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RESEARCH ARTICLE

Total Phenolic Contents and Antioxidant Variations in Raw and Cooked Dried Fruit of *Xylopia aethiopica*

Oso BJ[1*] and Oladiji AT[2]

[1] Department of Biochemistry, Kings University, Odeomu, Osun State, Nigeria
[2] Department of Biochemistry, University of Ilorin, Ilorin, Kwara State, Nigeria

* Corresponding author email: basjoe08@gmail.com

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ABSTRACT

Most plant products undergo one or more different thermal processes before consumption despite the claims that cooking fruits and vegetables could have detrimental effects on the beneficial properties of the plants. This work investigated the changes in antioxidant status occurring in dried fruit of *Xylopia aethiopica* subjected to cooking at different temperatures. The analyses were performed on both raw and boiled samples to assess the total phenolic contents (TPCs) and the antioxidant potential through reduction of ferric chloride salt and bleaching of 1,1-diphenyl-2-picrylhydrazyl (DPPH) radical. The data obtained were subjected to analysis of variance and pairwise comparisons by Tukey-Kramer test at $p < 0.05$. There was a significant heat-trend difference between the phenolic contents of the samples at the selected temperatures with the highest TPC recorded at 70°C. Similarly, the ferric reducing potentials of the cooked samples were significantly different ($p < 0.05$) from the raw. However, uncooked samples had significantly ($p < 0.05$) higher percentage of DPPH radical scavenging activity compared to cooked samples. The overall effect of cooking the dried fruit of *X. aethiopica* was due to an elevation in total phenolics concentrations and reducing potentials of the aqueous infusions. However, boiling decreases the DPPH radical scavenging ability of the samples. Therefore, this study suggests an optimum cooking temperature of 70°C which could result in the highest retention of phenolic contents and ferric reducing potentials in the fruit of *X. aethiopica* and lowest appropriate temperature to conserve its intrinsic radical-scavenging activity in order to assure a higher quality food for the maintenance of human health. Moreover, losses in the phenolic contents and antioxidant potential should be considered when the procedural temperature during processing is unalterable.

Keywords: Thermal treatment, *Xylopia aethiopica*, total phenolic contents, antioxidant capacity, temperature.

1 Introduction

It is generally believed that diets with high antioxidant capacities might enhance improved health status, and thus, references to 'healthy' diets have pointed to the consumption of fruit and vegetables, most especially when defined on the theme of antioxidant and sound health. Consequently, dietetic antioxidants in fruits and vegetables have been receiving attention from researchers due to their beneficial effects on human health. The benefits associated with the consumptions of fruits and vegetables are more than the basic nutrition and scrumptiousness as they have been related to be the ideal way of enhancing antioxidant status. This is because they are presumed to be rich in vitamins, minerals, enzymes, phenolics, flavonoids and essential oils which are implicit in providing desired health as antioxidant compounds [1]. Consequently, they are believed to reduce the risk of degenerative diseases such as cancer and cardiovascular disease [2]. However, there have been assertions by the raw *foodists* that cooking fruits and vegetables might lead to loss of beneficial components and thus advocating consumption of raw fruits and vegetables [3]. Even when these claims sound convincing, the reality is that some fruits and vegetables are cooked before intake. *Xylopia aethiopica* is an angiosperm belonging to the family Annonaceae. The fruit is commonly called Negro pepper and used as a spice in culinary preparations of local condiments. Several studies had documented the biological activities of the plant which include antioxidant [4], antimicrobial [5], anticancer [6], analgesic [7], anti-fungal [8], anti-inflammatory [9], anti-protozoan [10] and anti-allergic [11]. It must be noted that these earlier reports were largely obtained from uncooked samples. Likewise, the traditional and culinary use of *X. aethiopica* mostly requires thermal treatment with the intention of obtaining non-toxic, hygienic and high-quality food products with satisfactory sensory attributes. Therefore, this work investigated the changes in antioxidant occurring in dried fruit of *X. aethiopica* subjected to different cooking processes.

2 Materials and Methods

2.1 Sample Preparation

Dried fruits of *X. aethiopica* (100g) were powdered and divided into four separate portions. Three portions were boiled separately in 25ml of distilled water in a covered conical flask for 10 minutes at 50, 70 and 90°C. The remaining portion was immersed in 25ml of distilled water and extracted without boiling. The samples were filtered on WhatmanTM #1.

