OXIDANTS AND ANTIOXIDANTS IN MEDICAL SCIENCE, 2018
VOL 7, NO. 2, PAGE 28–33
10.5455/oams.20180602010303

ORIGINAL ARTICLE

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Comparative antioxidants content of ripe and unripe fruits consumed in Sokoto Metropolis

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ABSTRACT

Introduction: Fruits are naturally plant products and juicy seed in nature that may be taken raw as food. They are readily available, accessible, and affordable in many environments and are naturally endowed with potentials of health benefits. Humans are persistently exposed to various oxidants capable of causing many degenerative diseases.
Methods: Antioxidants vitamin and flavonoids contents were determined in ripe and unripe mango, guava, cashew, black plum, and shea fruits using standard analytical methods.
Result: It was apparent that the ripening process affects antioxidants contents. The results proved that unripe *Anacardium occidentale* has the highest vitamin A and C among all the fruits analyzed, while the least concentration was detected in ripe *Psidium guajava* and *Vitex doniana*, respectively. Vitamin E appeared highest in ripe *V. doniana* and least in unripe *P. guajava*. Percentage flavonoids contents range from 0.81 to 15.02 with unripe *P. guajava* having the highest and *Vitellaria paradoxa* with the lowest value.
Conclusion: This work depicted that the fruits analyzed are good sources of vitamins A, C, and E, as well as flavonoids. Therefore, when consumed in adequate quantity, will improve the antioxidant defense system; hence, could be used in the management of many degenerative disorders or slow down the process of oxidative stress.

ARTICLE HISTORY

Received June 02, 2018
Accepted October 15, 2018
Published October 22, 2018

KEYWORDS

Antioxidants; fruits; ripening; oxidative stress

Introduction

Fruits are referred to as juicy seed-bearing structure of the flowering plant, which may be eaten as food and are important sources of vitamins, carbohydrates, fiber, and water [1]. They are also good sources of natural antioxidants which include carotenoid, phenolic compounds, flavonoids, dietary glutathione, and endogenous metabolites [2]. Mangoes, papayas, melons, oranges, grapes, and citrus fruits were reported to have high vitamin C content [3]. It has been reported that peaches, cantaloupe, apricots, and nectarines are rich sources of vitamin A. Whole fruits significantly possess more fiber than fruit juices. However, the canned fruits packed in syrup have a lot of added sugar with high calories than fresh fruits [3].

Antioxidants are the important disease-fighting agents. Living system is frequently exposed to various oxidizing agents and is equally inbuilt with antioxidants to cater for the free radicals generated from the oxidants, thus maintaining a balance between the production of free radicals and neutralization by antioxidants. Therefore, they help to prevent and repair the stress that comes from a natural process that occurs during normal cell functions. Free radicals are generated which can start a chain reaction that eventually harms many cells and possibly leads to many degenerative diseases [4]. Unchecked free radical activity has been linked to cancer, heart disease, aging, Alzheimer's disease, and Parkinson's disease [4]. Epidemiological studies have shown that the regular consumption of fruits reduces the risk of chronic diseases [5]. The protection conferred by fruits against some diseases has been attributed to the various antioxidant contents. Fruits have been shown to scavenge

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singlet and triplet oxygen, free radicals, and decompose peroxides [2]. Flavonoids and carotenes are the potential antioxidant compounds due to their ability to scavenge reactive oxygen species; hence, inhibit lipid peroxidation. Thus, diets rich in fruits are believed to play an important role in preventing diseases but the human choice of diet is driving by necessity and economy. Many of these plants were found to have a number of pharmacological actions and possible health benefits [2].

Ignorance on the importance of the balanced diet and the composition of the diets taken by Nigerians coupled with exposure to different kinds of toxic substances such as smoke and pesticide have distorted the redox status of the cell resulting to oxidative damage. The research was set to determine the antioxidant contents of commonly eaten fruits and possible changes that may occur between ripe and unripe fruits.

Materials and Methods

Materials

Equipment used were drying cabinet, spectrophotometer (model 721A spectrophotometer), and weighing balance (model 440: FEJ-300).

Reagents

Standard and analytical grade chemicals and reagents were used for the research.

