochuko (2001).

### Proximate Analysis

Moisture, ash, fibre, and fat contents were determined according to AOAC (2005) methods. Crude protein content was calculated by converting percentage nitrogen, determined using the micro-Kjeldahl method (Pearson, 1976), using a conversion factor of 6.25. All analyses were performed in triplicate.

### Mineral Analysis

Mineral content was determined following the wet digestion (AOAC, 2000) method. 0.5 g of ground sample of each fruit was heated in a furnace at 550 °C with 5 ml concentrated HNO<sub>3</sub> and 5 mL 30% hydrogen peroxide for approximately 5 hours to achieve complete digestion. The digested samples were cooled, filtered sequentially through Whatman No. 45 and 0.45 µm Millipore filter papers, and diluted to 25 mL with deionized water. Calcium, magnesium and manganese were quantified using an Atomic Absorption Spectrophotometer (Buck Scientific AAS Model 210). Sodium and potassium were determined using flame photometry. Phosphorus content was assayed through phosphomolybdate by a spectrophotometric method (Shyla *et al.*, 2011).

### Anti-nutritional Analysis

Total oxalate was determined following Day and Underwood (1986). One gram of ground sample was mixed with 75 mL of 15 N tetraoxosulphate (vi) (H<sub>2</sub>SO<sub>4</sub>), stirred intermittently for 1 hour, and filtered. The filtrate (25 mL) was titrated against 0.1 N potassium tetraoxomanganate (vii) (KMnO<sub>4</sub>)

until a persistent faint pink color was observed for 30 seconds. Phytate content was assessed using the method of Reddy and Love (1999). 4 g of the ground sample was soaked in 100 mL of 2 % HCl for 5 hours and filtered. The filtrate (25 mL) was combined with 5 mL 0.3 % ammonium thiocyanate and titrated with iron (III) chloride until a persistent brownish-yellow color was observed for 5 minutes. Tannin content was determined spectrophotometrically at 760 nm following Trease and Evans as reported by Salamah *et al.* (2019), using Folin-Dennis reagent in an alkaline medium.

#### Antioxidant Activity Analysis

**DPPH Radical Scavenging Assay:** Free radical scavenging activity was evaluated using 1,1-diphenyl-2-picrylhydrazyl (DPPH) following established protocols (Brand-Williams *et al.*, 1995; Bondet *et al.*, 1997; Sanchez-Moreno *et al.*, 1998). Fruit extract supernatant (1000  $\mu$ L) was combined with 1000  $\mu$ L of 0.4 M DPPH in ethanol (0.004% w/v). After 30 minutes of incubation in darkness, absorbance was measured at 517 nm. Radical scavenging activity was calculated as inhibition percentage using the following equation:

$$\text{Inhibition (\%)} = \frac{(\text{ABS}_{\text{DPPH}} - \text{ABS}_{\text{EXTRACT}}) \times 100}{\text{ABS}_{\text{DPPH}}}$$

where  $\text{ABS}_{\text{DPPH}}$  represents the absorbance of DPPH radical and  $\text{ABS}_{\text{EXTRACT}}$  repre-

sents the absorbance of fruit extract, both at 517 nm.

#### Hydrogen Peroxide Scavenging Activity:

Antioxidant activity was also assessed through hydrogen peroxide scavenging following the method described by Kumari and Parida (2016).

#### Statistical Analysis

All results are presented as mean  $\pm$  standard error of the mean. Significant differences were determined at  $P \leq 0.05$ .

## RESULTS

#### Phytochemical Composition

Flavonoids and alkaloids contents were the most abundant compounds in these fruits with approximately 0.22-0.25% (Table 1). Alkaloid content was highest in Date at a value of  $0.25 \pm 0.001\%$  while Avocado and Cucumber had almost similar amounts of alkaloid content at  $0.23 \pm 0.002\%$  and  $0.22 \pm 0.001\%$ , respectively. Same value of 0.25% flavonoid was from both Avocado and Date, with Cucumber also at par with them ( $0.23 \pm 0.002\%$ ). Glycosides and total phenol contents were highest from Date ( $0.12 \pm 0.001$  and  $0.15 \pm 0.003$ , respectively). Saponin content was found to be almost same in concentration in all the fruits, ranging from  $0.12 \pm 0.002$  to  $0.13 \pm 0.002$  while Chalcones were not detected in any of the fruits (Table 1).