2.2 Estimation of Total Phenolic Content

The total phenolic content (TPC) was estimated using the Folin-Ciocalteu method as described by Singleton et al. [12]. Exactly 1.0 ml of Folin-Ciocalteu reagent solution (1:10 v/v) was added to 0.5ml of each filtrate. The mixture was allowed to stand at room temperature of 30°C for 25 minutes. Afterward, 5ml of 7.5% sodium carbonate was added to the reaction mixture. After 20 minutes, the absorbance was measured at 725 nm. The values were expressed in mg /100 g dried weight (DW).

2.3 Ferric Reducing Antioxidant Potential (FRAP)

The reducing potentials of the filtrates were determined as described by Oyaizu [13]. The sample (0.5ml) was mixed with 1.5ml of 0.1M sodium phosphate buffer (pH 6.7) and 0.1ml of 1% potassium ferricyanide. The mixture was allowed to incubate at room temperature of 29°C for 30 minutes. Thereafter, 0.1ml of 5% trichloroacetic acid (TCA) was added to the reaction mixture. This mixture was centrifuged at 600×*g* for 5 minutes. Subsequently, 2ml of the supernatant was mixed with an equal volume of water and 0.5ml of 0.1% ferric chloride and the absorbance was read at 700nm. The reducing antioxidant property was calculated using ascorbic acid as the standard and the result was expressed in mg per 100g of the dried weight.

2.4 DPPH Radical Scavenging Activity

The ability of each of the filtrate to donate a hydrogen atom or an electron was determined through the bleaching of DPPH solution prepared in methanol as described by Shirwaikar *et al.* [14]. An aliquot of 1.50ml of the sample was added to 2 ml of 0.001 M DPPH in methanol. Absorbance at 517nm was measured after the reacting mixture had been left in the dark for 30 minutes. The percentage inhibition was calculated as follow:

$$\%\ \text{Inhibition} = \frac{\text{Absorbance of blank} - \text{Absorbance of sample}}{\text{Asorbance of blank}} \times 100$$

3 Results and Discussion

Results from this study revealed that thermal treatment enhanced the availability of total phenolic contents (TPCs) (Table 1). However, boiling at 90°C resulted in significantly ($p<0.05$) lower TPC than that of boiling at 70°C. Similarly, a study on antioxidant assessment based on the reduction of ferric salt showed that boiling significantly ($p<0.05$) increased the reducing antioxidant potential of the sample compared with the raw sample. However, slight but non-significant differences were noted as the temperature changes with boiling at 70°C showing the highest reducing antioxidant potential (Figure 1). However, a significant reduction ($p<0.05$) in the radical scavenging

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ability was observed after boiling compared with the raw filtrate (Figure 2).

Table 1: *Total phenolic contents of the dried fruit of X. aethiopica after heat treatments at different temperature*

Temperature	TPC mg/100g DW	% Increase in mean
50°C	743.86±10.63^{a}	73.70
70°C	1801.38±1.88^{b}	320.64
90°C	702.00±20.00^{c}	63.92
Raw	428.25±1.25^{d}	-

Data are means ± standard deviations of three determinations. Values with in a column with different superscripts differ significantly at p<0.05

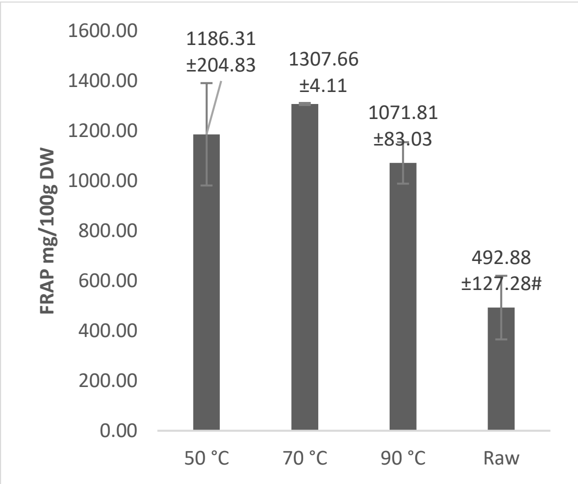

Figure 1: *Effect of cooking on ferric reducing antioxidant potential of the dried fruit of X. aethiopica. Data are means ± standard deviations of three determinations. # represents significant difference at p<0.05.*