Collection and authentication of fruits

Fresh ripe and unripe fruits were collected and identified by herbarium officer, Abdul-aziz Salihu of the Botany Unit of the Biological Sciences, Department of Usmanu Danfodiyo University, Sokoto. The following numbers were deposited: *Mangifera indica* (mango) UDUH/ANS/0261, *Psidium guajava* (guava) UDUH/ANS/0167, *Vitex doniana* (Black plum) UDUH/ANS/0264, *Anacardium occidentale* (cashew) UDUH/ANS/0263, and *Vitellaria paradoxa* (Shea Butter) UDUH/ANS/0248.

Sample preparation

The fresh fruits were crushed and shade dried and pulverized into coarsely powdered form and stored in airtight containers at room temperature until required.

Analyses

Determination of total flavonoid

Ten grams of the samples were soaked in 100 ml of 80% methanol at room temperature for 24 hours. The whole solution was filtered using Whatman No. 1 filter paper. The filtrate was transferred into a crucible and evaporated to dryness over a water bath and weighed [6].

Determination of vitamin A

Vitamin A was determined using the method of Rutkowski et al. [7].

Determination of vitamin C

Vitamin C was assayed by the method of Rutkowski and Grzegorczyk [8].

Determination of vitamin E

Vitamin E was estimated using the method of Rutkowski et al. [9].

Data analyses

Results were expressed as a mean ± standard deviation and presented in a tabular form. Analyses were done using in STAT software package 3.0 version (San Diego, CA). The comparison between groups was done using Students *t*-test, one-way analysis of variance was used within the group. Statistical significance was set at $p < 0.05$.

Results

The results showed the significant concentration of flavonoids and vitamins A, C, and E in both ripe and unripe fruits were analyzed. The detail of the results was presented in Tables 1 and 2 and Figures 1–4.

Table 1. Concentration of antioxidants in unripe fruits.

Parameters	Fruits				
	M. indica	*P. guajava*	*A. occidentale*	*V. doniana*	*V. paradoxa*
Vit. A (mg/dl)	73.05 ± 0.070^a	81.01 ± 0.015^b	81.00 ± 0.032^b	30.02 ± 0.040^c	81.01 ± 0.020^b
Vit. C (μM)	47.92 ± 0.043^a	21.81 ± 0.037^b	36.96 ± 0.020^c	5.25 ± 0.015^d	14.31 ± 0.015^e
Vit. E (mg/dl)	56.63 ± 0.010^a	12.06 ± 0.010^b	56.62 ± 0.015^a	51.65 ± 0.020^a	52.74 ± 0.020^a
Flavonoid (%)	8.02 ± 0.010^a	15.02 ± 0.015^b	6.04 ± 0.010^a	7.03 ± 0.020^a	7.02 ± 0.010^a

Values with different superscript in rows are statistically significant ($p < 0.05$). $N = 10$. Analyses were done in triplicate
M: Mangifera, *P: Psidium*, *A: Anacardium*, *V: Vitex*, *V: Vitellaria*, *Vit: Vitamin.*

Table 2. Concentrations of antioxidants in ripe fruits.

Parameters	Fruits				
	M. indica	*P. guajava*	*A. occidentale*	*V. doniana*	*V. paradoxa*
Vit. A (mg/dl)	58.02 ± 0.030[a]	29.99 ± 0.015[b]	89.01 ± 0.020[c]	48.03 ± 0.037[d]	49.33 ± 0.583[d]
Vit. C (µM)	13.49 ± 0.405[a]	13.91 ± 0.015[a]	55.74 ± 0.040[b]	5.52 ± 0.025[c]	21.44 ± 0.015[d]
Vit. E (mg/dl)	67.35 ± 0.010[a]	45.57 ± 0.020[b]	7.32 ± 0.020[c]	68.44 ± 0.010[a]	45.40 ± 0.010[b]
Flavonoid (%)	14.02 ± 0.015[a]	8.03 ± 0.020[b]	2.02 ± 0.010[c]	8.02 ± 0.005[b]	0.81 ± 0.015[d]

Values with different superscript in rows are statistically significant ($p < 0.05$). $N = 10$. Analyses were done in triplicate, *M: Mangifera*, *P: Psidium*, *A: Anacardium*, *V: Vitex*, *V: Vitellaria*, Vit: Vitamin.