**Table 1:** Phytochemical composition of Avocado, Cucumber and Date

Compound (%)	Avocado	Cucumber	Date
Alkaloid	$0.23 \pm 0.002$	$0.22 \pm 0.001$	$0.25 \pm 0.001$
Glycoside	$0.11 \pm 0.001$	$0.09 \pm 0.002$	$0.12 \pm 0.001$
Flavonoid	$0.25 \pm 0.002$	$0.23 \pm 0.002$	$0.25 \pm 0.003$
Total Phenol	$0.13 \pm 0.001$	$0.13 \pm 0.002$	$0.15 \pm 0.003$
Saponin	$0.13 \pm 0.001$	$0.12 \pm 0.002$	$0.13 \pm 0.002$
Chalcones	ND	ND	ND

ND: Not detected

**Anti-nutritional Factors**

Anti-nutritional factors were minimal in all samples (Table 2). Phytate was present in trace amounts in Avocado and Cucumber while oxalate was only found in Avocado at

trace amounts and was not detected in Date and Cucumber. Tannin was not detected in any of the fruits. The Date was free of the three antinutrients determined in this study.

**Table 2:** Anti-nutritional content of Avocado, Cucumber, and Date fruits

Compound	Avocado (%)	Cucumber (%)	Date (%)
Tannin	ND	ND	ND
Phytate	$0.01 \pm 0.001$	$0.01 \pm 0.001$	ND
Oxalate	$0.01 \pm 0.001$	ND	ND

ND: Not detected

**Proximate Composition**

Proximate analysis revealed significant variations among the three fruits (Table 3). Moisture content was highest from Cucumber ( $93.67 \pm 0.21\%$ ), followed by Date ( $86.27 \pm 0.12\%$ ) and Avocado ( $82.39 \pm 0.03\%$ ). Conversely, Avocado had the high-

est levels of crude protein ( $2.21 \pm 0.02\%$ ), crude fat ( $0.81 \pm 0.03\%$ ), crude fibre ( $2.32 \pm 0.03\%$ ), and total ash ( $1.89 \pm 0.03\%$ ). The moisture contents revealed the highest value  $93.67 \pm 0.21\%$  in Cucumber although Avocado and Date also had high moisture contents (Table 3).

**Table 3:** Proximate composition of Avocado, Cucumber, and Date fruits

Component	Avocado (%)	Cucumber (%)	Date (%)
Crude Protein	$2.21 \pm 0.02$	$0.68 \pm 0.04$	$0.90 \pm 0.01$
Crude Fat	$0.81 \pm 0.03$	$0.20 \pm 0.02$	$0.22 \pm 0.02$
Crude Fibre	$2.32 \pm 0.03$	$2.04 \pm 0.02$	$1.61 \pm 0.07$
Total Ash	$1.89 \pm 0.03$	$1.17 \pm 0.02$	$1.33 \pm 0.04$
Moisture	$82.39 \pm 0.03$	$93.67 \pm 0.21$	$86.27 \pm 0.12$
Dry Matter	$17.61 \pm 0.08$	$6.33 \pm 0.21$	$13.73 \pm 0.12$
Carbohydrate	$10.38 \pm 0.01$	$2.24 \pm 0.15$	$9.67 \pm 0.01$

**Mineral Composition**

There were substantial variations in the mineral analysis among the fruits (Table 4). Date exhibited the highest levels of most minerals, notably Potassium ( $4320.94 \pm 0.62$  mg/kg), Sodium ( $1619.29 \pm 0.84$  mg/kg), Calcium ( $530.47 \pm 0.56$  mg/kg), Manganese ( $3.86 \pm 0.04$  mg/kg), Magnesium ( $109.76 \pm$

$0.45$  mg/kg) and Phosphorus ( $71.98 \pm 0.00$  mg/kg). Avocado showed a reduced amount of minerals compared to Date though the Iron and Zinc contents were highest at values of  $18.82 \pm 0.23$  mg/kg and  $6.49 \pm 0.06$  mg/kg, respectively while Cucumber was noted to have the least minerals (Table 4).

**Table 4:** Mineral composition of Avocado, Cucumber and Date fruits

Mineral	Avocado (mg/kg)	Cucumber (mg/kg)	Date (mg/kg)
Calcium	76.66 ± 0.47	29.05 ± 0.10	530.47 ± 0.56
Magnesium	54.36 ± 0.09	46.94 ± 0.11	109.76 ± 0.45
Manganese	2.09 ± 0.06	0.68 ± 0.02	3.86 ± 0.04
Iron	18.82 ± 0.23	15.26 ± 0.14	16.32 ± 0.22
Zinc	6.49 ± 0.06	2.90 ± 0.15	3.52 ± 0.03
Sodium	199.77±1.57	118.32 ± 1.02	1619.29 ± 0.84
Potassium	1304.56 ± 0.89	631.45 ± 1.03	4320.94 ± 0.62
Phosphorus	12.07 ± 0.00	0.63 ± 0.00	71.98 ± 0.00

Values are Mean ± SEM, n = 5

### Antioxidant Activity

Antioxidant activity was assessed using DPPH and hydrogen peroxide (H<sub>2</sub>O<sub>2</sub>) scavenging assays (Table 5). Avocado had the highest antioxidant activity in both as-

says (DPPH: 88.98 ± 0.19%; H<sub>2</sub>O<sub>2</sub>: 78.90 ± 0.32%), followed closely by Cucumber (DPPH: 87.99 ± 0.69%; H<sub>2</sub>O<sub>2</sub>: 76.36 ± 0.22%). Date showed lower antioxidant activity in both assays (Table 5).