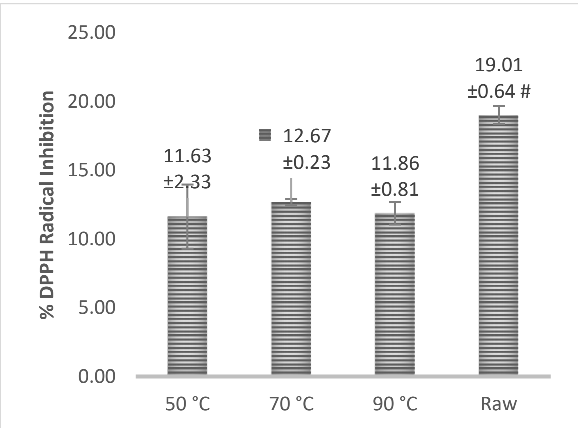

Figure 2: *Effect of DPPH radical scavenging potential of the dried fruit of X. aethiopica. Data are means ± standard deviations of three determinations. # represents significant difference at p<0.05*

There are several varieties of fruits and vegetables with varying degree of nutrients, antinutrients, anutrients, physicochemical properties, phytochemical components, fibrous contents and bioactivities. Even though some of these vegetables can be eaten raw, most of them undergo different cooking processes rather than being eaten raw. The proponents of *raw foodism* discourage cooking of fruits and vegetables ostensibly to retain the nutrients and the natural benefits of the vegetables for the reason that cooking decreases the bioavailability of nutrients as it enhances nutrient leaching into cooking water and also destroys heat- sensitive nutrients [3]. Consequently, thermal treatments of fruits and vegetables have thus been assumed to have a detrimental effect on their antioxidant values. Despite this advocacy, many tropical foods, especially spices, are usually consumed as cooked partly because culinary preparation of foods depends mostly on suitability and palate rather than nutrient value [15].

The present study revealed that the mean TPC increased after the sample was boiled. This observation is in agreement with the reports from other authors. Zambrano-Moreno et al. [16] reported significant increase in the total phenolic contents of eggplant after boiling. Equally short aquathermal treatment of five minutes at 80°C had been shown to have no detrimental effect on the total phenolic content of *Pterocarpus mildbraedii* and *Celosia argentea,* total flavonoid content and reducing power activity of *Piper guineense* but rather enhance the antioxidant value of the vegetables by increasing the bio-accessible phenolics and flavonoids [17]. The increase in the values of the TPC may be interconnected to increase in the liberation of phenolic compounds from the cellular matrix during the boiling process. This is because phenolic compounds are usually esterified with cell wall carbohydrates [18]. The enhancement of the total phenolic contents might invariably contribute to increase in the reducing power of the sample after cooking treatment. Besides, fat-soluble vitamins (A, D, E and K), phenolics, lycopene, flavonoids and various micronutrients in plant which have been found to become more bioavailable by cooking could also contribute largely to the antioxidant potentials of the fruit with respect to reducing potentials [19, 20]. Moreover, Maillard reaction products formed during thermal treatments could also contribute to increased reducing potentials after cooking [21]. However, cooking at a temperature of 90°C could lead to the destruction of the leached antioxidant compounds at a higher temperature as observed in the current report. This is in agreement with report that some phytochemicals become unstable and decreased with increased time and temperature when exposed to a cooking temperature of 90°C [22]. Similarly, there are reports of the decrease in total phenolics and total antioxidant values of some selected cruciferous vegetables blanched at 98°C [23].

In addition, the redox potential of antioxidant compounds in the sample could be influenced by several reactions during cooking condition as cooking could enhance formation or destruction of metabolites with redox potentials [24]. The reduction in the radical scavenging potential after cooking could be attributed to the perceived transformations in the redox potential of the sample. The cooking condition in this present study might be severely extreme for the sample as there are reports that some methods of treatments such as steaming could increase the radical scavenging potentials of botanicals [25, 26]. Moreover, disruption of plant cell walls during thermal treatment could also lead to the release of oxidative and hydrolytic enzymes that could rescind the antioxidant potentials in the samples. It is thus recommended to employ mild thermal treatment in processing procedures that require the use of the fruit of *X. aethiopica* and the losses in the phenolic contents and antioxidant potential should be considered when the technical temperature during processing is requisite.

4 Conclusion

The present study concludes that phenolic contents and antioxidant potentials of *X. aethiopica* were affected by cooking. Boiling at temperature of 70°C increased the phenolic contents and the ferric reducing potential in the fruit. However, the total phenolic content decreased at higher temperature of 90°C. Additionally, the study revealed that cooking at the temperatures of 50, 70 and 90°C could reduce the radical scavenging potentials in the fruit. Therefore, this study suggests an optimum cooking temperature, which could result in the highest retention of phenolic contents and ferric reducing potentials in the fruit of *X. aethiopica* and lowest appropriate temperature to conserve the radical-scavenging potential and assure a higher quality spice for the maintenance of human health.

5 Declarations

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5.2 Funding source

None

5.3 Competing interests

The authors declared no potential conflict of interest exists.

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