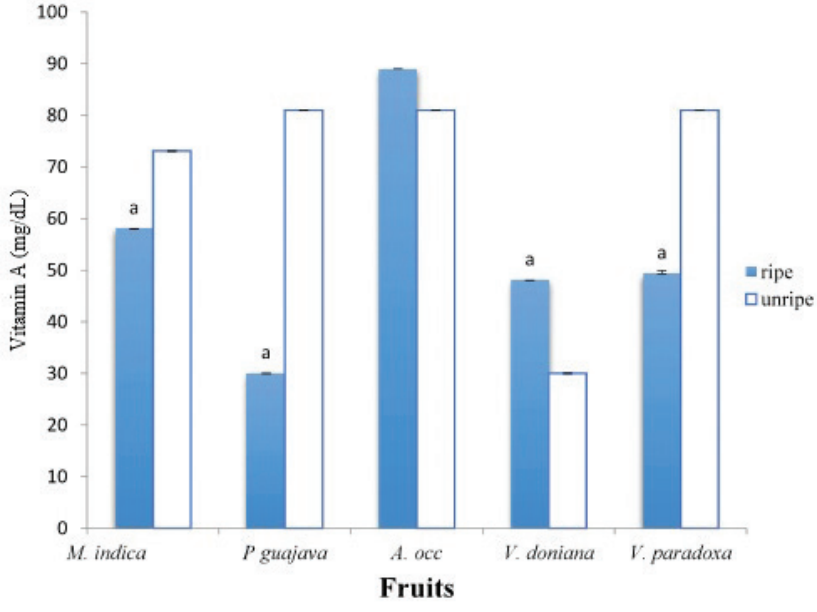

Figure 1. Concentrations of vitamin A in ripe and unripe fruits. Bars with different letters are statistically significant ($p < 0.05$), $N = 10$. Analyses were done in triplicate *M: Mangifera*, *P: Psidium*, *A. occ: Anacardium occidentale*, *V: Vitex*, *V: Vitellaria.*

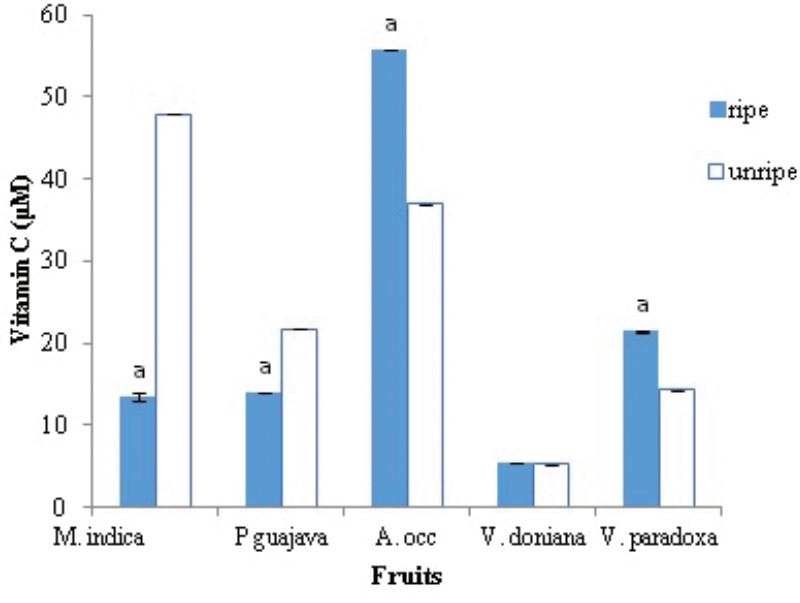

Figure 2. Concentration of vitamin C in ripe and unripe fruits. Bars with different letters are statistically significant ($p < 0.05$), $N = 10$. Analyses were done in triplicate *M: Mangifera*, *P: Psidium*, *A. occ: Anacardium occidentale*, *V: Vitex*, *V: Vitellaria.*