**Table 5:** Antioxidant activity of Avocado, Cucumber, and Date fruits

Sample	DPPH (%)	H <sub>2</sub> O <sub>2</sub> (%)
Avocado	88.98 ± 0.19	78.90 ± 0.32
Cucumber	87.99 ± 0.69	76.36 ± 0.22
Date	68.54 ± 0.39	59.21 ± 0.06

## DISCUSSION

Phytochemicals have been reported to promote growth, maintain good health, and mitigate the development of diseases in humans (Chukwuebuka and Chinenye, 2015). This study revealed the presence of phytochemicals such as alkaloids, glycosides, saponins, and phenols in the three fruits - Avocado (*Persea americana*), Cucumber (*Cucumis sativus*) and Date (*Phoenix dactylifera*). The presence of these bioactive compounds supports the therapeutic use of these fruits in managing oxidative stress. It highlights their anti-inflammatory and anti-tumorigenic potentials, consistent with reports on sea Cucumber (Janakiram *et al.*, 2015).

Alkaloid concentrations, among all phytochemical classes analyzed were in the as-

scending trend of Cucumber, Avocado and Date. The Date had the highest concentration of alkaloid, which was comparatively higher than what was reported by Shaba *et al.* (2015). The alkaloid content of the Avocado observed in this study was higher than the value reported by Anhwange *et al.* (2014). The alkaloid content of the Cucumber in this study was noted to be almost the same value as reported by Agatemor *et al.* (2018). This similarity in content is noteworthy despite the difference in geographical origin of the sources. Since the alkaloids are known to exhibit various pharmacological effects, including antibiotic and antihypertensive properties (Sofowora, 1993), the fruits could thus be consumed to take care of infections and at the same time control high blood pressure.

The saponin contents obtained for the fruits under study were generally lower than the values reported for Date from Minna (Shaba *et al.*, 2015). Saponin possesses antibiotic effects against fungi as observed in the works of Otuewu *et al.* (2017) and Siti *et al.* (2018). Consequently, consumption of appreciable amounts of the fruits could help fight against fungal infections.

The flavonoids were present in moderate concentrations across the samples, which is a major phytochemical in plants aside total phenolics and alkaloids as was also reported by Al-Tohamy *et al.* (2018). The presence of key phytochemicals, such as alkaloids, saponins, and flavonoids, supports the traditional use of these fruits in managing oxidative stress-induced ailments and suggests potential health benefits, including anti-inflammatory, antimicrobial, and antihypertensive effects.

Anti-nutrients, particularly phytate and oxalate, are naturally occurring compounds in plants that hinder nutrient absorption in humans. Phytates form insoluble complexes with mineral elements, reducing their bioavailability (Mwanri *et al.*, 2018). The phytate contents of the Avocado and Cucumber were in trace amounts in this study and these were substantially lower in value compared to the values reported by Bello *et al.* (2014) for Cucumber and Phillippy and Wyatt (2001) for Avocado. With the oxalate and tannin values being too small to quantify and thus reported as not determined in almost all the fruits in this study, significant oxalate content was found in the Cucumber from Akure in Ondo state, Nigeria (Bello *et al.*, 2014), although lower values of phytate and oxalate were also stated in the work of Anhwange *et al.* (2014). The low concentrations of the anti-nutritional factors in the

Cucumber and Avocado and the fact that they were not determined in Dates in this study suggested that these fruits may not pose significant health hazards and may not require extensive post-harvest processing.

The proximate composition values of the three fruits in this study align with previous findings by Olayinka and Etejere (2018) and Bello *et al.* (2014), and were consistent with recent studies by Rasyid *et al.* (2020) who reported similar moisture contents for sea Cucumber cultured in Bali, Indonesia. Imoisi and Michael (2020) and Duarte *et al.* (2016) found lower moisture contents in Avocado pulp, suggesting potential varietal or geographical influences on fruit composition. Ash content values for these fruits exceeded the value reported for Cucumber pulp by Olayinka & Etejere (2018) but corroborate the values reported by Najjar *et al.* (2021) for various Date cultivars. The higher ash content suggests that these fruits are good sources of minerals.