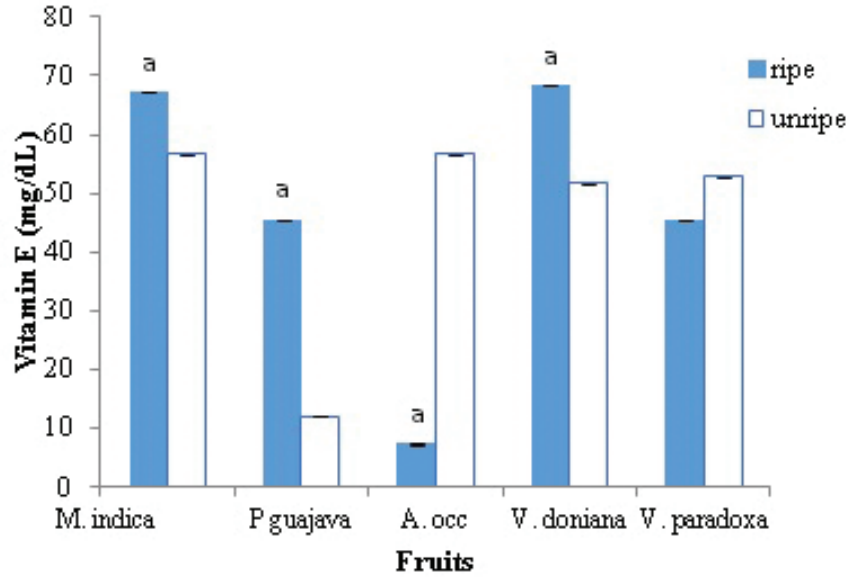

Figure 3. Concentration of vitamin E in ripe and unripe fruits. Bars with different letters are statistically significant ($p < 0.05$), $N = 10$, Analyses were done in triplicate *M: Mangifera*, *P: Psidium*, *A. occ: Anacardium occidentale*, *V: Vitex*, *V: Vitellaria.*

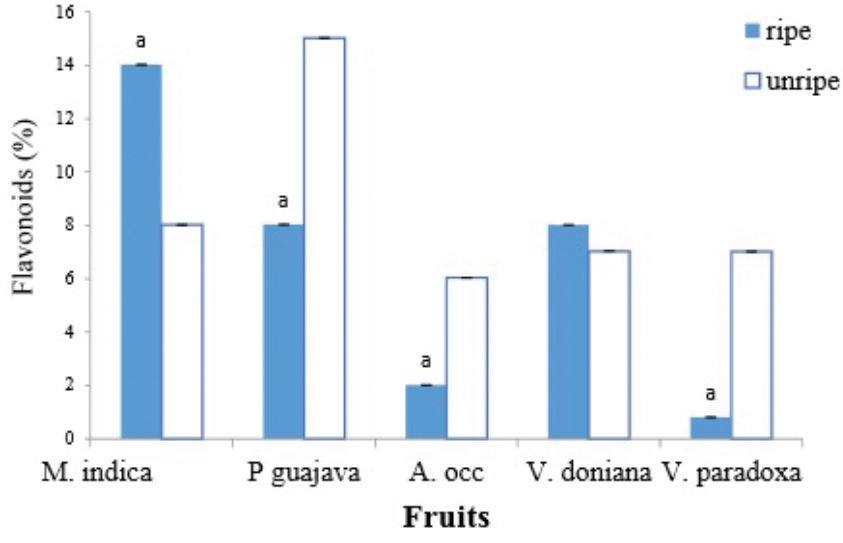

Figure 4. Total flavonoids in ripe and unripe fruits (%w/w). Bars with different letters are statistically significant ($p < 0.05$). *M: Mangifera*, *P: Psidium*, *A. occ: Anacardium occidentale*, *V: Vitex*, *V: Vitellaria*.

Discussion

Antioxidants are important biomolecules that help to prevent and repair the stress results from reactive oxygen species, generated due to either natural process that occurs during normal cell functions or from xenobiotics [10]. The present study compared the antioxidant vitamins and flavonoids content in unripe and ripe fruits. The appreciable amount of vitamins A and C was found in ripe *A. occidentale*. On the other hand, ripe *V. doniana* had the highest concentration of vitamin E. The unriped *P. guajava* had more percentage of flavonoids than other fruits.