The fat contents in the studied fruits were low, with the Avocado's fat content being the highest. We however, noted that the value reported for Cucumber is in tandem with the work of Olayinka & Etejere (2018) while Uba *et al.* (2015) reported a lower value in the three different Dates studied and a higher fat content was also found in the Dates from Minna market (Shaba *et al.*, 2015). The works of Watnick (2009) and Blakey *et al.* (2012) reported higher fat content in Avocado varieties. This difference could possibly be due to different ripening stages or cultivation conditions. Meanwhile, the low-fat content reported in our study supports the potential use of the fruits in weight-reduction diets, as also suggested by meta-analyses of fruit consumption and weight management (Mytton *et al.*, 2014).

As documented, these fruits have low protein content, with Avocado containing the highest level, followed by Cucumber and then Date, in increasing order. But, other studies had reported higher values for Cucumber (Bello et al., 2014), for Date (Shaba et al., 2015) and for Avocado pulp (Sores and Ito, 2000). The findings of Ogunbanjo et al. (2016) have reported higher protein content in some novel Cucumber cultivars, and Rolnik and Olas (2020) reported high protein contents in various cucurbitaceae fruits. It is therefore necessary to find a breeding program to enhance the nutritional value of these fruits.

The samples were not so rich in carbohydrates, as low values were noted in the Date, Cucumber and Avocado fruits. These carbohydrate contents are contrary to the reports of Shaba et al. (2015) for Date fruit, and Bello et al. (2014) for Cucumber, while a wider range was noted in Avocado fruit (DFTQC, 2012). The relatively low carbohydrate content, combined with the low fat content, supports the suitability of these fruits for diabetic and hypertensive individuals, as confirmed by the clinical studies of Parvin et al. (2015) and Ogunbanjo et al. (2016). Fibre contents were comparable to those reported for Avocado pulp by Soares & Ito (2000), Cucumber by Bello et al. (2014), and Date by Shaba et al. (2015). The observed fibre levels support potential benefits for diabetes management, consistent with recent meta-analyses linking fruit fibre intake to improved glycemic control (Silva et al., 2013). The proximate analysis revealed that the fruits are low in fat and carbohydrates (particularly Cucumber), which makes them suitable for weight management in individuals with diabetes or hypertension. Their high moisture content also highlights their hydrating properties, while

the fibre levels indicated a potential role in supporting digestive health and glycemic control.

Mineral analysis revealed diverse profiles across the studied fruits. Calcium content varied significantly for Avocado, Cucumber, and Date. The high calcium content in Dates aligns with findings by Dghaim et al. (2021) in premium Date varieties from the United Arab Emirates, although the Manganese, Iron and Sodium contents were comparatively lower than the values reported in this study. However, we attributed the differences noted to variation in the sources of this fruit. The results of the mineral analysis (Na, K, Zn and Ca) of the Cucumber from the South-Eastern and North-Central Regions of Nigeria, carried out by Okeke et al. (2021) were also observed to be lower in mean range values of these minerals compared to the results obtained in this study. In a similar vein, Aghili et al. (2011) and Venkataramani et al. (2023) reported lower magnesium contents in greenhouse-grown Cucumbers compared to the results obtained in this study.

Manganese being an essential mineral, is usually found in low concentrations and its main source of entry into the body is through diets, corroborating this claim is the low concentrations of this trace metal found in all the three fruits (Cucumber, Avocado and Date) in this study. However, higher concentrations have been found in the Date palm fruits from the United Arab Emirates as reported by Dghaim et al. (2021). It has been noted that low intake of potassium is a pointer to an increased risk of developing high blood pressure, especially with the consumption of food containing high salt concentration (McDonough et al., 2017). The highest potassium and sodium contents were noted in Date compared to the other two

fruits - Avocado and Cucumber. The Avocado's Potassium and Sodium contents determined in this study were noted to be higher than the values reported by Watnick (2009) and Dreher and Davenport (2013).

The same trend was observed for magnesium in Avocado when compared with its sodium and potassium levels reported in this study. Similarly, white and green Cucumbers were reported to contain higher potassium and sodium contents (Sambou et al., 2023). The concentrations of potassium in the three fruits were consistently higher than their sodium contents, which could significantly help mitigate health issues such as high blood pressure and related cardiovascular problems when regularly consumed. Deficiencies of iron and zinc are also well recognized as indicators of micronutrient malnutrition. Thus, insufficient intake of iron could lead to disorders which include most importantly iron deficiency anemia (Bathla and Arora, 2022), cognitive dysfunction (Jáuregui-Lobera, 2014), growth and development delays in youngsters (Georgieff, 2017) and disturbance of iron metabolism which eventually causes dysregulation of the immune system (Cronin *et al.*, 2019). The Recommended Dietary Allowance (RDA) of Iron for men in various categories and postmenopausal women is 8 mg/day while premenopausal women's RDA is 18 mg/day (Food and Nutrition Board, Institute of Medicine, 2001). At the same time, the Zinc's RDA for women is 8 mg/d and for men is 11 mg/d (Food and Nutrition Board, Institute of Medicine, 2001). The World Health Organization labeled Zn as a major contributing factor to various diseases. Thus, its pivotal role in maintaining the normal functioning of key components of the innate immune system cannot be overstated. The high values of

the Iron and Zinc contents obtained in the three fruits under study were higher than the contents in fruits and vegetables (apple, banana, carrot, Cucumber, garlic, grape, green peas, irish potato, lemon, lettuce, okra, orange, onion, pawpaw, pepper, pineapple, spinach, sweet potato, tomato and watermelon) found in the north central region of Nigeria (Iyaka, 2007).