Table 1 showed the concentration of antioxidants in unripe fruits. Vitamin A was found significantly high ($p < 0.05$) in unripe *P. guajava* and *A. occidentale* compared with other unripe fruits. A significant difference ($p < 0.05$) was observed in vitamin C contents among all the unripe fruits while vitamin E and flavonoids levels remained similar ($p > 0.05$) across the fruits. However, the concentration of *P. guajava* appeared significantly lower ($p < 0.05$). Table 2 compared the concentrations of

antioxidant vitamins and flavonoids in ripe fruits. The results showed the significant difference ($p < 0.05$) of vitamin A contents in all the ripe fruits analyzed with the similarity between *V. doniana* and *V. paradoxa*. Statistically similar amount ($p > 0.05$) of vitamin C was found in ripe *M. indica* and *P. guajava* but differed significantly ($p < 0.05$) in the midst of other ripe fruits. The appreciable amount of vitamin E was discovered in all the ripe fruits except *A. occidentale*. The percentage flavonoids contents were 14.02 ± 0.015, 8.03 ± 0.020, 2.02 ± 0.010, 8.02 ± 0.005, and 0.81 ± 0.015 for *M. indica*, *P. guajava*, *A. occidentalis*, *V. doniana*, and *V. paradoxa,* respectively.

The differences in antioxidants concentration observed among fruits (both ripe an unripe) could be as a result of differences in species, climatic conditions, maturity state, as well as handling and storage [11,12].

The results of the comparisons made between ripe and unripe fruits were presented in Figures 1–4. It was noted that the unripe *M. indica*, *P. guajava*, and *Phyllocrania paradoxa* had significantly high concentrations ($p < 0.05$) of vitamin A compared with ripe, whereas ripe *V. doniana* contains more vitamin A than unripe. Non-significant difference ($p > 0.05$) was observed between ripe and unripe *A. occidentale*. The level of vitamin C was significantly high ($p < 0.05$) in unripe *M. indica* and *P. guajava* compared with ripe while ripe *A. occidentale* and *V. paradoxa* contained high vitamin C compared with unripe. Similar amount of vitamin C was observed in ripe and unripe *V. doniana.* The result is contrary to the finding of Muhammad et al. [12] but in agreement to that of Nithiya and Rajeev [13]. The ripe *M. indica*, *P.guajava*, and *V. doniana* possess significantly ($p < 0.05$) more amount of vitamin E in comparison with ripe. On the other hand, unripe *A. occidentale* showed a high concentration of vitamin E than ripe while no statistical difference ($p > 0.05$) was observed between ripe and unripe *P. paradoxa.* High percentage flavonoids contents were revealed in unripe compared to ripe *P. guajava*, *A occidentale*, and *V. paradoxa*. The inconsistent decrease or increase in antioxidants content observed across the fruits could be due to ripening process and is in conformity with the results reported by Watada et al. [14] and Muhammed et al. [12].

From the results obtained, it was clear that the ripening process affects antioxidants contents as shown in Figures 1–4. Figure 1 indicates that both ripe and unripe fruits are a good source of vitamin A. However, unripe *A. occidentale* has the highest vitamins A and C among all the fruits analyzed, while least concentration was detected in ripe *P. guajava* and *V. doniana*, respectively. Vitamin E appeared as highest in ripe *V. doniana* and least in unripe *P.guajava*. Percentage flavonoids contents range from 0.81 to 15.02 with unripe *P. guajava* having the highest value and *V. paradoxa* with the lowest value.

The difference in antioxidants levels between ripe and unripe fruits could be associated with the ripening process which is known to be oxidatively stressful conditions in plants. Plant produces antioxidants as defensive mechanisms against biological and environmental stress [15].

Conclusion

Antioxidants vitamin and flavonoids contents were determined in mango, guava, cashew, black plum, and shea fruits. The results showed that these fruits are good sources of vitamins A, C, and E, as well as flavonoids. In fact, these fruits are readily available, assessable, and affordable environments so the appreciable amount of antioxidants determined from these fruits reveals that when consumed in adequate quantity, will bust the antioxidant defense system, hence could be used in the management of many degenerative disorders or delay the process of oxidative stress. No doubt, this research provides useful information to the human population in their quest for fruits with high antioxidants.

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