The mineral analysis results also demonstrated that the fruits are rich in essential nutrients like calcium, magnesium, and potassium, with Date showing particularly high levels of calcium and iron, which are crucial for bone health and oxygen transport, respectively. The low levels of anti-nutritional factors such as phytate and oxalate further enhance the nutritional value of these fruits, suggesting minimal health risks associated with their consumption.

## CONCLUSION

Avocado, Cucumber and Date possess significant nutritional and phytochemical properties that could contribute to overall health and well-being. The three fruits are good sources of these micronutrients, which can compensate for the disorders associated with Iron and Zinc deficiencies. This may eventually improve the quality of life and reduce the healthcare costs of managing the disorders.

Future studies should focus on exploring the bioavailability of these nutrients, their potential synergistic effects when consumed in combination and their application in clinical settings for disease management.

## REFERENCES

Aghili, F., Khoshgoftarmanesh, A. H., Afyuni, M. and Mobli, M. 2011. Mineral and Ascorbic Acid Concentrations of

- Greenhouse- and Field-Grown Vegetables: Implications for Human Health. *International Journal of Vegetable Science* 18(1): 64–77.
- Agatemor, U. M. M., Nwodo, O. F. C., & Anosike, C. A.** 2018. Phytochemical and proximate composition of cucumber (*Cucumis sativus*) fruit from Nsukka, Nigeria. *African Journal of Biotechnology* 17(38): 1215-1219.
- Al-Hammood, O., Oraibi, A. G., Al-Rajhi, S. H. and Kadhom, M.** 2024. A comparative study of the Anti-Diabetic effects of avocado seed extracts and biosynthesized silver nanoparticles in Alloxan-Induced diabetic Albino mice. *Results in Chemistry* 12: 101895.
- Al-Tohamy, R., Ali, S. S., Saad-Allah, K., Fareed, M., Ali, A., El-Badry, A. and Rupani, P. F.** 2018. Phytochemical analysis and assessment of antioxidant and antimicrobial activities of some medicinal plant species from Egyptian flora. *Journal of Applied Biomedicine* 16(4): 289-300.
- Anhwange, B. A., Tyohemba, R. L., Tukura, B. W. and Ogah., P.** 2014. “Screening of Some Indigenous Wild Fruits for Anti-Nutritional Factors”. *Journal of Scientific Research and Reports* 5 (3): 220-227.
- AOAC** 2000. Official Methods of Analysis. 17th Edition, The Association of Official Analytical Chemists, Gaithersburg, MD, USA. Methods 925.10, 65.17, 974.24, 992.16.
- AOAC** 2005 Official method of Analysis. 18th Edition, Association of Official Analytical Chemists, Washington DC, Method 935.14 and 992.24.
- Bathla, S. and Arora, S.** 2022. Prevalence and approaches to manage iron deficiency anemia (IDA). *Critical Reviews in Food Science and Nutrition* 62(32): 8815-8828.
- Bello, M. O., Owoeye, G., Abdul Hamed, M. and Yekeen, T. A.** 2014. Characterization of Gourd Fruits (Cucurbitaceae) for Dietary Values and Anti Nutrient Constituents. *Research Journal of Pharmaceutical, Biological and Chemical Sciences (RJPBCS)*, 5(4): 416-424.
- Blakey, R. J., Tesfay, S. Z., Bertling, I., and Bower, J. P.** 2012. Changes in sugars, total protein and oil in ‘Hass’ avocado (*Persea americana* Mill.) fruit during ripening. *The Journal of Horticultural Science and Biotechnology* 87 (4):381–387.
- Bondet, V., Brand-Williams, W. and Berset, C.** 1997. Kinetics and Mechanisms of Antioxidant Activity Using the DPPH Free Radical Method. *LWT-Food Science and Technology* 30: 609-615.
- Brand-Williams, W., Cuvelier, M.E. and Berset, C.L.W.T.** 1995. Use of a Free Radical Method to Evaluate Antioxidant Activity. *LWT-Food Science and Technology* 28: 25-30.
- Chukwuebuka, E. and Chinenye, J. I.** 2015. Biological functions and anti-nutritional effects of phytochemicals in the living system. *Journal of Pharmacy and Biological Sciences*. 10 (2): 10-19.
- Cronin, S. J. F., Woolf, C. J., Weiss, G. and Penninger, J. M.** 2019. The Role of Iron Regulation in Immunometabolism and Immune-Related Disease. *Frontiers in Molecular Biosciences* 6: 116.
- Day, R. A. and Underwood, A. L.** 1986.

- Quantitative analysis. 5th ed. Prentice Hall Publication. 701 pp.
- Dghaim, R., Hammami, Z., Al Ghali, R., Smail, L. and Haroun, D.** 2021. The Mineral Composition of Date Palm Fruits (*Phoenix dactylifera* L.) under Low to High Salinity Irrigation. *Molecules* (Basel, Switzerland), 26(23): 7361.
- Ding, P.** Tropical fruits. In Encyclopedia of Applied Plant Sciences; Thomas, B., Murray, B.G., Murphy, D.J., Eds.; Academic Press: Oxford, UK, 2017; pp. 431–434.
- Dreher, M. L. and Davenport, A. J.** 2013. Hass Avocado Composition and Potential Health Effects. *Critical Reviews in Food Science and Nutrition* 53(7):738-750.
- Duarte, P. F. Chaves, M. A. Borges, C. D. and Mendonça, C. R. B.** 2016. Avocado: Characteristics, health benefits and uses. *Ciência Rural* 46(4): 747-754.
- Ganan, J., Martinez-Garcia, G., Morante-Zarcelero, S., Perez-Quintanilla, D. and Sierra, I.** 2023. Nanomaterials-modified electrochemical sensors for sensitive determination of alkaloids: Recent trends in the application to biological, pharmaceutical and agri-food samples. *Microchemical Journal* 184: 108136.
- Georgieff, M. K.** 2017. Iron assessment to protect the developing brain. *American Journal of Clinical Nutrition* 106:1588S-93S.
- Imoisi, C. and Michael, U.** 2020. Comparative Physicochemical and Proximate Analyses of Different Extracts of *Persea americana*. *Journal of Chemical Society of Nigeria* 45(6): 1139- 1146.
- Iyaka, Y. A.** 2007. Concentration of Cu and Zn in some fruits and vegetables commonly available in the north-central zone of Nigeria. *Electronic Journal of Environmental, Agricultural and Food Chemistry* 6 (6): 2150-2154.
- Janakiram, N. B., Mohammed A., Rao C. V.** 2015. Sea Cucumbers Metabolites as Potent Anti-Cancer Agents. *Marine Drugs* 13 (5):2909-2923.
- Jáuregui-Lobera, I.** 2014. Iron deficiency and cognitive functions. *Neuropsychiatric Disease and Treatment* 10: 2087–2095.
- Kumari, A. and Parida, A. K.** 2016. Metabolite profiling of the leaf extract reveals the antioxidant and nutraceuticals potential of the halophyte *Salvadora persica*. *Royal Society of Chemistry Advances* 6: 51629–51641.
- McDonough, A. A., Veiras, L. C., Guevara, C. A., & Ralph, D. L.** 2017. Cardiovascular benefits associated with higher dietary K<sup>+</sup> vs. lower dietary Na<sup>+</sup>: evidence from population and mechanistic studies. *American Journal of Physiology, Endocrinology and Metabolism* 312(4): E348–E356.
- Monge, A., Stern, D., Cortés-Valencia, A., Catzín-Kuhlmann, A., Lajous, M. and Denova-Gutiérrez, E.** 2023. Avocado consumption is associated with a reduction in hypertension incidence in Mexican women. *British Journal of Nutrition* 129(11): 1976–1983.
- Mwanri, A. W., Mamboleo, T. F., Msuya, J. M. and Gowele, V. F.** 2018. Oxalate, phytate and nitrate content in African nightshade, spider plant and amaranths at different stages of maturity. *African Journal of Food Science* 12 (11): 316–322.

- Mytton, O. T., Nnoaham, K., Eyles, H., Scarborough, P., and Mhurchu, C. N.** 2014. Systematic review and meta-analysis of the effect of increased vegetable and fruit consumption on body weight and energy intake. *BMC Public Health*, 14(1): 886.
- Najjar, Z., Kizhakkayil, J., Shakoor, H., Platat, C., Stathopoulos, C. and Ranasinghe, M.** 2022. Antioxidant potential of cookies formulated with date seed powder. *Foods* 11(3): 448.
- Obadoni, B. O. and Ochuko, P. O.** 2001. Phytochemical Studies and Comparative Efficacy of the Crude Extracts of Some Homeostatic Plants in Edo and Delta States of Nigeria. *Global Journal of Pure and Applied Science* 8: 203-208.
- Ogunbanjo, O. R., Awotoye, O. O., Jayeoba, F. M., and Jeminiwa, S. M.** 2016. Nutritional Analysis of Selected Cucurbitaceae Species. *Universal Journal of Plant Science*. 4. 1-3.
- Okafor, J.C., Arazu, B.C., Ibusu J., Nsofor M. and Okolo A.N.** 2005. Checklist of medicinal plants of Nigeria and their uses, James Enugu Nigeria, 1-97.
- Okeke, H., Okeke, O., Nwanya, K., Ofor, C. and Aniobi, C.** 2021. Comparative Assessment of the Proximate and Mineral Composition of *Cucumis sativus* L. and *Solanum aethiopicum* L. Fruit Samples Grown in South-Eastern and North Central Regions of Nigeria. *Natural Resources* 12: 237-249.
- Okobi, O. E., Odoma, V. A., Okunromade, O., Louise-Oluwasanmi, O., Itua, B., Ndubuisi, C., Ogbeifun, O. E., Nwatomole, B. C., Elimihele, T. A., Adekunle, J. O., Adekunle, A. A., Obi, C. B. and Evbayekha, E. O.** 2023. Effect of Avocado Consumption on Risk Factors of Cardiovascular Diseases: A Systematic Review and Meta-Analysis. *Cureus*, 15(6): e41189.
- Olayinka, B. U. and Etejere, E. O.** 2018. Proximate and Chemical Compositions of Watermelon (*Citrullus lanatus* (Thunb.) Matsum and Nakai cv Red and Cucumber (*Cucumis sativus* L. cv Pipino). *International Food Research Journal* 25(3): 1060-1066.
- Otuewu, O. O., Akindele, S. T., Ajayi, O. A., Alawode, B.O., Sunmola, N.O., and Amisu Tugbogbo A.** 2017. Evaluation of physiochemical and antimicrobial activities of *Adansonia digitata* against some clinical isolates. *International Journal of Science Yaba Technology* 5(1): 54-60.
- Parvin, S., Easmin, D. and Sheikh, A., Biswas, M. and Sharma, S., Sharma, D., Rabbani, Md., Jahan, S. and Islam, A., Roy, N. and Shariar, S.** 2015. Nutritional Analysis of Date Fruits (*Phoenix dactylifera* L.) in Perspective of Bangladesh. *American Journal of Life Sciences* 3(4): 274-278.
- Patra, A. K.** 2012. Dietary Phytochemicals and Microbes. ISBN 978-94-007-3925-3 ISBN. 978-94-007-3926-0 (eBook).
- Pearson, D. A.** 1976. Chemical analysis of foods. 7th Edition. Church Hill Livingstone, New York. 1: 422-511.
- Philip, W. A., Jacob, K. and David, A.** 2018. Anti-nutrient contents of watermelon seed. *MOJ Food Processing Technology* 6(2):116-121.
- Phillippy, B.Q. and Wyatt, C. J.** 2001. Degradation of phytate in foods by phytases

- in fruit and vegetable extracts. *Journal of Food Science* 66(4): 535-539.
- Rasyid, A., Murniasih, T., Putra, M. Y., Pangestuti, R., Harahap, I. A., Untari, F., and Sembiring, S. B.** 2020. Evaluation of nutritional value of sea cucumber *Holothuria scabra* cultured in Bali, Indonesia. *Aquaculture, Aquarium, Conservation and Legislation* 13(4): 2083-2093.
- Reddy, M. B. and Love, M.** 1999. The impacts of food processing on the nutritional quality of vitamins and minerals. *Advances in Experimental Medicine and Biology* 459: 99-106.
- Rolnik, A. and Olas, B.** 2020. Vegetables from the Cucurbitaceae family and their products: Positive effect on human health. *Nutrition* 78: 110788.
- Saeedi, R., Sultana, A., and Rahman, K.** 2020. Ethnomedicinal uses and pharmacological activities of different parts of *Cucumis sativus* Linn: an update. *International Journal of Pharmaceutical Sciences and Research* 11(4):1549-1556.
- Salamah, A., Srihardyastutie, A., Prasetyawan, S. and Safitri, A.** 2019. Influence of mixed cultures of *Saccharomyces cerevisiae* and *Acetobacter aceti* for hydrolysis of tannins in the cabbage fermentation (*Brassica oleracea* L. var. capitata). In IOP Conference Series: Materials Science and Engineering (546 (6): 062028). IOP Publishing.
- Sambou, A., Samb, N., and Ayessou, N.** 2023. Nutritional values of green and white cucumber (*Cucumis sativus* L.) and African horned cucumber (*Cucumis metuliferus* E.). *Journal of Horticulture and Postharvest Research* 6(3): 221-234.
- Sánchez-Moreno, C., Larrauri, J. A., and Saura-Calixto, F.** 1998. A procedure to measure the antiradical efficiency of polyphenols. *Journal of the Science of Food and Agriculture* 76(2): 270-276.
- Setyawan, H. Y., Sukardi, S., and Puriwangi, C. A.** 2021. Phytochemicals properties of avocado seed: A review. In IOP Conference Series: *Earth and Environmental Science* 733 (1): 012090). IOP Publishing.
- Shaba, E. Y. Ndamitso, M. M., Mathew, J. T., Etsunyakpa, M. B., Tsado, A. N. and Muhammad, S. S.** 2015. Nutritional and anti-nutritional composition of date palm (*Phoenix dactylifera* L.) fruits sold in major markets of Minna, Niger State, Nigeria. *African Journal of Pure and Applied Chemistry* 9 (8):167-174.
- Shraim, A. M., Ahmed, T. A., Rahman, M. M., and Hijji, Y. M.** 2021. Determination of total flavonoid content by aluminium chloride assay: A critical evaluation. *LWT-Food Science and Technology* 150: 111932.
- Shyla, B., Mahadevaiah, and Nagendrapa, G.** 2011. A simple spectrophotometric method for the determination of phosphate in soil, detergents, water, bone and food samples through the formation of phosphomolybdate complex followed by its reduction with thiourea. *Spectrochimica acta. Part A, Molecular and Bimolecular Spectroscopy* 78(1): 497-502.
- Silva, F. M., Kramer, C. K., de Almeida, J. C., Steemburgo, T., Gross, J. L., and Azevedo, M. J.** 2013. Fibre intake and glycaemic control in patients with type 2 diabetes mellitus: a systematic review with meta-

- analysis of randomized controlled trials. *Nutrition reviews*, 71(12), 790–801.
- Singleton, V. L., Orthofer, R., and Lamuela-Raventós, R. M.** 1999. Analysis of total phenols and other oxidation substrates and antioxidants by means of Folin-Ciocalteu reagent. *Methods in Enzymology* 152–178.
- Siti, S. H., Muhd, H. M., Liliwirianis, N., Marlina, M. M., Rohaiza, S.** 2018. Studies on Phytochemical Constituents and Antimicrobial Properties of *Citrullus lanatus* Peels. *Malaysian Journal of Analytical Sciences* (22) 1: 151156.
- Soares, H.F. and Ito, M. K.** 2000. The monounsaturated fatty acid from avocado in the control of dyslipidemia. *Revista Ciências Médicas* 9(2):47-51.
- Sodimu, A.I., Usman, M. B., Oladele, N. O., Lapkat, L. G., Awobona, T. A. Suleiman, R.** 2020. Assessment of profitability of watermelon (*Citrullus lanatus*) in selected markets in parts of Kaduna Northern guinea savannah of Nigeria, *International Journal of Research Granthaalayah* 8(5): 121–125.
- Sofowora, A.** 1993. Medicinal plants and traditional medicine in Africa. Spectrum books Ltd. Ibadan, Nigerian. 289 pp.
- Tegen H, Alemayehu M, Alemayehu G, Abate E, Amare T.** 2021. Response of watermelon growth, yield, and quality to plant density and variety in Northwest Ethiopia. *Open Agric.* 6(1):655–672.
- Uba, A., Abdullahi, M. I., Yusuf, A. J., Ibrahim, Z.Y.Y., Lawal, M., Nasir, I. and Abdullah, F. T.** 2015. Mineral profile, proximate and amino acid composition of three date varieties (*Phoenix dactylifera* L.) *Der Pharma Chemica* 7(5):48-53.
- Uthpala, T. G. G., Marapana, R. A. U., Lakmini, K. P. C., and Wettimuny, D. C.** 2020. Nutritional bioactive compounds and health benefits of fresh and processed cucumber (*Cucumis sativus* L.). *Journal of Biotechnology* 3(9):75-82.
- Venkataramani, S., Kafle, A., Singh, M., Singh, S., Simpson, C., and Siebecker, M. G.** 2023. Greenhouse cultivation of cucumber (*Cucumis sativus* L.) in standard soilless media amended with biochar and compost. *HortScience* 58(9): 1035-1044.
- Vivek, K. B., Ji-Eun, K.M., Young-Ha P., and Sun, C.K.** 2017. In vitro pharmacological effectiveness of heat-treated cucumber (*Cucumis sativus* L.) juice against CCl<sub>4</sub>, induced detoxification in a rat model. *Indian Journal of Pharmaceutical Education and Research* 51(2):280-287.
- Watnick, M.** 2009. Hass avocado composition and potential health effects. *Critical Review in Food Science and Nutrition* 53(7): 738-750.
- Yahia, E. M., and Woolf, A. B.** 2011. Avocado (*Persea americana* Mill.). In Elhadi M. Yahia (Ed.), Postharvest biology and technology of tropical and subtropical fruits. Açai to citrus. First Edit. 2:125–186.

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